Software Requirement Specification Document for Smart Inventory

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Table 1: Document version history

Version	Date	Reason for Change
1.0	15-Jan-2024	SRS First version's specifications are defined.
1.1	7-April-2024	Prototype Update

GitHub: https://github.com/Farahhamed/SmartInventory

Contents

Abstract

In the realm of inventory management, traditional systems often necessitate extensive human involvement and consuming considerable time. Moreover, the susceptibility to human errors introduces an additional layer of complexity. To address these challenges, the proposed system advocates for the integration of Internet of Things (IoT) technology with inventory management practices, thereby streamlining operations for inventory owners. The envisioned smart inventory management system leverages Radio-Frequency Identification (RFID) tags strategically placed on products, vehicles facilitating transportation, and employees. This integration ensures precise tracking of inventory movements and elevates security measures. By harnessing machine learning algorithms, the system further augments its capabilities by offering sophisticated purchases forecasting. This data-driven approach provides strategic insights to optimize stock management, contributing to enhanced efficiency and accuracy in the inventory industry.

1 Introduction

1.1 Purpose of this document

The Software Requirements Specification (SRS) document outlines what the system will do and how it will work. It explains the main goals of the system and provides clear instructions for developers and everyone involved in building it. This document acts as a roadmap for the technical team, guiding them on how to create and integrate the different parts of the system. It also helps everyone understand what the system will be capable of once it's finished.

1.2 Scope of this document

This document covers the application's detailed description,including a thorough description of its functionalities, both functional and non-functional requirements,data designs, as well as a detailed analysis outlining the necessary classes and their relationships within the system.

1.3 Business Context

In today's rapidly evolving market, efficient inventory management is crucial for companies to meet customer demands, optimize resources, and maintain a competitive edge. Recognizing the transformative power of IoT (Internet of Things) technology, leading companies such as Amazon and Zara have successfully integrated IoT solutions into their inventory management processes, showcasing significant improvements in operational efficiency and customer satisfaction.

Amazon, As one of the world's largest e-commerce companies, Amazon extensively uses IoT technology in its inventory management. They employ RFID tags, and sensors to track inventory movement, monitor stock levels, and automate replenishment processes. This enables them to maintain accurate inventory data, optimize storage space, and ensure timely order fulfillment. [1]

Zara, a global fashion retailer, utilizes IoT technology to optimize inventory management and improve operational efficiency. They employ RFID tags on clothing items, enabling them to track

each item's location, movement, and sale. This real-time data allows Zara to streamline their inventory processes, reduce stock discrepancies, and respond quickly to changing customer demands. [2]

2 Similar Systems

2.1 Academic

This paper [3] addresses the challenge of accurately predicting spare parts inventory in the auto parts industry, particularly for components with large data and a short replacement cycle, the authors propose a prediction method based on Long Short-Term Memory (LSTM). The experimental verification of their approach demonstrates the effectiveness of the LSTM-based predictive model in efficiently adjusting auto parts inventory. This innovation ensures a prompt supply to the market, alleviating pressure from corresponding backlog and making a significant contribution to the determination of auto parts inventory and sales prediction.

This paper [4] discusses the potential of IoT-driven smart inventory systems in pharmacies. These systems, equipped with sensors and readers, aim to enhance operational visibility and provide seamless data reporting to pharmacists, enabling informed decision-making. The authors emphasize the challenges faced by pharmaceutical distribution companies in controlling inventory levels to prevent costs of excess or inadequate stock. They highlight the significance of efficient inventory management in meeting customer needs, avoiding stockouts, and ensuring patient well-being. The paper reviews existing literature, noting the limited exploration of IoT-enabled inventory management in the Cachar district. The proposed system integrates IoT to create an automated and continuous inventory linked to a real-time point-of-sale system. The use of RFID technology is suggested for tracking medicines throughout the supply chain, offering advantages over traditional methods such as barcodes. The authors present survey findings from retail pharmacies in the Cachar district, indicating a need for improved inventory systems, with most respondents facing challenges related to stock tracking and excess inventory. The proposed framework aims to address these challenges by automatically placing orders for restocking and preventing wastages. Real-time tracking, RFID tagging, and cloud-based inventory management contribute to enhanced visibility and efficiency in the proposed IoT-driven system, presenting a novel approach for the pharmaceutical retail industry.

In this paper [5], the authors propose a cost-effective solution for grocery inventory management using IoT devices. The system incorporates load cells and HX711 load cell amplifiers interfaced with NodeMCU to measure the weight of grocery containers. The load cell, a transducer converting mechanical energy to electrical output, is connected to a 24-bit ADC, providing digital load cell data. In paper proposed as a reference used the Smart Shelf that comprises two sections: weight sensing and level sensing. The NodeMCU, a Wi-Fi SoC, facilitates internet connectivity and acts as a powerful tool for Wi-Fi networking. The HX711 load cell amplifier module amplifies and converts the load cell's low electric output to digital form. The proposed system was effectively tested, and the cloud monitor displays insights in the form of a line chart. The system's potential includes creating multiple load cell prototypes for different grocery items, implementing

a SQL database for past records, and developing an application platform for live tracking, database access, and contacting vendors when items are running out of stock. The authors emphasize the system's cost-effectiveness, easy implementation, and support for the smart home initiative. They suggest its application in smart homes as an essential prototype for efficient grocery item identification and tracking.

2.2 Business Applications

Odoo inventory [6], Odoo Inventory is an inventory management software solution that helps businesses efficiently manage their inventory. It provides a centralized platform for monitoring stock levels, tracking movements, and optimizing warehouse operations. With features like multiple warehouse support and real-time stock tracking, businesses can streamline their inventory management processes. Odoo Inventory also offers seamless integration with other Odoo modules, enabling smooth coordination across departments and improving overall efficiency.

