

Smart Pantry Manager

Capstone Project Report

END SEMESTER EVALUATION

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ABSTRACT

This report presents a comprehensive analysis of the Smart Pantry Manager, a mobile application designed to revolutionize household food management. The report delves into the technical aspects of the application, including the integration of Optical Character Recognition (OCR) for automated inventory updates, machine learning algorithms for personalized recipe recommendations, and real-time expiration date tracking to reduce food waste. It explores the benefits this technology brings to pantry management, such as enhancing efficiency in grocery shopping, providing personalized meal suggestions, and minimizing unnecessary waste.





The report also features case studies demonstrating the practical application of the Smart Pantry Manager in various household settings. These examples illustrate the system's effectiveness in reducing food waste, streamlining pantry management, and improving the overall efficiency of meal preparation.

By balancing the exploration of technical capabilities with practical applications, this report provides a comprehensive assessment of the Smart Pantry Manager's role in modern household management, emphasizing its potential to promote sustainable living and enhance everyday convenience.

DECLARATION

We hereby declare that the design principles and working prototype model of the Smart Pantry Manager is an authentic record of our own work carried out in the Computer Science and Engineering Department, TIET, Patiala, under the guidance of Dr. Rajesh Kumar. during 6th – 7th semester (2024).

Date: 19/12/2024

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1.1 Project Overview

1.1.1 Technical Terminology

- **OCR (Optical Character Recognition):** A technology used to extract text, such as item names, from scanned or photographed images of bills.
- **Expiry Date Tracking:** The ability to monitor and notify users of items nearing expiration.
- **Inventory Management:** Organizing, updating, or deleting pantry items based on availability or expiration.
- **Recipe Recommendation System:** A feature that suggests recipes based on available pantry ingredients.

1.1.2 Problem Statement:

A prevalent issue in household management is the inefficiency in tracking pantry inventory, often leading to unnecessary food waste and overstocking. This challenge is compounded by the significant problem of food waste, with uncertainty around expiration dates being a major contributor to domestic food waste. Such inefficiencies not only lead to a substantial waste of resources but also reflect the urgent need for a solution that can address these challenges effectively.

1.1.3 Goal

The goal of the *Smart Pantry Manager* is to:

- Provide an organized system for tracking pantry items.
- Reduce food wastage by reminding users of expiry dates.
- Simplify meal planning with recipe suggestions based on available ingredients.
- Promote sustainability and help users save money by managing grocery usage efficiently.

1.1.4 Proposed Solution:

The Smart Pantry Manager offers a comprehensive solution through a mobile application designed to revolutionize pantry management. Utilizing Optical Character Recognition (OCR) for seamless inventory updates, integrating food and recipe APIs for customized meal suggestions, and implementing an advanced expiry date tracking system, the app aims to minimize food waste and optimize grocery shopping. Additional features include user account creation for data synchronization across devices and the use of machine learning algorithms to refine recipe suggestions and shopping list predictions based on user feedback, making it a dynamic tool that evolves with its users' needs.

The Smart Pantry Manager stands as a pioneering solution, meticulously designed to tackle the inefficiencies of pantry management and the broader issue of food waste. By incorporating technological innovations such as OCR, expiry date tracking, and personalized recipe suggestions, this app significantly enhances the meal preparation process and optimizes kitchen operations. Its strategic use of machine learning algorithms further ensures that the app remains responsive to user preferences, offering a tailored experience that simplifies the complexities of modern household management. In addressing the critical challenges of food waste and pantry inefficiency, the Smart Pantry Manager not only represents a practical tool for families but also aligns with the growing movement towards sustainable living, making it an essential application for the conscious consumer.

1.2 Need Analysis

The global food waste challenge is both vast and urgent, with the United Nations Environment Programme (UNEP) reporting a staggering 931 million tonnes of food wasted annually, a figure that illuminates the critical need for solutions aimed at curbing this issue (UNEP, 2021). In India alone, the Food Safety and Standards Authority of India (FSSAI) estimates that one-third of all food produced is either wasted or spoiled before it can be consumed. This not only signifies a substantial loss of resources but also highlights the inefficiencies in household food management.



Fig:1.2.1 Need analysis chart

- **Inefficiency in Household Pantry Management:** Many households lack an effective system to track food inventory and expiry dates, leading to unnecessary waste and over-purchasing.
- **Fast-Paced and Busy Lifestyles:** In today's fast-paced world, consumers are looking for quick and convenient solutions to manage their daily tasks. A smart pantry management

system can cater to busy lifestyles by simplifying meal preparation and grocery shopping, saving time and reducing stress.

- **Demand for Sustainable Living Practices:** Increasing awareness and demand for sustainable lifestyle practices among consumers call for innovative solutions to reduce food waste and promote efficient food consumption.
- **Technological Advancement:** The potential of technology to address food management inefficiencies is discussed in "The Impact of Digital Technology on Consumer Purchase Behavior " (Grewal, Roggeveen, & Nordfält, 2017), which highlights the gap in applying these technologies to reduce food waste.
- **Need for Personalized Meal Planning:** There is a growing interest in personalized nutrition and meal planning, driven by health consciousness and busy lifestyles, requiring solutions that can suggest recipes based on existing pantry items.
- **Fragmented Market Solutions:** Existing pantry management solutions often lack comprehensive features, such as expiry date tracking, recipe suggestions, and user-friendly inventory management, indicating a gap in the market for a more integrated solution.
- **Adoption of Smart Home Technologies:** As smart home technologies become more prevalent, there is an opportunity to integrate pantry management solutions with other smart home systems, providing a more interconnected and automated approach to managing food and household tasks.
- **Economic Impact of Food Waste:** The economic implications of food waste for households are detailed in "The \$1 Trillion Mountain: The Actual Cost of Food Waste" (FAO, 2013), underscoring the financial benefits of reducing food waste through effective management tools.

1.3 Research Gaps

- **Limited Integration of Expiry Date Tracking with Personalized Recommendations:** Although there are solutions that track expiration dates, there is a lack of comprehensive systems that integrate expiry date tracking with personalized recipe suggestions. Most existing tools focus either on inventory management or recipe suggestions but fail to

combine these with real-time tracking of food expiry to reduce waste effectively.

- **Contextual Understanding of Ingredient Substitutions:**

Existing recipe recommendation systems often lack the ability to suggest suitable ingredient substitutions based on the context of the recipe and pantry availability.

There is insufficient research on algorithms that can dynamically suggest substitutions while maintaining the integrity of the dish.

- **Lack of User-Centered Design in Pantry Management Applications:**

Existing pantry management applications often lack a user-centered design approach, making them difficult to use and unattractive to the average consumer. There is a gap in the research focusing on the user experience (UX) and the need for more intuitive, user-friendly interfaces that can increase adoption and consistent use of these tools.

- **Scalability of Machine Learning Models for Large-Scale Recipe Data:**

The scalability of machine learning models used in recipe recommendation systems is a challenge, especially when dealing with large and diverse datasets. The ability to efficiently process and make predictions from vast ingredient and recipe databases is not yet fully optimized.

- **Fragmented Market Solutions and Lack of Comprehensive Systems:**

The current market is fragmented, with various tools addressing parts of the pantry management problem, such as inventory tracking or recipe suggestions, but few offer a comprehensive solution. There is a research gap in developing an integrated system that combines all necessary features, including OCR, expiry date tracking, personalized recommendations, and machine learning, into one seamless application.

These research gaps highlight the need for advancements in algorithms, personalization, and technology integration to enhance the functionality and user experience of smart pantry management systems. By addressing these gaps, the app can offer more accurate, efficient, and user-friendly solutions for pantry management and meal planning.

1.4 Problem Definition and Scope

Problem Definition:

A prevalent issue in household management is the inefficiency in tracking pantry inventory, often leading to unnecessary food waste and overstocking.

This challenge is compounded by the significant problem of food waste, with uncertainty around expiration dates being a major

contributor to domestic food waste. Such inefficiencies not only lead to a substantial waste of resources but also reflect the urgent need for a solution that can address these challenges effectively.

Scope:

The "Smart Pantry Manager" project aims to develop a mobile application that addresses the inefficiencies in household pantry management. The app will integrate key features, including Optical Character Recognition (OCR) for automated inventory updates, real-time tracking of expiration dates, and personalized recipe suggestions using food and recipe APIs. Additionally, it will leverage machine learning algorithms to offer tailored shopping lists and meal planning based on user preferences and inventory data. The app will also support user accounts for data synchronization across devices, ensuring all household members have access to up-to-date information. By providing a comprehensive and user-friendly solution, the Smart Pantry Manager will help busy households reduce food waste, optimize grocery shopping, and enhance meal preparation, aligning with the growing demand for sustainable living practices.

1.5 Assumptions and Constraints

S.NO	Assumptions
1	It is assumed that all target users possess a smartphone or similar mobile device capable of running the Smart Pantry Manager application.
2	A stable internet connection is presumed necessary for optimal app functionality, enabling data synchronization and access to external food and recipe databases.
3	Accurate and up-to-date inventory information is essential for effective pantry management. It is assumed that users will diligently input and maintain inventory details within the app.
4	The system presumes active user engagement with the app to leverage personalized features, including recipe suggestions and grocery lists.
5	It is assumed that the device cameras utilized for receipt or bill image capture are of sufficient quality to produce clear and usable images for data extraction.
6	The system relies on the assumption that timely notifications regarding product expiration dates will effectively encourage users to consume or discard items accordingly, minimizing food waste.

Table:1.5.1 Assumptions

S. No	Constraints:
1	The system relies on external food and recipe data. Fluctuations in data quality can impact meal suggestions.
2	Protecting user privacy is paramount. Robust security measures must be implemented.
3	The app's performance may be affected by device variations. Compatibility issues could hinder user experience.
4	Accurate inventory data is crucial for optimal system performance. User errors can lead to discrepancies.
5	Machine learning models require ongoing refinement. Algorithm accuracy impacts recipe and shopping list suggestions.
6	User engagement and adoption of new habits influence the app's effectiveness in reducing food waste.

Table:1.5.2 Constraints

1.6 Standards

1. Coding

[1] Dart Programming Language Specification, Dart 2.12, 2021.

2. Design

[2] Material Design Guidelines, Google Design, 2018.

3. Security

[3] OWASP Mobile Security Testing Guide, MSTG v1.3, 2022.