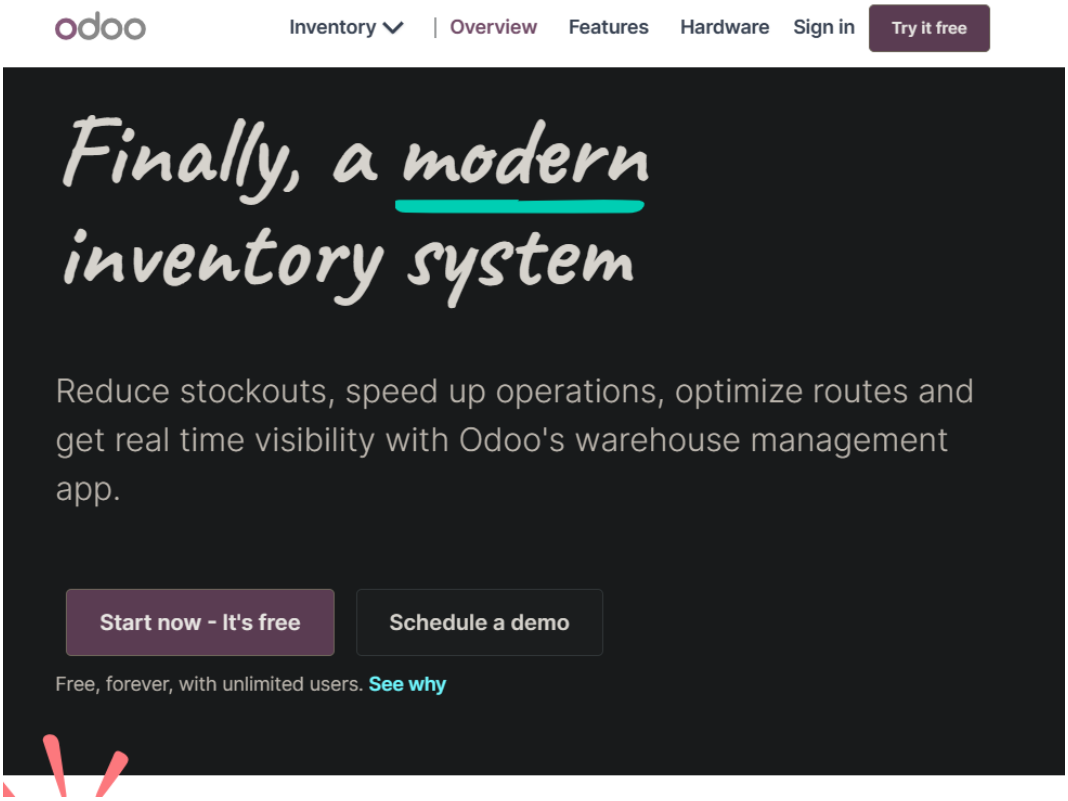

Figure 1: odoo inventory

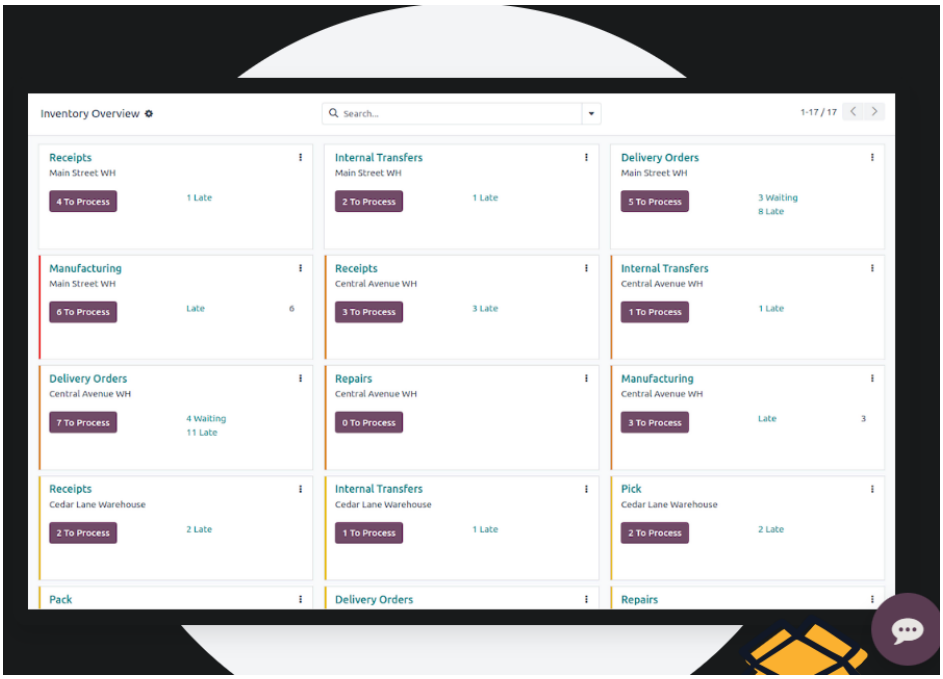

Figure 2: odoo interface snippet

3 System Description

3.1 Problem Statement

Traditional inventory management systems suffer from inefficiencies and inaccuracies. Manual processes hinder real-time visibility into inventory movements, leading to stockouts, overstocks, and misplacements. The absence of automated inventory counts and established stock control techniques results in suboptimal inventory management practices. Manual forecasting methods lead to inaccurate predictions and inefficient stock management. [7]

Our project, Smart Inventory, offers a comprehensive solution to address these challenges. by integrating IoT and forecasting capabilities into Odoo, a comprehensive business management software. By leveraging RFID tags on items and employees, the Smart Inventory system enables precise tracking of inventory movements through personnel access monitoring. This integration with Odoo allows us to make use of its ready-made features for inventory management, including stock control techniques and Customer Relationship Management (CRM) capabilities . We utilize machine learning for accurate purchase forecasting. With Smart Inventory, organizations can achieve streamlined inventory management, minimize costs, optimize stock levels, and enhance operational efficiency.[8][9]

3.2 System Overview

Our system provides automated inventory management for pharmaceuticals using Odoo ready made features and additionally integration with RFID and AI predictive model for demand.

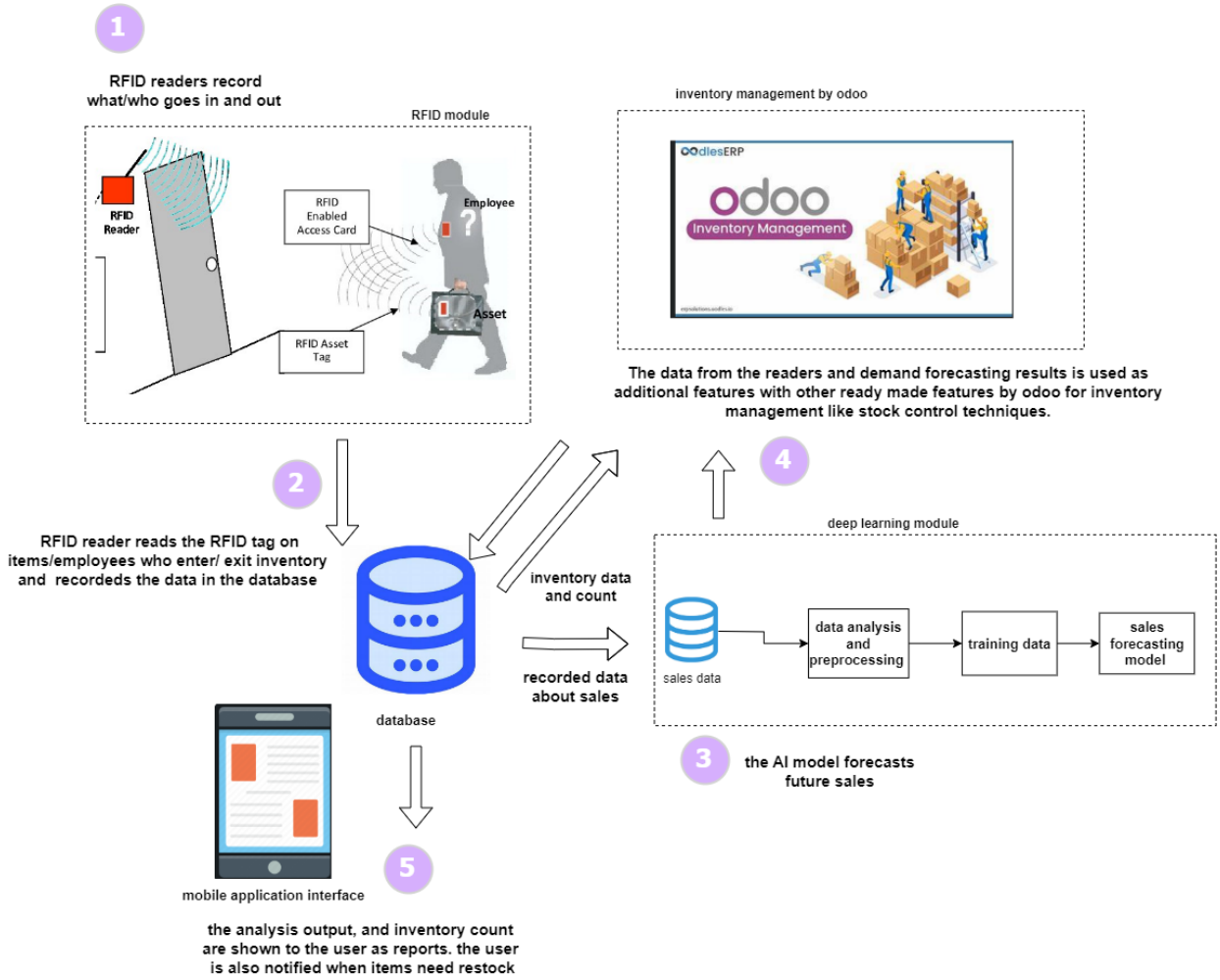

Figure 3: System Overview

1. RFID Tags and Readers:

- **Utilizing Radio-Frequency Identification (RFID) technology:** the system employs RFID tags affixed to inventory items and personnel, along with RFID readers strategically placed at entry and exit points.

- **Functionality:**

  - Enables real-time tracking of inventory movements.
  - Enhances security by monitoring personnel access.
  - Automates the tracking of items entering and leaving the inventory.

2. **Machine learning Demand Forecasting :**

The system incorporates advanced machine learning algorithms to predict future demand based on historical sales data, current trends, and external factors.

- **Functionality:**
  - Provides accurate, data-driven sales forecasts for informed decision-making.
  - Enables proactive stock management to meet customer needs efficiently.

3. Odoo:
The Odoo Inventory module is the central hub for managing inventory within the system.

- **Functionality:**
  - Allows easy configuration of inventory settings, including categories, units of measure, and warehouse configurations.
  - Offers robust reporting features for generating analytics on inventory levels and stock movements.
  - Facilitates data-driven decision-making with insights into inventory trends.

3.3 System Scope

Develop a Smart inventory management system with the following functionalities:

1. Implement RFID-based Inventory Tracking with RFID Tags on Goods.
2. Integrate RFID tags on employees to monitor personnel access and enhance security within the inventory management system.
3. Use Odoo's effective Stock Control Techniques.
4. Using machine learning algorithms to forecast future demand and provide strategic insights for stock management.
5. Enable business owner to track inventory levels in real-time.

3.4 System Context

The Smart Inventory Management System, as illustrated in Figure 4, seamlessly integrates RFID technology for efficient item tracking. Employees interact with the system by passing items through RFID-equipped gates, enabling the RFID readers to capture unique tag numbers. The captured data is stored in a centralized database and used by machine learning forecasting algorithms to predict inventory needs. Managers access an interface displaying both real-time RFID data and forecasting results, facilitating informed decision-making. Additionally, the system integrates with Odoo CRM, enhancing customer relationship insights. Overall, this integrated system, as depicted in Figure 4, optimizes inventory management, empowers decision-makers, and provides a holistic view of inventory and customer interactions.