4. Data Management

[4] General Data Protection Regulation (GDPR), Regulation (EU) 2016/679, 2016.

5. Software Development

[5] Continuous Integration and Continuous Deployment (CI/CD), IEEE standard 29119-3, 2013.

6. Accessibility

[6] Web Content Accessibility Guidelines (WCAG), ISO/IEC 40500-2012, 2018.

1.7 Objectives

- **Functional Pantry Management:**

Ensure the application's functionality allows users to adeptly add, remove, and manage pantry items using diverse methods such as manual input, receipt scanning, and checkbox selection.

- **Effective Expiry Date Handling:**

Institute a dependable system for users to manually input or utilize a calendar feature to specify expiry or scan expiration dates for items. Develop a color-coded representation feature to alert users about impending or expired items, with the overarching goal of minimizing food waste through meticulous expiry date tracking. Notably, items with a brief shelf life, such as bread or milk, may possess a pre-determined expiry date from the item's entry date.

- **Recipe Generation and Recommendation:**

Construct a robust algorithm or integrate external APIs to derive precise recipe suggestions based on the available items in the user's pantry. This algorithm should consider dietary preferences and cooking time, aiming to facilitate meal planning by offering tailored recipes aligned with the user's inventory.

1.8 Methodology

Requirements Analysis:

- Conduct a thorough analysis of the requirements, including user stories, features, and functionalities.
- Identify the key components needed for successful pantry management, receipt scanning, expiry date handling, and recipe generation.

Technology Stack Selection:

- Choose the appropriate technologies for each aspect of the project.
- Select a reliable OCR library for bill scanning.
- Opt for Flutter for cross-platform mobile app development.

Data Collection and Preprocessing:

- Gather a diverse dataset for recipe analysis, ensuring it covers a wide range of cuisines and dietary preferences.
- Preprocess the dataset to extract relevant information, such as ingredients, cooking instructions, and dietary labels.

OCR Implementation:

- Integrate OCR functionality for bill scanning and expiry date extraction.
- Test the OCR system with various bill formats and product labels to ensure accuracy.

Machine Learning Model Development:

- Design and implement a machine learning algorithm for recipe recommendation based on pantry items or use of Restful API for recipe generation.

- Train the model using the preprocessed recipe dataset and fine-tune it for improved accuracy.

App Development with Flutter:

- Utilize Flutter to develop a user-friendly and visually appealing mobile app.
- Implement features for manual item entry, receipt scanning, checkbox selection, and expiration date management.

Integration of Components:

- Establish seamless integration between the OCR module, ML algorithm, and the Flutter app.
- Develop clear communication channels and data exchange mechanisms between different components.

User Testing and Feedback

- Conduct iterative user testing throughout the development process.
- Gather feedback on the app's usability, accuracy of scanned information, and effectiveness of recipe recommendations.
- Iterate on the app based on user feedback to improve overall user experience.

Error Handling and Optimization:

- Implement robust error handling mechanisms for potential issues with OCR, ML algorithms, and app functionalities.
- Optimize the performance of the app and algorithms for responsiveness and efficiency.

Documentation:

- Document the entire methodology, including technology choices, implementation details, and testing procedures.
- Create user manuals and developer documentation for future reference.

1.9 Project Outcomes and Deliverables

- **Smart Pantry Manager Mobile Application:**

A fully functional mobile application equipped with features for pantry management, expiry date tracking, recipe generation, and user-friendly interface.

- **Documentation Package:**

Comprehensive documentation covering methodology, technology choices, implementation details, testing procedures, user manuals, and developer documentation.

- **Optimized OCR System:**

A robust OCR system integrated into the app for receipt scanning.

- **Machine Learning Model:**

Developed machine learning algorithm for recipe recommendation based on pantry items, tailored to user preferences.

These accomplishments collectively aim to yield a substantial reduction in food waste, streamlined grocery shopping, and enhanced meal preparation method, making the Smart Pantry Manager an indispensable tool for modern households.

1.10 Novelty of Work

The Smart Pantry Manager project stands out with its innovative integration of OCR technology, allowing users to effortlessly update their pantry inventory by scanning grocery receipts, significantly reducing manual entry errors. It further distinguishes itself with versatile expiry date tracking options—calendar selection, package scanning, or voice input—coupled with notifications for expiring items, streamlining the process to minimize food waste. The app's unique recipe suggestion engine, powered by food and recipe APIs, tailors meal plans based on available pantry items, promoting efficient food utilization.

A key feature includes a user-friendly interface for account creation and data synchronization

across devices, ensuring a cohesive experience for managing pantry information. Additionally, the application employs machine learning algorithms to refine recipe suggestions and shopping lists, adapting to user preferences for a personalized experience.

Moreover, the Smart Pantry Manager integrates a rewards system, incentivizing user engagement through gamification. By completing tasks like updating the pantry or using suggested recipes, users earn points redeemable for discounts at partner stores, enhancing the app's appeal and encouraging sustainable food management practices. This comprehensive approach to pantry management, combining technological advancements with a focus on user engagement and sustainability, positions the Smart Pantry Manager as a novel solution in the realm of food management apps.

2. Requirement Analysis

2.1 Literature Survey

S. No.	Roll Number	Name	Paper Title	Tools/ Technology	Findings	Citation
1	102103227	Anchal	Deep Learning based approach to suggest recipes	Deep learning models for recipe suggestion	The paper presents a deep learning model that suggests recipes based on certain criteria, detailing the model's performance and user satisfaction.	https://www.researchgate.net/publication/329064063_Deep_Learning_based_approach_to_suggest_recipes
2			Deep Reinforcement Learning for Perishable Inventory Optimization Problem	Deep reinforcement learning algorithms	The paper discusses the application of deep reinforcement learning to optimize inventory management, particularly for perishable goods, highlighting the algorithm's effectiveness in reducing waste and improving efficiency.	https://ieeexplore.ieee.org/document/10406759
3			OCR using CRNN: A Deep Learning Approach for Text Recognition	Convolutional Recurrent Neural Network (CRNN) for OCR.	The paper discusses the use of CRNN in OCR, focusing on text recognition, and may include the model's accuracy, speed, and comparison with traditional OCR methods.	https://ieeexplore.ieee.org/document/10170436
1	102103396	Chetna	A Clean Approach to Flutter Development through the Flutter Clean Architecture Package	Flutter Clean Architecture Package.	The paper explains how the Flutter Clean Architecture Package can be used to develop clean, maintainable, and scalable Flutter applications, potentially including case studies or best practices.	https://www.researchgate.net/publication/340813389_A_Clean_Approach_to_Flutter_Development_through_the_Flutter_Clean_Architecture_Package
2			Software Engineering Issues for Mobile Application Development	Agile processes and Development Environment	This paper provides an <u>overview of</u> important software engineering research issues related to the development of applications that run on mobile devices. Among the <u>topics are</u> development processes, tools, <u>user interface design</u> , application portability, quality, and security.	https://www.researchgate.net/publication/221560176_Software_engineering_issues_for_mobile_application_development

S. No.	Roll Number	Name	Paper Title	Tools/ Technology	Findings	Citation
1	102103419	Prachi Kumar	A Comprehensive Study of Optical Character Recognition	Deep learning models for recipe suggestion	The paper provides an in-depth analysis of OCR technology, its applications, challenges, and advancements.	https://ieeexplore.ieee.org/document/9837974
2			ChefAI.IN: Generating Indian Recipes with AI Algorithm	Artificial Intelligence (AI) algorithms,	The paper discusses the development and findings of an AI system designed to generate Indian recipes, potentially including the system's accuracy, creativity, and cultural relevance.	https://ieeexplore.ieee.org/document/10041463
3			<u>AutoChef</u> : Automated Generation of Cooking Recipes	involves AI and machine learning for recipe generation.	The paper introduces <u>AutoChef</u> , a system for automatically generating cooking recipes, possibly discussing its methodology, success rate, and user feedback.	https://ieeexplore.ieee.org/document/9185605
1	102103291	Sukhmanjot Kaur	Application of Firebase in Android App Development -A Study	Flutter , Firebase	Firebase, excels in managing unstructured data with its JSON format and flexible schema, unlike traditional RDBMS. Key Firebase features include Analytics, Cloud Messaging (FCM), Auth, Real-time Database, Storage, Crash Reporting, and Notifications. The paper contrasts Firebase with SQL , emphasizing differences in data storage and schema flexibility	Khawas, C., & Shah, P. (2018). Application of Firebase in Android App Development - A Study. <i>International Journal of Computer Applications</i> , 179(46), 49-54.

Table 2.1 Literature Survey

2.1.1 Related Work

Several studies and systems have been developed to address pantry management and food waste reduction using technology. Existing solutions can be categorized into traditional inventory apps, smart fridge systems, and emerging IoT-based technologies:

1. **Traditional Inventory Management Apps:** Applications like *Pantry Check* and *Out of Milk* allow users to manually input food items, track expiration dates, and manage inventory. While these tools are useful, they rely heavily on manual input, which can be tedious and lead to poor user engagement.
2. **Smart Refrigerator Systems:** High-end smart fridges, such as Samsung's Family Hub, come equipped with cameras, barcode scanners, and inventory tracking systems. These technologies automate pantry monitoring but are expensive and limited to the refrigerator space.
3. **Recipe Recommendation Systems:** Platforms like *SuperCook* and *KitchenPal* integrate inventory management with recipe generation, helping users make better use of available food. However, these systems often do not include automated inventory updates or advanced analytics.

Despite these advancements, existing systems lack an integrated, affordable, and user-friendly approach that combines automated inventory tracking, predictive analytics, and personalized suggestions.

2.1.2 Research Gaps of Existing Literature

A review of existing literature and systems reveals key gaps that limit their effectiveness and widespread adoption:

1. **Manual Data Entry:** Many solutions require users to manually input inventory details, which is time-consuming and error-prone.
2. **High Costs of Advanced Systems:** Smart fridge solutions and IoT devices are often expensive, limiting accessibility for average households.
3. **Lack of Integration:** Current systems address inventory tracking or recipe generation independently, but very few provide an integrated solution that combines tracking, analytics, and food waste reduction.
4. **Limited Predictive Analytics:** Existing platforms rarely incorporate machine learning

algorithms to predict food usage, suggest optimized purchase plans, or recommend recipes based on historical data.

5. User Behavior Analysis: There is minimal focus on understanding user behavior and preferences to enhance system usability and engagement.
6. Scalability: Many advanced IoT solutions are still in prototype stages and lack scalability for broader market adoption.

Addressing these gaps can lead to the development of a more holistic and efficient smart pantry management system.

2.1.3 Detailed Problem Analysis

The challenges surrounding pantry management and food waste reduction can be broken into the following key problem areas:

1. Food Wastage: Food items often expire or spoil because users lose track of inventory and fail to use items on time. This contributes to significant household food waste globally.
2. Manual Inventory Tracking: Many existing systems require manual input of food items, which is time-intensive and reduces user adoption rates.
3. Inefficient Meal Planning: Without visibility into pantry contents, users often struggle to plan meals efficiently, leading to over-purchasing and wasted ingredients.
4. Lack of Automation: Advanced technologies such as image recognition, IoT, and machine learning are not widely adopted in existing systems, leaving a gap for automation and predictive capabilities.
5. High-Cost Solutions: Technologies like smart refrigerators and IoT-based inventory systems are expensive, making them inaccessible to a majority of households.
6. Limited Personalization: Most systems fail to tailor recommendations or suggestions based on user habits, preferences, and consumption patterns.

An ideal solution should address these issues through automation, advanced analytics, cost-effectiveness, and user-friendly features that improve efficiency and reduce food waste.

2.1.4 Survey of Tools and Technologies Used

The development of smart pantry management systems relies on a range of tools and technologies,

including:

1. Optical Character Recognition (OCR): OCR can extract information from labels or receipts to automate pantry item addition.
2. Image Recognition: Technologies like computer vision can identify food items based on photos, simplifying inventory tracking.
3. Machine Learning (ML): ML algorithms analyze usage patterns, predict food consumption, and suggest personalized meal plans and shopping lists.
4. Barcode and QR Scanners: Scanning barcodes or QR codes allows quick and accurate entry of food items into the inventory system.
5. Cloud-Based Platforms: Cloud storage enables real-time access and synchronization of pantry data across multiple devices.
6. Mobile and Web Interfaces: User-friendly applications with intuitive UI/UX designs enhance accessibility and ease of use for users.
7. Recipe Recommendation Engines: By leveraging these tools and technologies, smart pantry systems can become more automated, efficient, and effective in reducing food waste.

2.1.5 Summary

Existing pantry management solutions focus on either manual inventory tracking or isolated features like recipe generation and expiration reminders. These systems often lack automation, predictive analytics, and cost-effective approaches that make them accessible to average households.

My work builds on this foundation by developing an integrated smart pantry manager that combines multiple technologies to address food waste holistically. Key differentiators include:

1. User-Centric Design: Building a user-friendly web and mobile interface with behavior-driven features that improve user engagement and adoption.
2. Automation: Using OCR, image recognition, minimize manual inputs and automate inventory tracking.
3. Affordability: Ensuring the solution is cost-effective by focusing on software-based automation rather than expensive hardware.
4. Predictive Analytics: Implementing machine learning algorithms to predict food usage,

recommend optimized shopping lists, and suggest personalized recipes.

5. Comprehensive Solution: Integrating inventory tracking, meal planning, and waste analysis into a single, seamless platform.

By addressing the limitations of existing systems, this project aims to provide a more efficient, affordable, and user-friendly solution to pantry management and food waste reduction.

2.2 Software Requirement Specification

2.2.1 Introduction

The Smart Pantry App project is aimed at redefining how users organize and utilize their kitchen inventories through the integration of cutting-edge technology. The app is designed to make pantry management more efficient by enabling users to keep track of their food items, easily monitor expiration dates, and receive recipe recommendations that align with the ingredients they already have.

Featuring advanced tools such as Optical Character Recognition (OCR) for accurately scanning expiration dates or Image recognition for identifying and adding items to pantry seamlessly and machine learning algorithms for crafting personalized recipe suggestions, the app offers a modern solution to common kitchen challenges. The project seeks to help users minimize food waste, streamline meal planning, and maintain a well-organized pantry, all through an intuitive and accessible platform.

2.2.1.1 Purpose

The purpose of our smart pantry app project is to revolutionize how users manage their household food inventory by leveraging modern technology. The app aims to simplify pantry management, reduce food waste, and enhance meal planning by providing users with tools to track their pantry items, monitor expiration dates, and receive personalized recipe recommendations based on available ingredients.

By integrating features like Optical Character Recognition (OCR) for scanning expiration dates or Image recognition for identifying and adding items to pantry seamlessly, machine learning algorithms for tailored recipe suggestions, and secure data synchronization across devices, the app seeks to offer a seamless, efficient, and user-friendly experience. Ultimately, the project's goal is to empower users to make smarter decisions in the kitchen, leading to more sustainable food practices and a more organized pantry.

2.2.1.2 Intended Audience and Reading Suggestions

This document is intended for the following audiences:

- **Individuals:** Busy households seeking efficient pantry and meal management, health-conscious users wanting personalized meal planning, and environmentally-conscious people focused on reducing food waste.
- **Project Managers:** To understand the project's scope, objectives, and deliverables.
- **Development Team:** To obtain detailed requirements and design guidelines for implementation.
- **Quality Assurance Team:** To use as a basis for creating test plans and validating the application's functionality.
- **Stakeholders and Clients:** To review and confirm the requirements to ensure the application meets their expectations.
- **User Experience Designers:** To design the user interface and ensure it aligns with the specified requirements.

For a comprehensive understanding, readers should familiarize themselves with the following sections:

- **Purpose and Scope:** For an overview of the project and its goals.
- **Functional Requirements:** For detailed descriptions of the features and functionalities of the application.
- **Non-Functional Requirements:** For performance, reliability, and usability criteria.
- **Use Cases and User Stories:** For practical examples of how users will interact with the application.

2.2.1.3 Project Scope

The Smart Pantry Manager is a mobile application aimed at improving household pantry management and reducing food waste. The project involves developing a tool that integrates advanced technologies for efficient pantry management, meal planning, and grocery shopping. Key aspects include:

- **Inventory Management:** Manual and automatic updates of pantry items via OCR from receipts and product labels.

- **Expiry Date Handling:** Tracking and managing expiry dates through manual input, calendar selection, and OCR, with notifications for upcoming expirations.
- **Recipe Generation and Recommendation:** Integration with food and recipe APIs for personalized meal suggestions based on available ingredients and dietary preferences.
- **User Interface and Engagement:** Development of an intuitive user interface with gamification features to enhance user interaction.
- **User Account Management:** Account creation, data synchronization across devices, and secure authentication.
- **Machine Learning:** Algorithms to refine recipe suggestions, predict shopping lists, and adapt to user feedback.

The application is designed to streamline pantry management, optimize meal planning, and support sustainable living.

2.2.2 Overall Description

The Smart Pantry Manager project is a comprehensive application designed to revolutionize pantry organization and management for users. The app integrates state-of-the-art technology to create a more efficient and user-friendly experience in the kitchen.

2.2.2.1 Product Perspective:

- The Smart Pantry Manager is intended to serve as a comprehensive solution for pantry organization and management.
- The app aims to address common challenges faced by users in maintaining a well-organized pantry and minimizing food waste.

2.2.2.2 Product Features:

- Features advanced tools such as Optical Character Recognition (OCR) for accurately scanning expiration dates and Image recognition for seamless item identification and addition to the pantry.

- Utilizes machine learning algorithms to provide personalized recipe suggestions based on the ingredients available in the pantry.
- Offers a modern and intuitive platform for users to keep track of food items, monitor expiration dates, and receive recipe recommendations.

2.2.3 External Interface Requirements

2.2.3.1 User Interface

- **Simple Navigation:** User-Friendly Layout: A clean design with easy access to key features like adding and viewing pantry items.
- **Expiry Date Tracking:** Indicators for upcoming and expired items to help users manage their pantry.
- **OCR Integration or Image recognition:** Easy Scanning: A straightforward camera interface for scanning expiration dates with an option for manual input or adding items to pantry via image recognition.
- **Recipe Recommendations:** Suggest recipes based on existing pantry items or search for new ones.
- **Notifications:** Custom Alerts: Timely reminders for expiration dates.

2.2.3.2 Hardware Interfaces

- **Camera Integration:** The app requires access to the device's camera for OCR and image recognition to scan labels and packaging.
- **Storage and Memory:** Efficient use of device storage and memory is essential for processing and temporarily storing scanned images.
- **Network Connectivity:** The app needs stable internet access for data syncing, API requests, and updates, with offline functionality for temporary storage.

2.2.3.3 Software Interfaces

- **Operating System Compatibility:** The app will work on iOS and Android, utilizing

platform- specific APIs for camera and notifications.

- **OCR and Image Recognition:** Integration with OCR/image recognition libraries (e.g., Google Vision) for accurate text and object identification from scans.
- **Database Management:** The app will interface with a database to store pantry items and user data, supporting cross-device synchronization. (Firebase or Hive)
- **Recipe API Integration:** The app will connect to recipe APIs to provide suggestions.

2.2.4 Other Non-functional Requirements

- **Portability**

The Smart Pantry Manager will be developed as a cross-platform mobile application, ensuring compatibility with both Android and iOS operating systems. The app will be optimized for various device types, including smartphones and tablets, providing flexibility for users to manage their pantry from any device with consistent functionality.

- **Security**

User data, including pantry inventory, personal preferences, and account details, will be encrypted using industry-standard encryption algorithms like AES-256. Secure authentication mechanisms, including multi-factor authentication, will be implemented to prevent unauthorized access. Data synchronization between devices will occur over secure, encrypted channels to safeguard user information.

- **Scalability**

The Smart Pantry Manager will be built on a scalable cloud-based infrastructure, enabling the system to handle an increasing number of users and larger datasets as the app gains popularity. The application architecture will support future enhancements, such as additional features or integrations with third-party services, without compromising performance.

- **Performance**

The app will be designed to operate efficiently, with pantry inventory updates, OCR processing, and recipe generation completed within a few seconds. Notifications regarding expiration dates will be delivered promptly, ensuring users can act in a timely

manner to prevent food waste. The user interface will be responsive, with minimal loading times to enhance user experience.