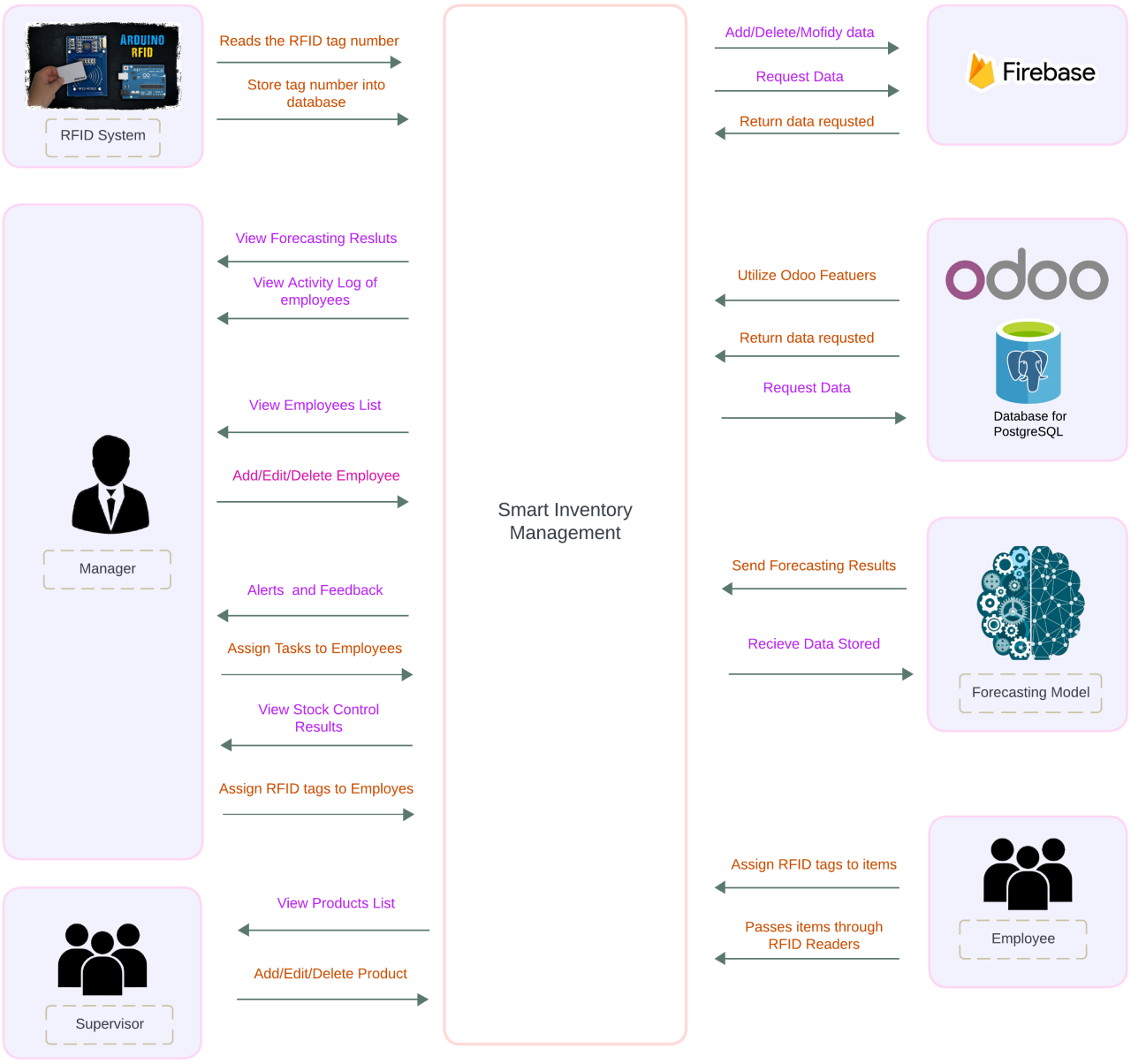

Figure 4: Context Diagram

3.5 Objectives

In our project we aim to :

- Implementing RFID technology to enable precise tracking of inventory movements.
- Enhance Security and Access Control with RFID Tags on Employees
- Automate Inventory Counts
- Utilize Odoo's stock control techniques, such as ABC analysis, EOQ, and FIFO, to optimize inventory management.
- Utilize Machine Learning for Purchase Forecasting
- Provide a user-friendly interface for businesses to access sales forecasts, optimize inventory levels, and monitor inventory-related activities.

3.6 User Characteristics

The primary target users of the system include inventory managers, warehouse supervisors, and administrative personnel involved in inventory control. Additionally, technicians responsible for system maintenance and integration will utilize the platform for operational support.

Moreover, the system is designed with a user-friendly interface to ensure ease of use for all stakeholders involved.

However, it is essential for all users to have:

- Proficiency in basic computer skills, including navigation through software interfaces and familiarity with online systems.
- Fundamental knowledge of inventory management practices, including terminology and processes.
- Familiarity with RFID technology and its applications within inventory management for efficient utilization of the system's capabilities

4 Functional Requirements

4.1 System Functions

Figure 5 Use-Case diagram demonstrates the system's functional requirements. The system comprises five user types: Manager, Employee, Forecasting Model, Odoo System and Supervisor

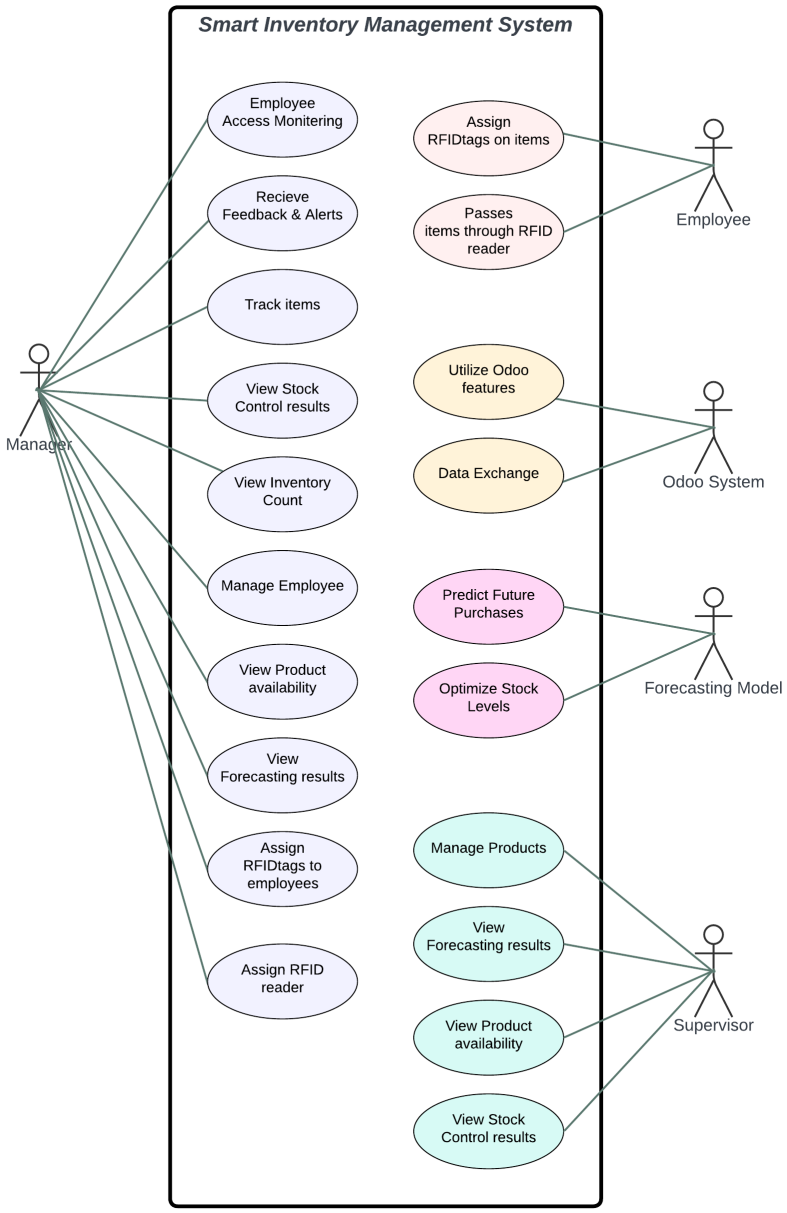

Figure 5: Use Case

General Requirements

1. Managers should be able to manage Employees'. (GR01)
2. The system should show inventory counts in real time.(GR02)
3. The system should record the data of the items entering or exiting inventory.(GR03)
4. The system should record the data of the Employees entering or exiting inventory.(GR04)
5. The system should be able to forecast future sales and provide insights to assist in stock control.(GR05)
6. The system should notify managers when a certain item reaches the purchase limit so that the managers can restock on time. (GR06)

Mobile Application for Managers

User Authentication (MA01)

- Managers should log in securely using credentials to access the mobile application.