- **Reliability**

The Smart Pantry Manager will ensure high reliability by employing robust error-handling mechanisms and data recovery options. In the event of an app crash or unexpected issue, users will be able to restore their pantry data without loss. The system will also provide accurate and timely expiry notifications, helping users manage their pantry effectively.

- **Availability**

The application will be available 24/7 with no restrictions on usage. It will offer offline functionality, allowing users to manage their pantry and access core features even without an internet connection. Once reconnected, the app will synchronize data across devices seamlessly.

- **Robustness**

The Smart Pantry Manager will implement comprehensive error-handling routines to manage unexpected user inputs or system errors. In the event of an error, the app will execute rollback procedures to preserve data integrity and maintain operational stability. Error logs will be generated for review and resolution in future updates.

2.2.4.1 Performance Requirements

- **Inventory Management Speed:** The app must process inventory updates, including OCR- based item additions, in under 2 seconds per operation to ensure a smooth user experience.
- **Notification Delivery:** Expiry notifications should be delivered within 1 second of the scheduled time, ensuring timely alerts for users.
- **Data Synchronization:** The app should synchronize user data across devices within 5 seconds of connection to the internet.

2.2.4.2 Safety Requirements

- **User Data Protection:** All user data, including pantry inventory and personal preferences, will be encrypted both at rest and in transit, using AES-256 or equivalent encryption methods. This ensures that user information remains secure from unauthorized access.
- **Error Handling:** The app will include error-handling routines that can detect and manage common errors, such as failed data entries or synchronization issues. Any critical errors will be logged, and rollback procedures will be initiated to maintain data integrity.
- **Reliability:** The app will ensure that expiry notifications are accurate and delivered on time. A secondary verification process will be implemented to minimize the risk of missed or incorrect notifications.

2.2.4.3 Security Requirements

- **Data Encryption:** All sensitive user data, including login credentials and personal information, will be encrypted using AES-256. This encryption will protect data both at rest and during transmission between devices and cloud servers.
- **Secure Authentication:** The app will implement multi-factor authentication (MFA) to enhance the security of user accounts. This will prevent unauthorized access, even if login credentials are compromised.
- **Data Privacy Compliance:** The Smart Pantry Manager will adhere to data privacy regulations such as GDPR, ensuring that user data is handled in a compliant and ethical manner. Users will have control over their data, with options to delete or export their information as needed.

2.3 Cost Analysis:

The cost analysis for the Smart Pantry Manager project reveals that the current development phase incurs no direct financial costs. All software components utilized are open-source, and no additional hardware is required, making the project highly cost-effective at this stage.

However, as the Smart Pantry Manager evolves and potentially expands its features—such as integrating with smart appliances, enhancing machine learning algorithms, or incorporating advanced image recognition—there may be future costs associated with these developments. These costs could include software licensing, cloud services, or additional hardware requirements. While the project is currently budget-neutral, careful consideration of these potential future expenses will be crucial to ensure sustainable growth and continued success.

2.4 Risk Analysis:

- **Technical Risks:**
 - Integration of complex technologies may lead to technical difficulties or glitches
 - Compatibility issues with different devices or operating systems
- **Financial Risks:**
 - Project costs could exceed initial estimates
 - Lack of funding or budget constraints
- **Security Risks:**
 - Data breaches or unauthorized access to user information
 - Vulnerabilities in the app that could be exploited by hackers
- **Market Risks:**
 - Competitive landscape with similar pantry management apps
 - Changing user preferences or market trends
- **Regulatory Risks:**
 - Compliance with data protection laws and regulations
 - Legal challenges related to intellectual property rights

3.Methodology Adopted

3.1 Investigative Techniques

S. No			
1.	Descriptive	Our project involves investigating and documenting how users manage and utilize their kitchen inventories. This includes observing user interactions with the Smart Pantry Manager app, cataloguing how they track food items, and documenting the challenges they face in pantry management.	1. Designing new system models for efficient pantry tracking. 2. Developing algorithms for Optical Character Recognition (OCR) to accurately scan and log expiration dates. 3. Creating user-friendly interfaces to enhance the user experience in pantry management
2.	Comparative	This technique involves comparing traditional pantry management methods with the Smart Pantry Manager app. Observations focus on the differences in efficiency, food waste reduction, and meal planning effectiveness between conventional methods and our app	1. Conducting comparison-based projects to evaluate the accuracy and efficiency of image recognition versus manual entry of pantry items. 2. Analyzing user satisfaction and usability metrics between the Smart Pantry Manager app and other existing pantry management solutions
3.	Experimental	Our project includes structured experiments to test hypotheses related to improving pantry management and reducing food waste. This involves setting up control groups to compare results with and without the use of the Smart Pantry Manager app. We will examine independent variables such as user demographics and dependent variables like the amount of food wasted, user satisfaction levels, and time spent on meal planning.	1. Implementing machine learning algorithms to generate personalized recipe suggestions based on available pantry items. 2. Conducting experiments to assess the accuracy and reliability of OCR and image recognition technologies in practical scenarios. 3. Measuring the impact of the app on food waste reduction and pantry organization over a specified period through controlled studies.

Table: 3.1.1 Investigative Techniques

3.2 Proposed Solution: Smart Pantry App

Introduction: In response to the increasing need for efficient pantry management and food waste reduction in households, we propose the Smart Pantry Manager, a mobile application that integrates advanced technologies to streamline inventory tracking, meal planning, and grocery shopping. The solution is designed to offer a user-friendly, accurate, and sustainable approach to managing pantry items, tailored to the needs of modern households.

System Architecture: Our proposed solution leverages a combination of innovative techniques to ensure accuracy, reliability, and ease of use. The solution consists of the following key components:

Pantry Inventory Management: Manual Entry for items without barcodes or recognizable images, the app provides a manual entry option, allowing users to input product details manually, with the option to use Optical Character Recognition (OCR) to automatically update inventory from grocery receipts and product labels. This feature ensures that pantry items are accurately tracked and reduces the manual effort required to maintain the inventory. Item Categorization, the app categorizes pantry items based on their type (e.g., grains, canned goods, spices) for easy navigation and organization. Quantity Tracking users can specify the quantity of each item added to the pantry, enabling accurate inventory management and preventing stockouts.

Expiry Date Handling: The system includes robust functionality for managing expiry dates. Users can manually input expiry dates, select dates from a calendar, or utilize OCR to scan expiration dates from product labels. The application also provides timely notifications to alert users of upcoming expirations, helping to minimize food waste.

Recipe Generation and Recommendation: The solution integrates with food and recipe APIs to generate personalized meal suggestions based on available pantry items, dietary preferences, and cooking times. This component enhances meal planning by offering relevant recipe options that utilize existing ingredients, thereby reducing the need for unnecessary grocery purchases.

Mobile Application Development: To enhance accessibility and user experience, we will develop a mobile application that allows users to manage their pantry, track expiry dates, and receive recipe recommendations from any device. The application will feature an intuitive user interface, ensuring easy navigation and engagement.

Machine Learning Integration: The Smart Pantry Manager incorporates machine learning algorithms to refine recipe suggestions and predict shopping lists based on user behavior, pantry inventory, and feedback. Over time, the system becomes more tailored to individual preferences, offering increasingly relevant recommendations.

Workflow:

- **Pantry Item Management:** Users can manually or automatically add items to their

pantry inventory using OCR. The application will update the inventory in real-time.

- **Expiry Date Notifications:** The system tracks expiry dates and provides users with notifications for items nearing expiration.
- **Recipe Suggestions:** Based on pantry inventory, dietary preferences, and cooking time, the application will generate meal suggestions through integrated APIs.
- **User Interaction:** The mobile app will allow users to interact with their pantry inventory, update items, receive expiry notifications, and access personalized recipes.

Benefits:

- **Efficiency:** The integration of OCR and real-time inventory management reduces the effort required to maintain pantry records and helps prevent over-purchasing.
- **Food Waste Reduction:** Expiry date tracking and recipe suggestions help minimize food waste by encouraging the use of ingredients before they expire.
- **User Engagement:** The mobile application, with its intuitive design and interactive features, fosters regular use and encourages sustainable pantry management practices.
- **Personalization:** Machine learning algorithms ensure that recipe and shopping suggestions become increasingly tailored to individual preferences, enhancing the user experience.

Conclusion: The proposed Smart Pantry Manager offers a comprehensive solution for modern households seeking to optimize pantry management, reduce food waste, and enhance meal planning. By integrating advanced technologies such as OCR, machine learning, and real-time notifications, the application provides a practical and sustainable tool that evolves with user needs, making it an essential asset for efficient and eco-friendly household management.

3.3 Work Breakdown Structure

Work Plan

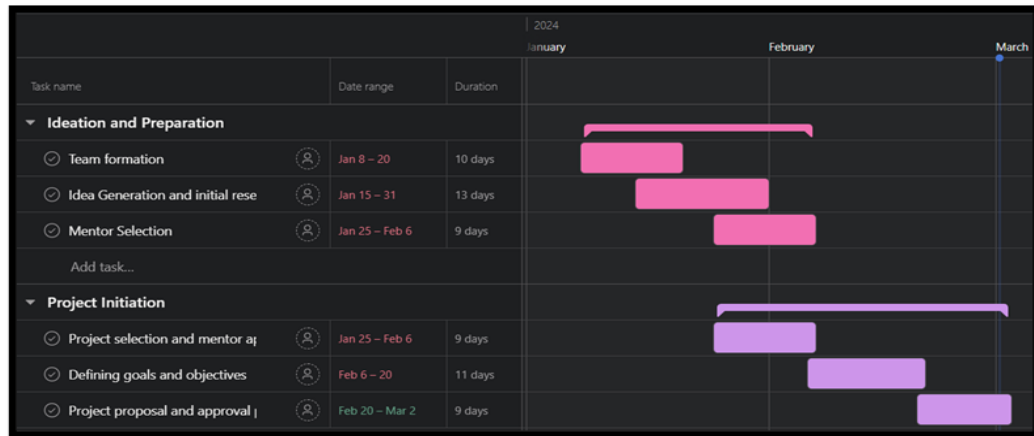


Fig: 3.3.1 Project Management Phase

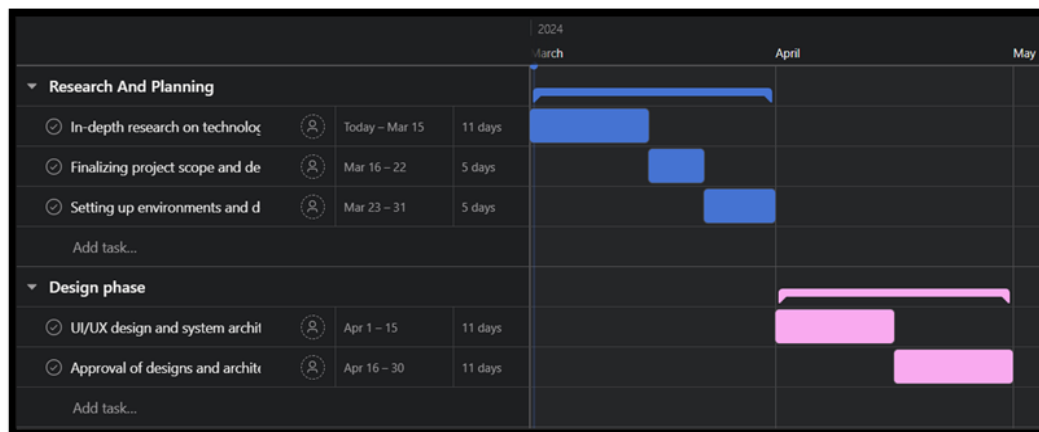


Fig: 3.3.2 Analysis and Design Phase

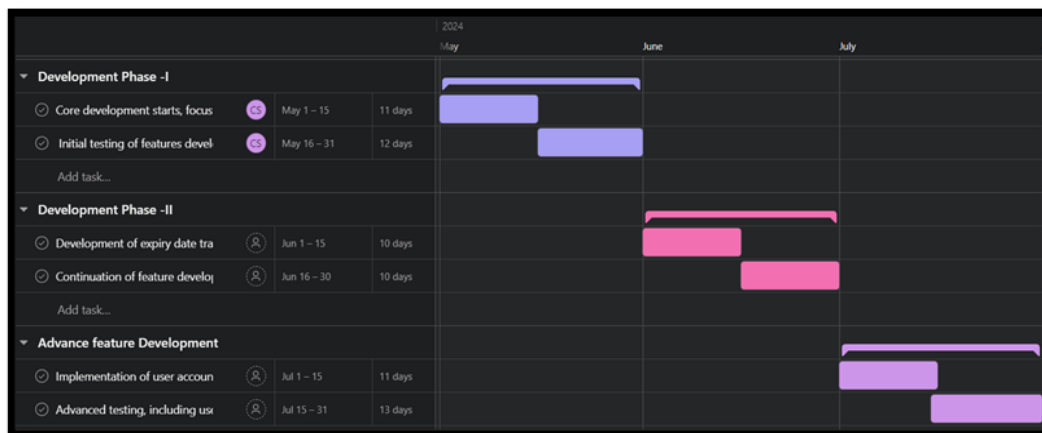


Fig: 3.3.3 Development Phase

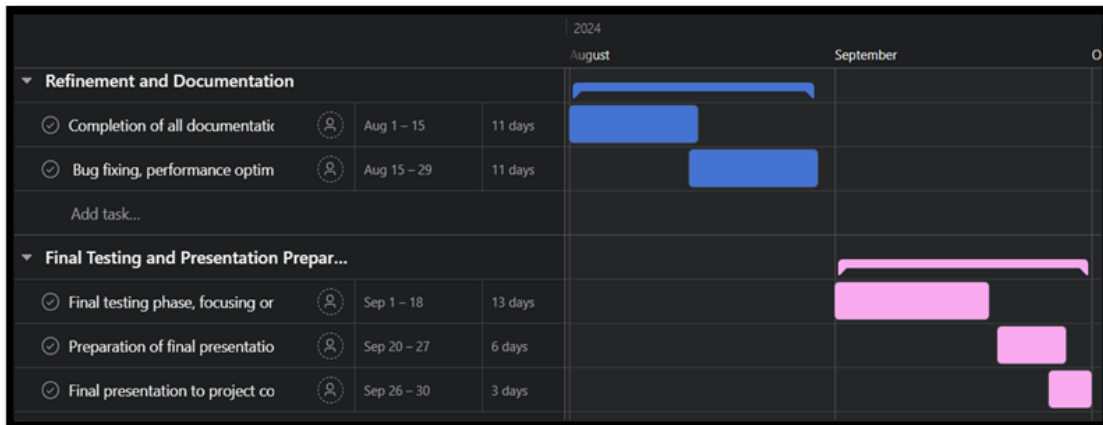


Fig: 3.3.4 Testing Phase

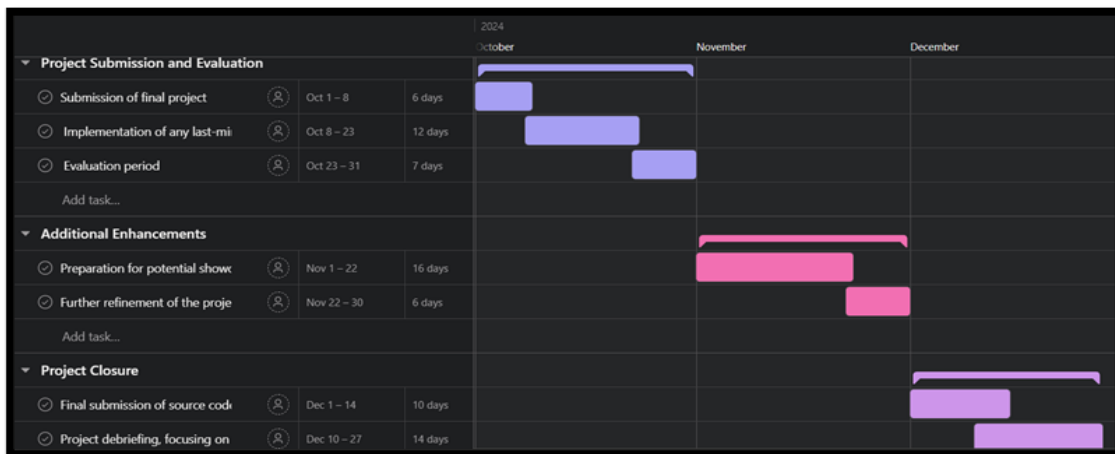


Fig: 3.3.5 Support and Maintenance Phase

The Work Breakdown Structure for the "Smart Pantry Manager" project outlines the development process and the key modules involved in building the application. This structured approach ensures all aspects of the project are methodically addressed, from planning through deployment.

3.3.1 Project Management Phase

The project management phase involves initiation, stakeholder engagement, planning, resource allocation, and risk assessment.

3.3.2 Analysis and Design Phase

- **User Research and Requirements Gathering:** Conduct surveys and interviews to understand user needs, especially related to pantry management, food waste, and meal planning.
- **Process Mapping:** Map out the current pantry management processes to identify inefficiencies and areas for improvement, focusing on workflows like adding items via image recognition and OCR, updating inventory, and generating shopping lists.
- **System Design:** Develop the system architecture, including the design of the database, API integrations, and user interface (UI) components.

Module Design:

- **Image Recognition Module:** Design the module responsible for identifying fresh produce (e.g., carrots, onions) and snack items (e.g., chips) through image recognition.
- **OCR Integration Module:** Design the module for Optical Character Recognition to accurately scan and identify text on packaged items, such as labels and barcodes.
- **Inventory Management Module:** Design the system for tracking pantry items, including the addition, update, and removal of items based on inputs from image recognition and OCR.
- **Expiration Date Management Module:** Design a system to track the expiration dates of packaged items and trigger notifications when they are nearing their expiry.
- **Recipe Suggestion Module:** Design the module that integrates with external recipe APIs and uses machine learning to provide personalized recipe suggestions based on available pantry ingredients.
- **User Account Management Module:** Design the authentication system using Firebase, enabling users to create accounts and synchronize data across devices.

Development Phase

- **Implementation of Key Modules:** Develop and integrate the designed modules, including Image Recognition using TensorFlow Lite, OCR with Google Vision, and the Recipe API Integration.
- **Database and Backend Integration:** Implement Firebase Firestore for database management, and integrate Firebase Authentication for secure user management.

- **User Interface Development:** Build the front-end using Flutter, ensuring a seamless user experience across platforms.

3.3.3 Testing Phase

- **Unit Testing:** Test individual modules such as image recognition, OCR, database management, and recipe suggestions to ensure they function correctly.
- **Integration Testing:** Test the interaction between modules, ensuring smooth data flow across different components of the app, from image/OCR scans to inventory updates and recipe suggestions.
- **User Acceptance Testing (UAT):** Validate the app with a group of users to ensure it meets expectations and functions as intended.
- **Security and Performance Testing:** Evaluate the app's overall security and performance.

3.3.4 Deployment Phase

- **System Configuration and Deployment:** Prepare the app for release by configuring system settings, optimizing performance, and ensuring compatibility with iOS and Android.
- **User Training and Documentation:** Provide in-app tutorials, user guides, and support documentation to help users navigate the app effectively.
- **Pilot Testing and Launch:** Conduct a pilot launch with a select group of users to identify and fix any issues before the full public release. Deploy the app to app stores for wide distribution.

3.3.5 Support and Maintenance Phase

Finally, the support and maintenance phase involves post-deployment support, monitoring, ongoing security updates, and iterative improvements based on user feedback.

3.4 Tools and Technologies Used

The tools and technologies used for the Smart Pantry Manager project include Flutter for cross- platform app development and Firebase for backend services.

- **Flutter:** A versatile framework used for building dynamic and responsive user interfaces, ensuring a consistent experience across iOS and Android devices.
- **Firebase:** Provides robust backend support, including real-time database management, authentication, and cloud functions, enabling secure and scalable app performance.
- **Python and OpenCv:** Used for implementing image recognition and OCR, these tools enhance the app's ability to accurately identify pantry items and manage inventory with minimal user input.

These technologies empower the Smart Pantry Manager to offer an efficient, user-friendly experience, automating pantry management and reducing food waste.