Inventory Activity Logs (MA02)

- Managers must be able to view detailed logs of inventory activities, including entries, exits, and any associated transactions.

Real-time Activity Tracking (MA03)

- The mobile application should enable real-time tracking of system activities, providing managers with immediate insights into inventory movements.

System Feedback and Alerts (MA04)

- Managers should receive timely feedback and alerts on critical events, such as items reaching purchase limits or unauthorized access attempts.

Employee Access Monitoring (MA05)

- The application should facilitate monitoring of employee access, allowing managers to oversee and control access permissions.

Stock Control Techniques Results (MA06)

- Managers must have access to the results of stock control techniques, including ABC classification, EOQ calculations, and FIFO method recommendations.

Inventory Overview (MA07)

- The application should provide an intuitive interface for managers to view an overview of current inventory status, including stock levels and availability.

Employee Management (MA07)

- Managers should be able to manage employee data, including RFID tagging and access permissions through the mobile application.

Product Availability Check (MA08)

- Managers must be able to check the availability of specific products in real-time through the mobile application.

Employee Access Monitoring (MA09)

- Managers should actively monitor and control employee access, ensuring secure entry and exit of personnel within the system.

Feedback and Alerts (MA10)

- Managers should receive system feedback and alerts, keeping them informed of critical events and ensuring prompt decision-making.

Inventory Tracking (MA11)

- Managers must have the ability to track items within the inventory, allowing for efficient oversight of stock movements.

Stock Control Techniques Results (MA12)

- The manager should be able to view the results of stock control techniques, aiding in strategic decision-making for inventory management.

Machine Learning (ML) Actor

Sales Prediction (ML01)

- The ML component should analyze historical data and market trends to predict future sales accurately.

Stock Optimization (ML02)

- Utilizing predictive analytics, the ML component should optimize stock levels based on forecasted sales, preventing stockouts or overstocking.

RFID System

Tag Reading (RFID01)

- Reading RFID tags should be seamless, enabling quick and precise data retrieval from tagged items and employees.

Employee

RFID Tagging (EFR01)

- Employees should be able to use RFID tags for data input and verification, ensuring accurate tracking of their activities within the system.

Supervisor

Products Management (SP01)

- Supervisor can add, delete, and update products.

Odoo Actor

Comprehensive Business Management (OFR01)

- Odoo should serve as a comprehensive business management software, integrating seamlessly with the Smart Inventory system to enhance inventory and customer relationship management.

4.2 Detailed Functional Specification

Table 2: ManagingEmployees

Name	ManagingEmployees
Code	GR01
Priority	Critical
Critical	This function is critical as it ensures efficient operations, accurate RFID tagging, and compliance, and an organized environment.
Description	The manager should determine which employees have access to the inventory and when. Also, assign tasks to each employee.
Input	The RFID tag of the employee.
Output	The activity log of each employee on the mobile application.
Pre-condition	Managers are required to have an account on the mobile application. Required to have list of employees
Post-condition	View the activity log on the application.
Dependency	MA01

Table 3: InventoryCounts

Name	InventoryCounts
Code	GR02
Priority	Critical
Critical	This functionality is crucial to ensure that both the manager and inventory owner have access to comprehensive and up-to-date inventory counts.
Description	This function calculates the remaining stock of a specific item by analyzing its sales data, providing insights into the current inventory levels based on the quantity sold. It ensures accurate tracking of item availability and facilitates informed decision-making.
Input	RFID tags number on the items, and number of sold items from this product.
Output	The remaining items in the stock.
Pre-condition	Recorded sales history for a specific item is sent to the function.
Post-condition	The real-time count will appear on the mobile applications
Dependency	GR03

Table 4: RecordItemsData

Name	RecordItemsData
Code	GR03
Priority	Critical
Critical	This function is crucial to ensure that all data of the items' activity (entering and exiting items) inventory is recorded to be used in the other functions.
Description	Systematically capturing and storing comprehensive information about inventory items. This forms a foundational database crucial for informed decision-making and strategic planning within the system.
Input	RFID tags number of the item
Output	Non
Pre-condition	RFID tagging items
Post-condition	Storing data
Dependency	RFID01

Table 5: RecordEmployeesData

Name	RecordEmployeesData
Code	GR04
Priority	Critical
Critical	This function is crucial to ensure that all data of the employees" activity (entering and exiting items) inventory is recorded to be used in the other functions.
Description	Systematically capturing and storing comprehensive information about inventory employee's entering and exiting. This forms a foundational database crucial for informed decision-making and strategic planning within the system.
Input	RFID tags number of the Employee
Output	Non
Pre-condition	RFID tagging employees
Post-condition	Storing data
Dependency	RFID01

Table 6: ForecastFutureSales

Name	ForecastFutureSales
Code	GR05
Priority	Critical
Critical	This function is important to prevent or minimize the stock outs
Description	This vital function enables the system to predict future sales, offering valuable insights to enhance stock control measures. By anticipating demand trends, the system proactively prevents or minimizes stockouts in the inventory, ensuring a consistent and reliable supply to meet customer needs.
Input	Data of past sales
Output	Prediction of what item should be restocked
Pre-condition	RThe availability of historical sales data and accurate inventory records
Post-condition	Generates insightful predictions and recommendations for stock control.
Dependency	GR02 and GR03

Table 7: NotificationPurchaseLimit

Name	NotificationPurchaseLimit
Code	GR06
Priority	Critical
Critical	TThis critical function ensures that the system proactively alerts managers when a specific item reaches its predetermined purchase limit.
Description	By promptly notifying managers, the system enables timely and informed re-stocking decisions. This proactive notification mechanism prevents stockouts, ensuring a continuous and seamless supply chain, and empowers managers to maintain optimal inventory levels in accordance with defined limits.
Input	Forecasting Results
Output	Notification on the mobile application
Pre-condition	Real-time inventory data
Post-condition	System triggers timely alerts to managers when a specific item reaches its purchase limit
Dependency	GR05

5 Design Constraints

5.1 Standards Compliance

- **RFID Standards:** Ensure that the RFID tags and readers comply with industry standards (e.g., ISO 18000, EPCglobal) to guarantee interoperability and compatibility with other RFID systems.