4 Design Specifications

4.2 System Architecture

4.2.1 For Sign Up/Registration:

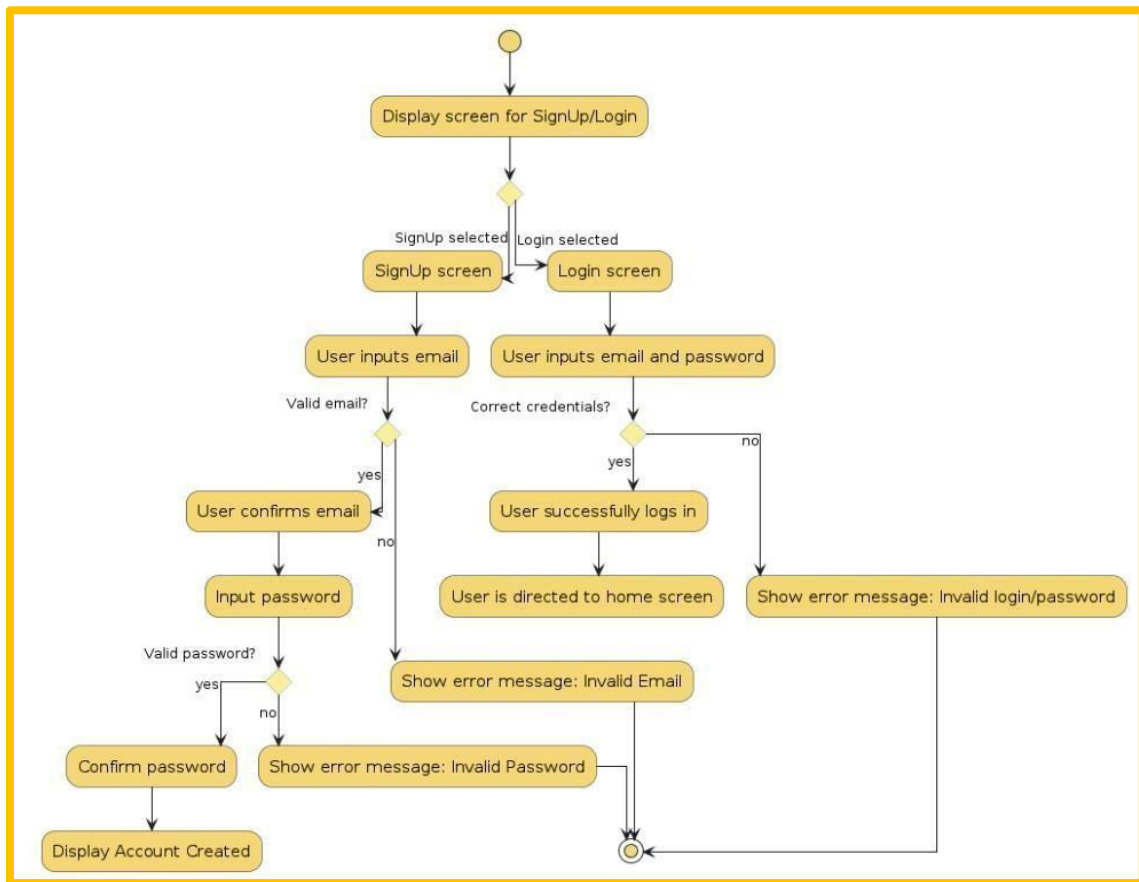
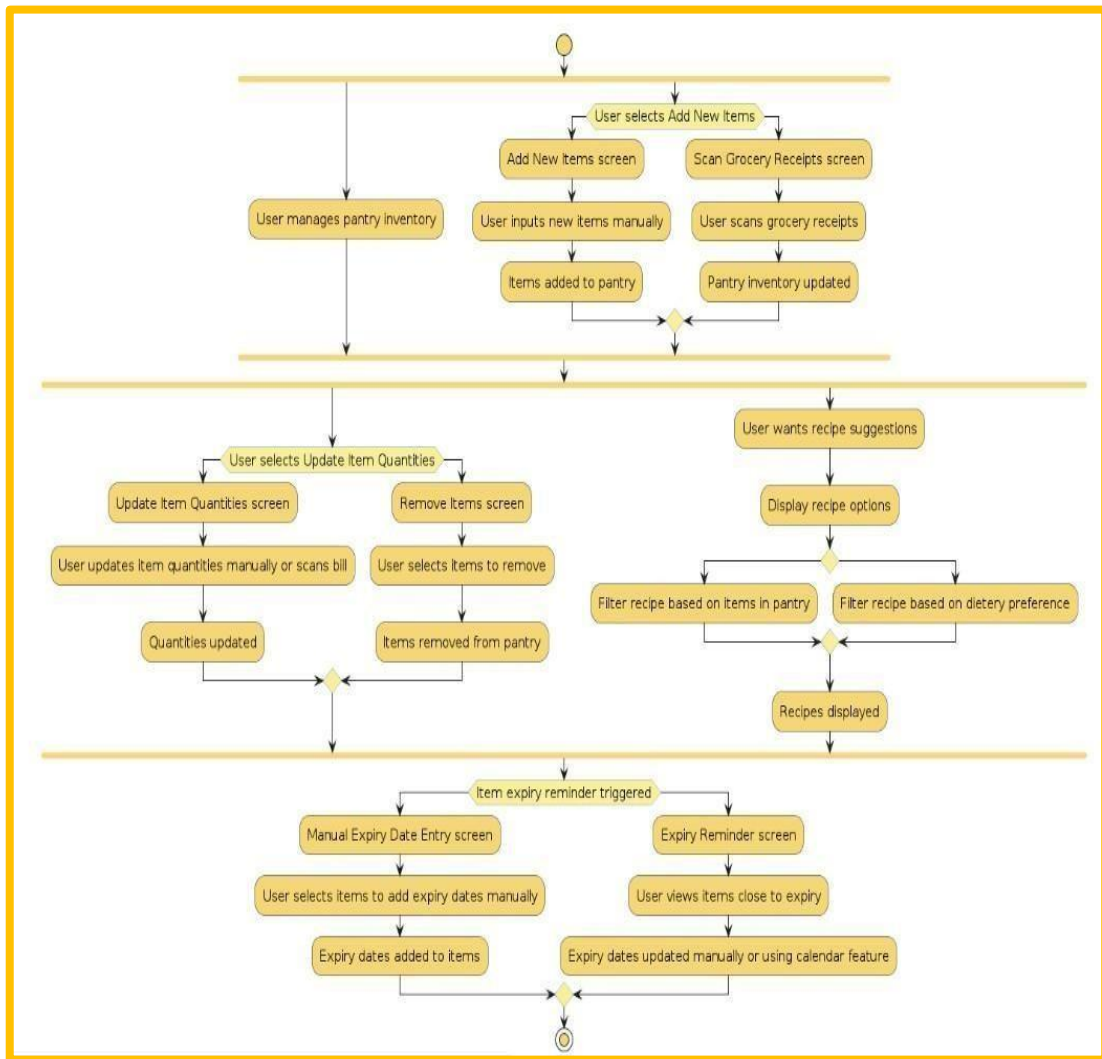


Fig : 4.1.1 For Sign Up/Registration:

Flowchart depicting the user login and signup process. It starts with a display screen where the user can choose to sign up or log in. If the user selects sign up, they input their email, confirm it, and then input and confirm their password. Upon successful password confirmation, the account is created. If the email or password is invalid, an error message is shown. If the user selects login, they input their email and password. If the credentials are correct, they are directed to the home screen; otherwise, an error message is displayed.

4.2.2 For the major system features:

The image is a flowchart illustrating the management of pantry inventory, item quantities, and recipe suggestions-



4.1.2 For the major system features:

Pantry Inventory Management

1. User selects "Add New Items."
2. Options to either:
 - Manually input new items.
 - Scan grocery receipts.

3. Items are added to the pantry, and inventory is updated.

Updating Item Quantities

1. User selects "Update Item Quantities."
2. Options to either:
 - Manually update quantities or scan bill.
 - Select items to remove.
3. Quantities or items are updated in the pantry.

Recipe Suggestions

1. User requests recipe suggestions.
2. Display of recipe options based on:
 - Items in the pantry.
 - Dietary preferences.
3. Recipes are displayed.

Expiry Date Management

1. Triggered by item expiry reminder.
2. Options to either:
 - Manually enter expiry dates.
 - View items close to expiry and update dates manually or using a calendar feature.
3. Expiry dates are updated for the items.

4.3 Design Level Diagrams

4.3.1 Level 0 DFD:

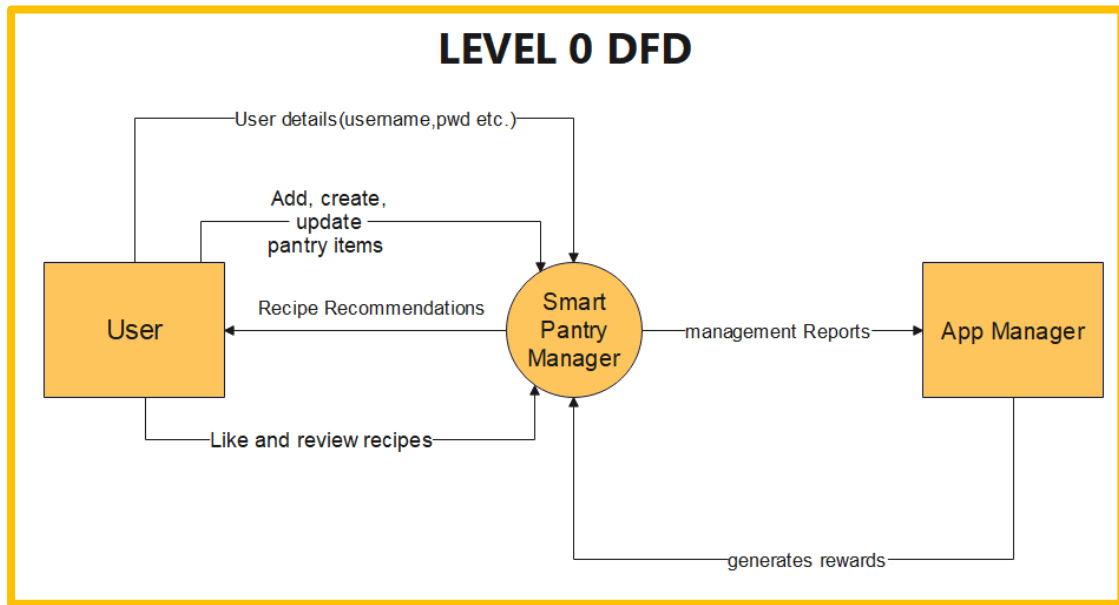


Fig:4.2.1

Level 0 Data Flow Diagram (DFD) for Smart Pantry Manager System

The image depicts a Level 0 Data Flow Diagram (DFD) for a system named "Smart Pantry Manager." This diagram illustrates the major processes and data flows between the main components of the system, which include the User, Smart Pantry Manager, and App Manager.

1. User:

- Inputs: The User provides details such as username and password to the Smart Pantry Manager.
- Actions: The User can add, create, and update pantry items. Additionally, the User can like and review recipes.
- Outputs: The Smart Pantry Manager provides recipe recommendations to the User based on the pantry items.

2. Smart Pantry Manager:

- Central Component: Acts as the core system that manages the interaction between the User and the App Manager.
- Functions: Handles user details, pantry item management, and recipe recommendations.
- Outputs: Generates management reports for the App Manager and receives input regarding rewards.

3. App Manager:

- Inputs: Receives management reports from the Smart Pantry Manager.
- Outputs: Provides rewards to the Smart Pantry Manager, which are then relayed to the User.

Data Flow:

- User details (username, password, etc.) are sent from the User to the Smart Pantry Manager.
- Pantry items are added, created, or updated by the User and sent to the Smart Pantry Manager.
- Recipe recommendations are sent from the Smart Pantry Manager to the User.
- The User can like and review recipes, which are sent back to the Smart Pantry

Manager.

- Management reports are generated by the Smart Pantry Manager and sent to the App Manager.
- Rewards are generated by the App Manager and sent to the Smart Pantry Manager.

Purpose:

This Level 0 DFD provides an overview of how data flows through the Smart Pantry Manager system, highlighting the interactions between the User, the central Smart Pantry Manager, and the App Manager.

4.3.2 Level 1 DFD

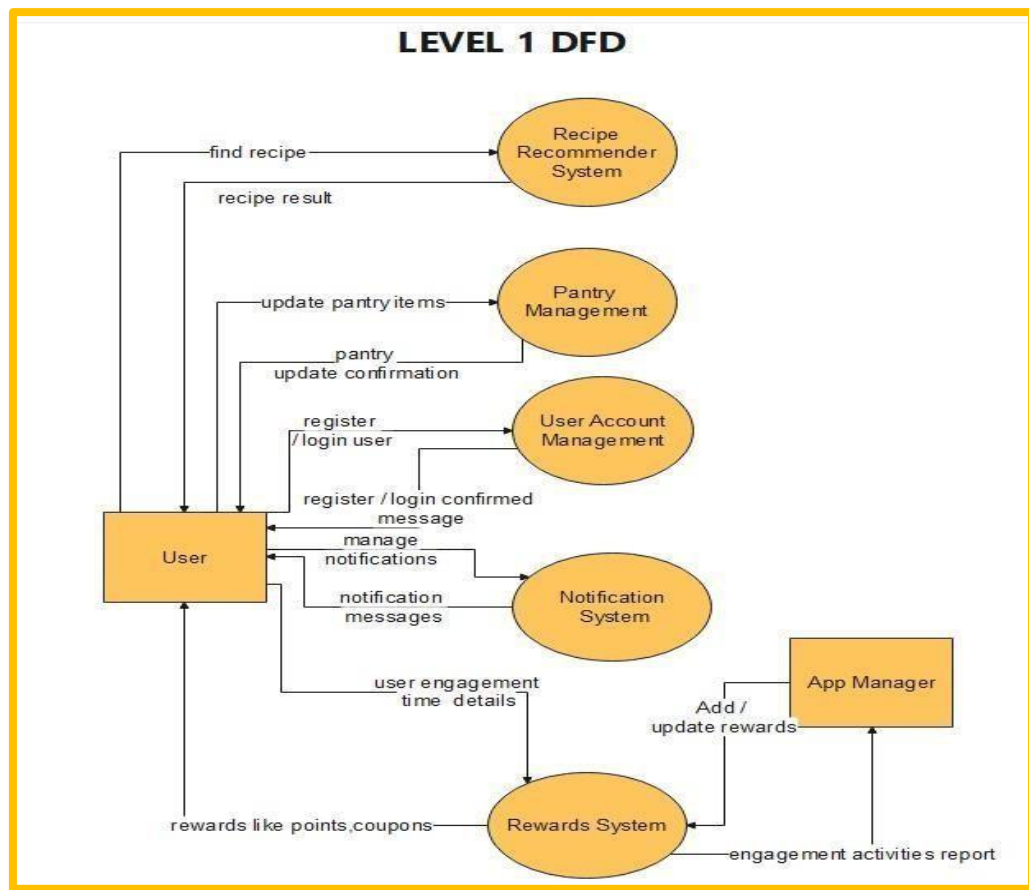


Fig: 4.2.2

Level 1 Data Flow Diagram (DFD) for Smart Pantry Manager System

Description:

The image illustrates a Level 1 Data Flow Diagram (DFD) for the Smart Pantry Manager system. This diagram provides a more detailed view of the processes and data flows between the system's components, which include the User, Recipe Recommender System, Pantry Management, User Account Management, Notification System, Rewards System, and App Manager.

1. User:

- Inputs: The User interacts with various subsystems to perform actions such as finding recipes, updating pantry items, registering/logging in, and managing notifications. Outputs: The User receives recipe results, pantry update confirmations, registration/login confirmation messages, and notification messages. Additionally, the User engages with the Rewards System.

2. Recipe Recommender System:

- Inputs: Receives requests from the User to find recipes.
- Outputs: Provides recipe results to the User.

3. Pantry Management:

- Inputs: Receives updates on pantry items from the User.
- Outputs: Sends pantry update confirmations to the User.

4. User Account Management:

- Inputs: Handles user registration and login details.
- Outputs: Sends registration/login confirmation messages to the User.

5. Notification System:

- Inputs: Manages notifications for the User.
- Outputs: Sends notification messages to the User and receives user engagement time details.

6. Rewards System:

- Inputs: Receives user engagement time details from the Notification System and updates rewards from the App Manager.
- Outputs: Provides rewards like points and coupons to the User.

7. App Manager:

- Inputs: Receives engagement activities reports from the Rewards System.
- Outputs: Adds/updates rewards in the Rewards System.

Data Flow:

- The User finds recipes through the Recipe Recommender System and receives recipe results.
- The User updates pantry items via Pantry Management and receives pantry update confirmation.
- The User registers/logs in through User Account Management and receives a registration/login confirmation message.
- Notification System manages notifications and sends notification messages to the User, also receiving user engagement time details from the User.
- Rewards System processes user engagement details and provides rewards to the User, while receiving updates from the App Manager.
- The App Manager adds/updates rewards and receives engagement activities reports from the Rewards System.

Purpose:

This Level 1 DFD provides a detailed view of the interactions and data flows within the Smart Pantry Manager system, showing how each subsystem communicates with the User and other components to process and manage data effectively.

4.3.3 Level 2 DFD:

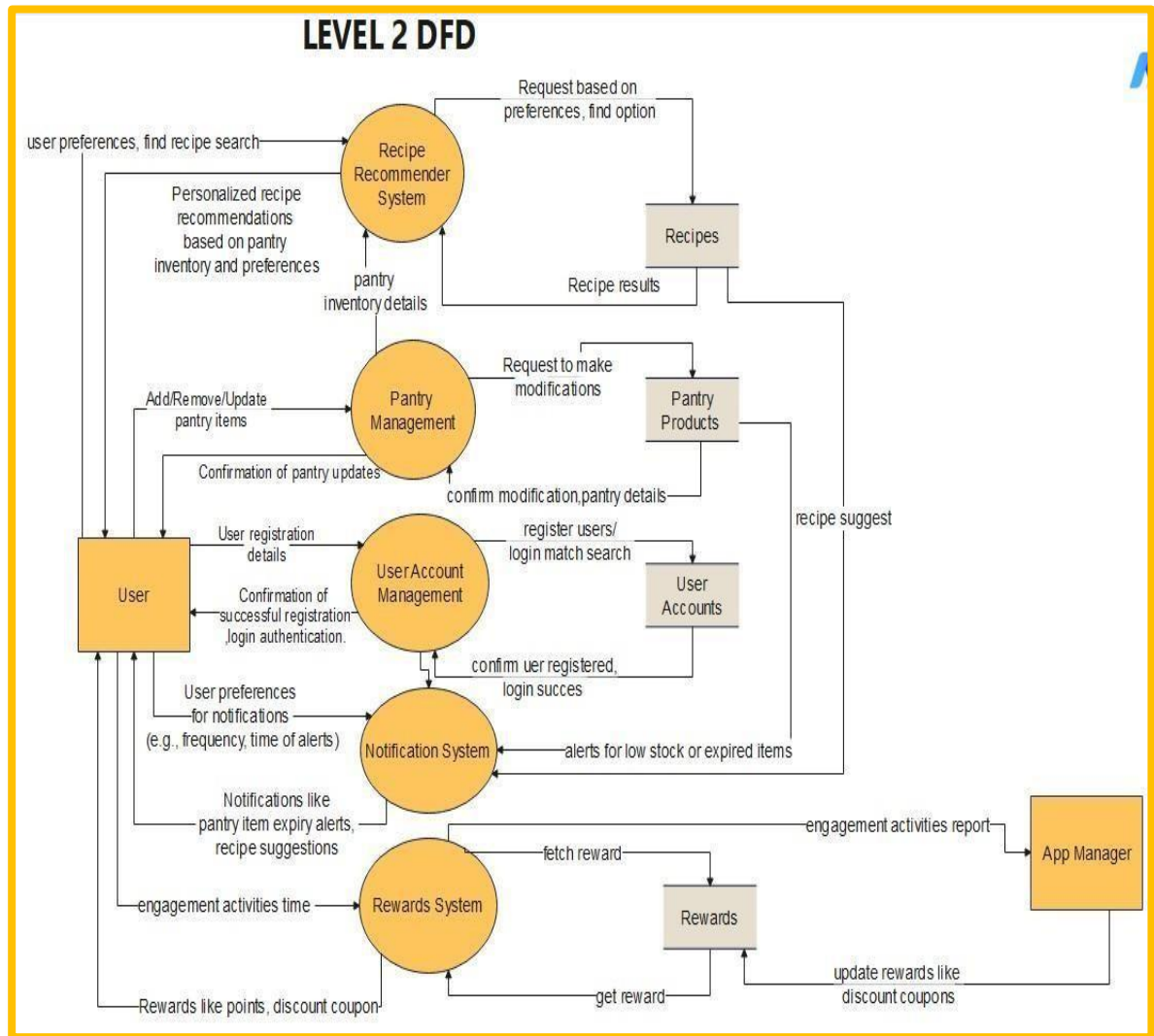


Fig: 4.2.3 Level 2 DFD

Description

The image is a Level 2 Data Flow Diagram (DFD) which models the data flow and processes within a system that manages user preferences, pantry inventory, recipe recommendations, notifications, rewards, and user accounts.