5.2 Hardware Limitations

- **RFID Reader Range:** The range of RFID readers may be limited, and the system should be designed to accommodate this limitation. Consideration should be given to the layout of the physical space and the placement of RFID readers to ensure coverage.
- **Machine Learning Processing Power:** The hardware used for machine learning algorithms should be capable of handling the computational requirements for analyzing historical data and market trends. Ensure that the hardware is scalable to accommodate future increases in data volume and processing needs.

5.3 Integration Constraints

- **Odoo API Compatibility:** Ensure that the Smart Inventory system can seamlessly integrate with the version of Odoo being used by the business. Any updates or changes to Odoo should be considered to maintain compatibility.
- **Data Synchronization:** Address challenges related to real-time data synchronization between the Smart Inventory system and Odoo to maintain accuracy and consistency in inventory and CRM data.

5.4 Power Consumption

- **RFID Tag Power:** Some RFID tags may have limited battery life or rely on ambient energy sources. Consider power consumption constraints when selecting RFID tags to avoid frequent replacements or disruptions in tracking.

5.5 Integration Constraints

- **Odoo API Compatibility** Ensure that the Smart Inventory system can seamlessly integrate with the version of Odoo being used by the business. Any updates or changes to Odoo should be considered to maintain compatibility.
- **Data Synchronization (5.6):** Address challenges related to real-time data synchronization between the Smart Inventory system and Odoo to maintain accuracy and consistency in inventory and CRM data.

5.6 Power Consumption

- **RFID Tag Power** Some RFID tags may have limited battery life or rely on ambient energy sources. Consider power consumption constraints when selecting RFID tags to avoid frequent replacements or disruptions in tracking.

5.7 Environmental Factors

- **RFID Interference** Environmental factors, such as metal or dense materials, can interfere with RFID signals. Design the system to account for potential interference and ensure reliable tracking in various environments.

5.8 User Training and Adoption

- **Employee Training** The success of the system relies on employees understanding and using the technology correctly. Design constraints include the time and resources available for training employees on how to use the RFID system and interpret machine learning insights.

5.9 Cost Constraints

- **Budget Constraints** Consider budget limitations for hardware, software, and ongoing maintenance. Strive to design a cost-effective solution that aligns with the organization's financial resources.

5.10 Regulatory Compliance

- **Data Privacy Regulations** Compliance with data protection regulations is crucial, especially when dealing with personal and sensitive information. Ensure that the Smart Inventory system adheres to relevant legal and regulatory frameworks.

6 Non-functional Requirements

1. Performance
    - Accuracy: Ensuring a high level of accuracy in inventory tracking and purchase forecasting.
    - Scalability: Ability to handle a growing number of items, employees, and transactions without performance degradation.
2. Reliability
    - System Uptime: Ensuring the system is available and reliable for continuous inventory monitoring and forecasting.
3. Compatibility

- Compatibility with Devices: Ensuring compatibility with various RFID readers, devices, and operating systems.

4. Usability

   - User Training: Providing user training and support for efficient system utilization.
   - Accessibility: Designing an intuitive interface accessible to users of varying technical abilities.

5. Regulatory Compliance

   - Compliance with Standards: Ensuring compliance with industry standards and regulations related to inventory management and data privacy.

6. Security

   - Data Security: Safeguarding sensitive information related to inventory, personnel, and purchases.

7. Portability

   - Cross-Platform Compatibility: Developing the application using a cross-platform framework or technology stack to ensure it can run seamlessly on different operating systems..

7 Data Design

7.1 Dataset

Our dataset [10] is a time series dataset of item on pharmaceuticals. It consists of 4 columns:

- date
- store
- Item
- sales

913001 record.

7.2 Database

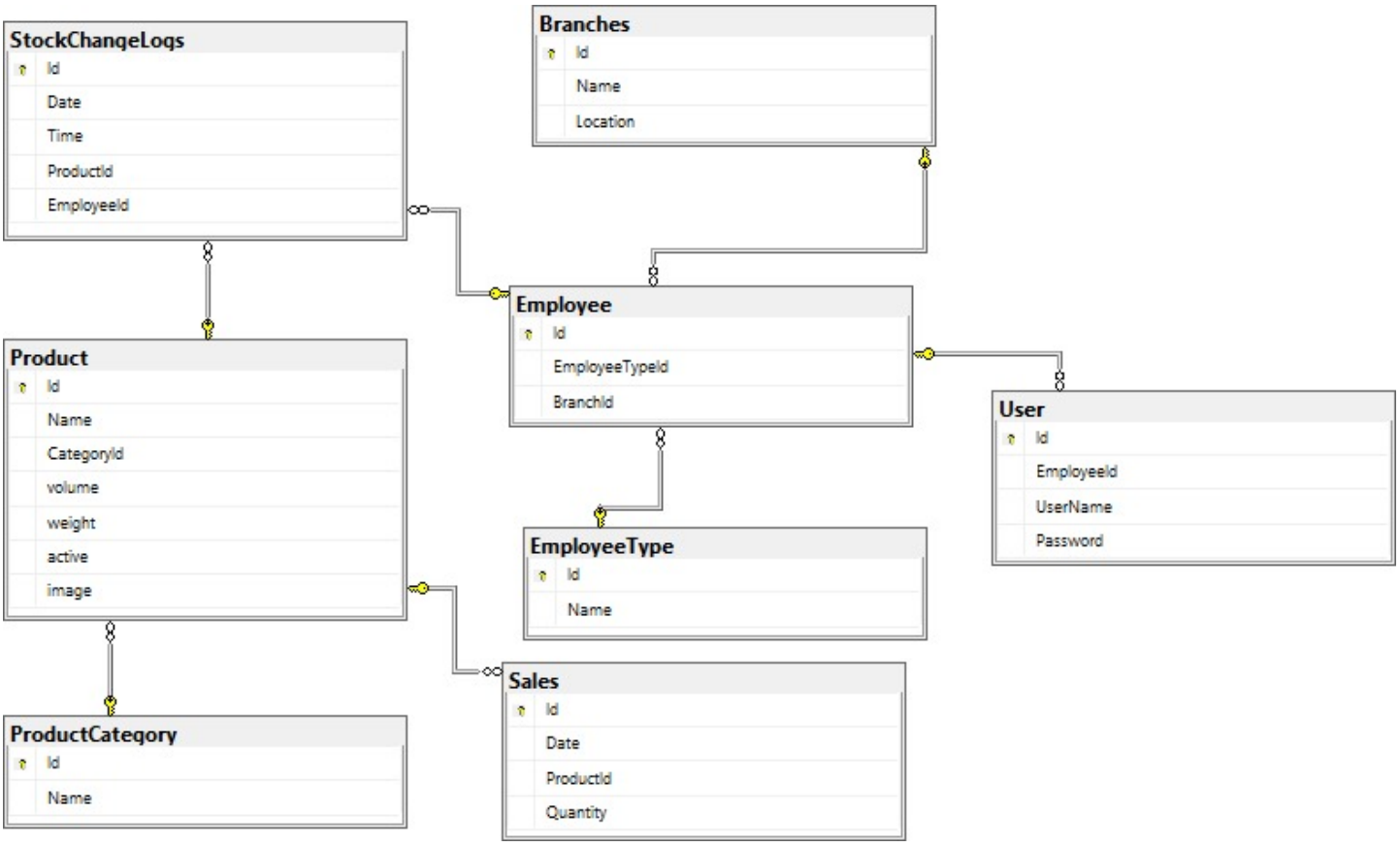

Figure 6: Database Schema

8 Preliminary Object-Oriented Domain Analysis

The initial Class Diagram of the system is found in Figure 7

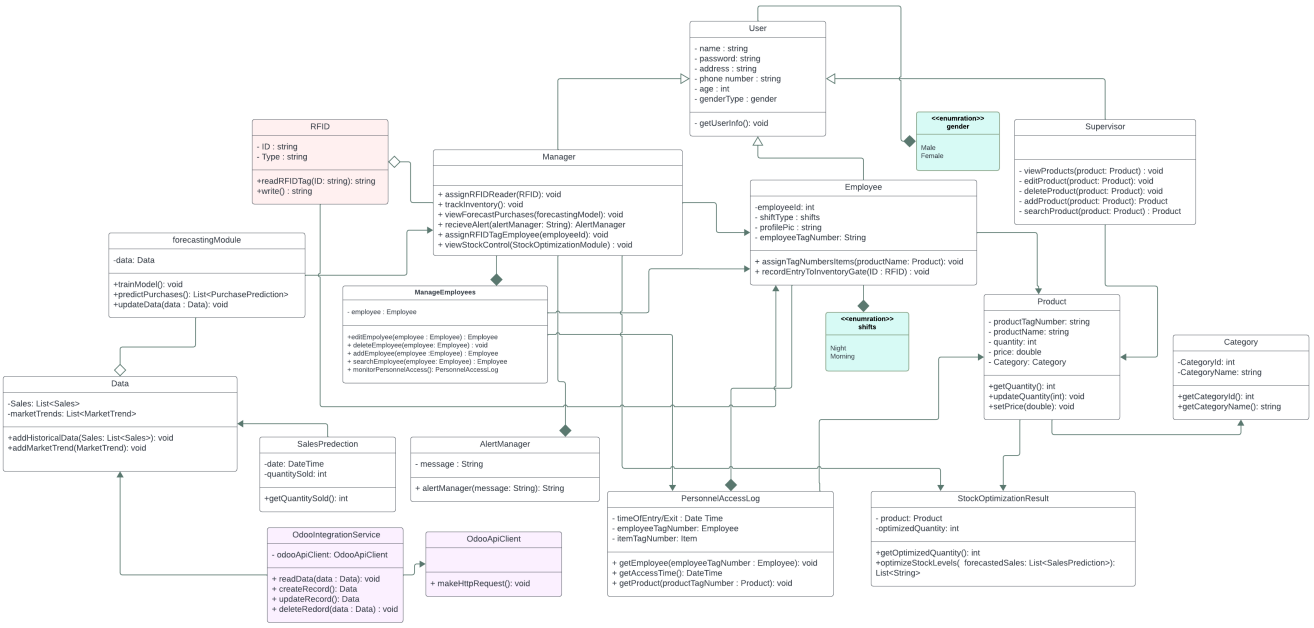

Figure 7: Class Diagram

9 Operational Scenarios

Scenario 1: Integration with Odoo

Assumption: Odoo integration is set up properly

Normal:

1. The mobile application integrates seamlessly with Odoo, establishing a connection for real-time data exchange.
2. The system verifies the integration, and administrators confirm successful setup.

What can go wrong:

1. Integration issues may arise, causing data inconsistencies between Smart Inventory and Odoo

Scenario 2 : Inventory Movement Tracking

Assumption: RFID tags are functioning correctly and actively tracking inventory movements.

Normal:

1. When an item or an employee moves within the inventory area, the system logs the movement, updating the item's and the employee's location

What can go wrong:

1. RFID tags may malfunction, causing inaccurate location tracking

Scenario 3 : New Item Addition

Assumption: Users have the necessary access rights to add new items.

Normal:

1. A user successfully adds a new item with its corresponding RFID tag to the system. The item details are accurately recorded , and the RFID tag is linked for tracking purposes.

What can go wrong:

1. Failed attempt to add a new item. RFID tag may not be properly configured, causing tracking issues.

Scenario 4 : Machine Learning Forecasting

Assumption: Smart Inventory's machine learning algorithms are trained and operational.

Normal:

1. The machine learning algorithms analyze historical data and market trends, providing accurate forecasts for future purchases to optimize stock levels.

What can go wrong:

1. Insufficient historical data may lead to inaccurate forecasts. Changes in market conditions that the model couldn't predict may also impact accuracy.

10 Project Plan

This time plan in Figure 8 and 9

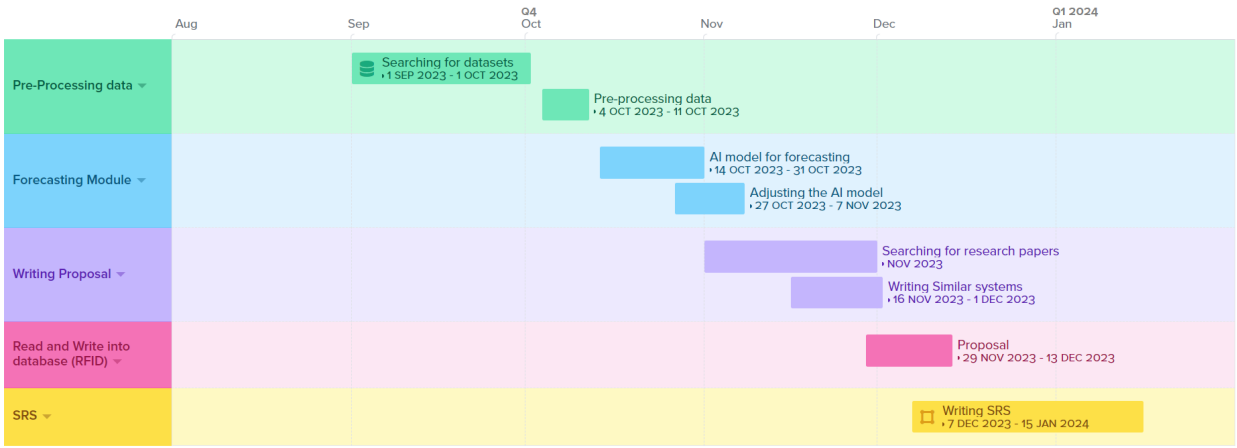

Figure 8: First Section in time plan

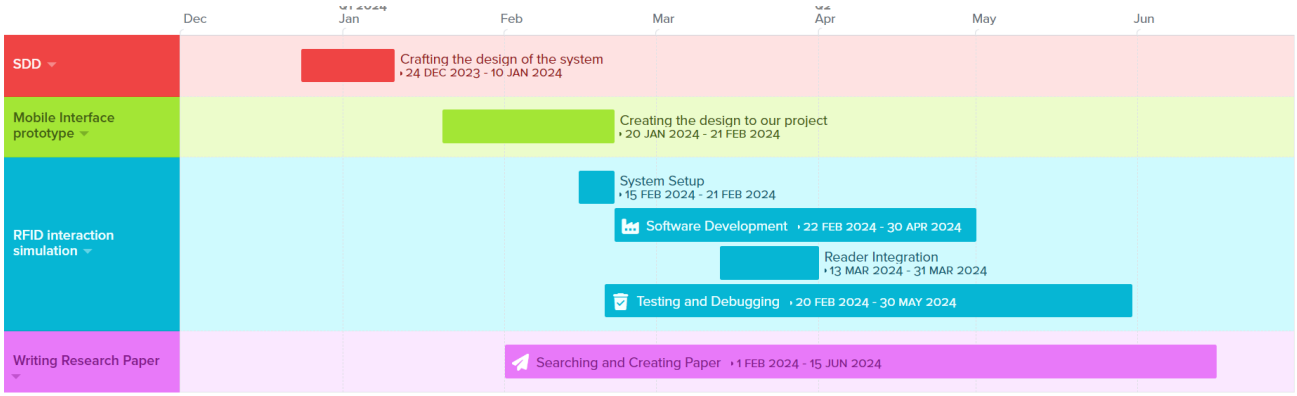

Figure 9: Second Section in time plan

11 Appendices

11.1 Definitions, Acronyms, Abbreviations

Table 8: Appendices

RFID	Radio-Frequency Identification - Technology for automatic identification and tracking using electromagnetic fields.
IoT	Internet of Things - Network of interconnected physical devices and objects.
ML	Machine Learning - Subset of AI enabling systems to learn from data.
LSTM	Long Short-Term Memory - Recurrent neural network architecture for learning long-term dependencies.
API	Application Programming Interface - Set of rules and protocols for software communication.

11.2 Supportive Documents

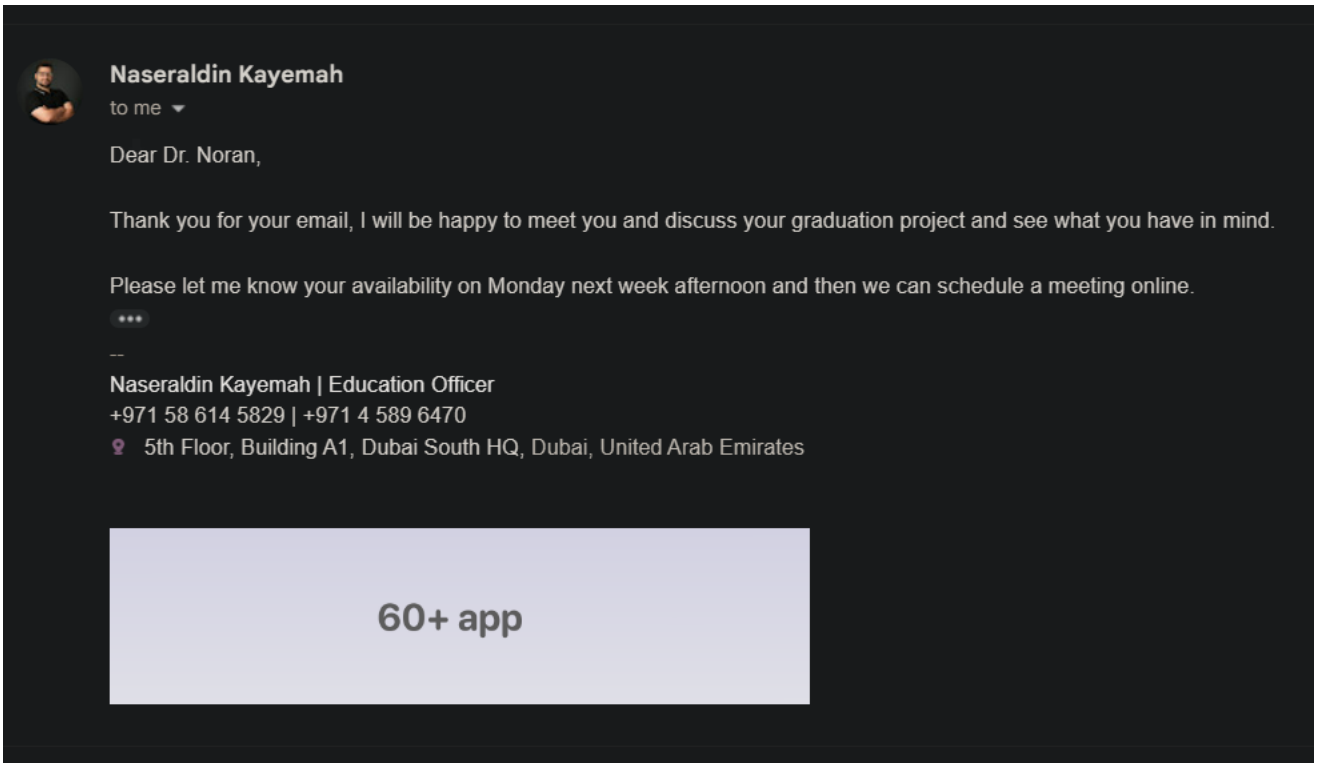

Figure 10: Odoo's mail

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