1. User

○ Inputs:

- User preferences for recipes and notifications.

- User registration details.
- Engagement activities time.
- **Outputs:**
 - Add/Remove/Update pantry items.
 - Confirmation of pantry updates.
 - Confirmation of successful registration and login authentication.
 - Notifications like pantry item expiry alerts and recipe suggestions.
 - Rewards like points and discount coupons.

2. Recipe Recommender System

- **Inputs:**
 - User preferences.
 - Pantry inventory details.
- **Outputs:**
 - Request based on preferences to find an option.
 - Recipe results to the Recipes data store.

3. Pantry Management

- **Inputs:**
 - Add/Remove/Update pantry items from the User.
 - Pantry inventory details from Recipe Recommender System.
- **Outputs:**
 - Confirmation of pantry updates to the User.
 - Request to make modifications to Pantry Products data store.

4. User Account Management

- **Inputs:**

- User registration details.
- **Outputs:**
 - Register users/login match search to User Accounts data store.
 - Confirmation of user registration and login success to Notification System.

5. Notification System

- **Inputs:**
 - User preferences for notifications.
- **Outputs:**
 - Alerts for low stock or expired items to the User.

6. Rewards System

- **Inputs:**
 - Engagement activities time from the User.
- **Outputs:**
 - Fetch reward from Rewards data store.
 - Get reward to the User.

7. App Manager:

- **Inputs:**
 - Engagement activities report from Rewards System.
- **Outputs:**
 - Update rewards like discount coupons to Rewards data store.

8. Data Stores

- **Recipes:** Stores recipe results.

- **Pantry Products:** Stores pantry inventory details.
- **User Accounts:** Stores user accounts information.
- **Rewards:** Stores rewards details.

Data Flow Connections

- The Recipe Recommender System fetches user preferences and pantry inventory details to provide recipe suggestions.
- Pantry Management handles modifications to pantry items based on user inputs.
- User Account Management ensures that users are registered and authenticated.
- The Notification System sends alerts based on user preferences and pantry updates.
- The Rewards System manages and fetches rewards based on user engagement.
- The App Manager updates reward options and monitors user engagement activities.

This DFD illustrates how user interactions and data are managed and processed within the system, ensuring a coherent flow of information and actions between various component

4.4 User Interface Diagrams

4.3.1 Component Diagram

The component diagram illustrates the structural configuration of the "Smart Pantry App," detailing its various components and their interactions. The system is divided into two main segments: the User Interface and Backend Services.

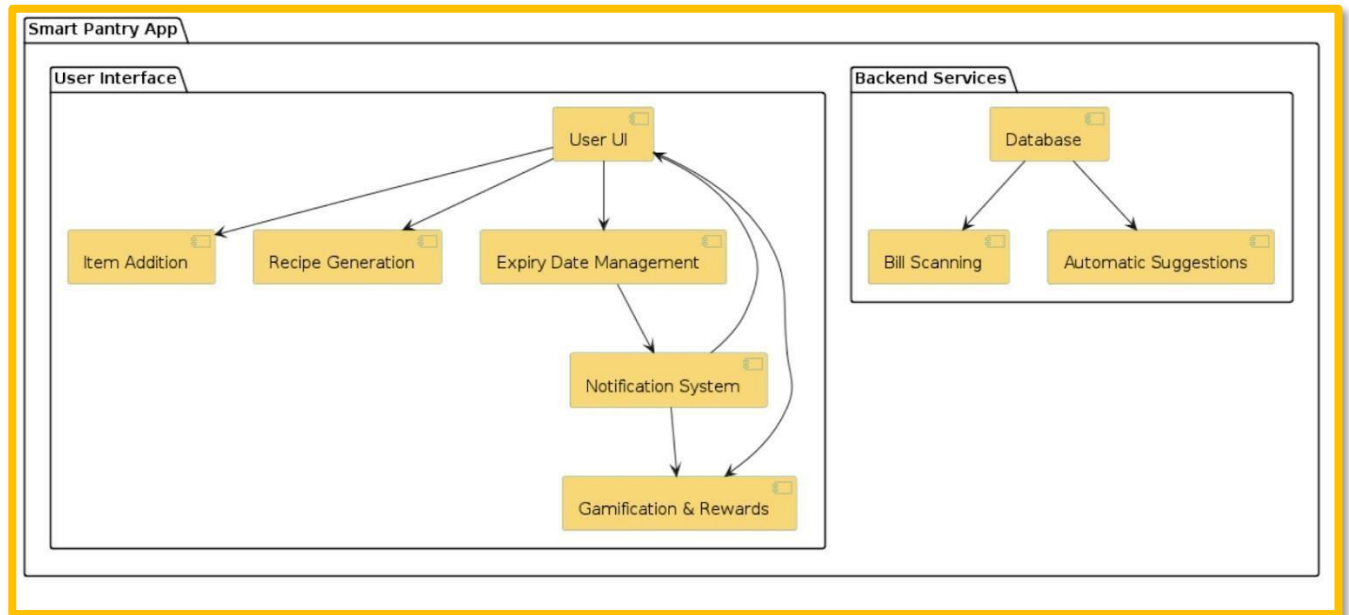


Fig:4.3.1 Component Diagram

User Interface

1. **Item Addition:** This component allows users to add items to their pantry inventory. It is directly connected to the User UI, enabling seamless interaction for item management.
2. **Recipe Generation:** This module generates recipes based on the items available in the pantry. It receives data from the Item Addition component to suggest relevant recipes.
3. **Expiry Date Management:** Responsible for tracking the expiration dates of pantry items. It integrates with the User UI to provide timely updates and alerts about expiring items.

4. **Notification System:** This system sends notifications to users regarding various events, such as item expirations or new recipe suggestions. It interacts heavily with the Expiry Date Management and Gamification & Rewards components.

Backend Services

1. **Database:** The central repository for all data related to the Smart Pantry App. It stores information about items, user activities, and other crucial data points.
2. **Bill Scanning:** This component processes scanned bills to automatically update the pantry inventory. It interfaces with the Database to store and retrieve item details.
3. **Automatic Suggestions:** Provides users with suggestions based on their pantry contents and usage patterns. It relies on the data stored in the Database to offer relevant and timely recommendations.

Component Interactions

- The **User UI** serves as the central hub for user interaction, connecting various components like Item Addition, Recipe Generation, and Expiry Date Management.
- The **Notification System** is triggered by both the Expiry Date Management and Gamification & Rewards components to keep users informed.
- The **Backend Services** support the User Interface by handling data processing and storage, ensuring that the system functions efficiently and effectively. This component diagram provides a clear overview of the Smart Pantry App's architecture, highlighting the key functionalities and their interdependencies.

5 Implementation and experimental Result

5.2 Experimental Setup

The data utilized in the Smart Pantry project revolves around household inventory management, focusing on the following key elements:

- **Inventory Details:** Includes information about items in the pantry, their quantities, and expiry dates to ensure effective tracking and management.
- **Receipt Data:** Leveraged through Google ML Kit OCR to scan receipts and automatically extract item details for seamless inventory updates.
- **Local Storage:** Inventory data, including item details and expiry notifications, is stored locally on the device, ensuring offline accessibility without relying on cloud services.
- **Firebase Authentication:** Exclusively used for managing user login and signup functionalities, ensuring secure access and user-specific data management.

5.3 Experimental Analysis

5.2.1 Data

The data utilized in the Smart Pantry project revolves around household inventory management, focusing on the following key elements:

- **Inventory Details:** Includes information about items in the pantry, their quantities, and expiry dates to ensure effective tracking and management.
- **Receipt Data:** Leveraged through Google ML Kit OCR to scan receipts and automatically extract item details for seamless inventory updates.
- **Local Storage:** Inventory data, including item details and expiry notifications, is stored locally on the device, ensuring offline accessibility without relying on cloud services.
- **Firebase Authentication:** Exclusively used for managing user login and signup functionalities, ensuring secure access and user-specific data management.

5.2.2 Performance Parameters

Performance parameters in capstone projects are crucial benchmarks for success, assessing efficiency and effectiveness. Common parameters include accuracy, speed, scalability, user satisfaction, reliability, security, cost efficiency, compliance, innovation, and sustainability. Measuring these parameters ensures comprehensive evaluation and successful outcomes.

5.3 Working of the project

5.3.1 Procedural Workflow

1. Login

- Start
 - User opens the app.
 - User enters credentials (Username and Password).
 - System validates credentials.
 - If valid, proceed to the Home Screen.
 - If invalid, show an error message.
- End of Login Process

2. Item Addition

- Manual Item Addition
 - User selects "Add Item" from the menu.
 - Input fields displayed for:
 - Item Name
 - Quantity
 - Category
 - Expiry Date
 - User fills in details and clicks "Confirm."
 - Item is added to inventory.
- OCR-Based Item Addition
 - User uploads a bill photo/receipt.
 - OCR scans and extracts item names.
 - Items are displayed for user review.
 - User updates:

- Quantity
- Category
- Expiry Date
- Confirmed items are added to inventory.

3. Inventory Management

- User selects "Inventory" from the menu.
- Inventory items are displayed with details:
 - Item Name
 - Quantity
 - Expiry Date
 - Category
- System highlights items nearing expiry.
- User can:
 - Update items (e.g., change quantity or details).
 - Delete items (e.g., consumed or expired items).

4. Recipe Search and Recommendations

- Recipe Search
 - User enters ingredient(s) in the search bar.
 - System fetches and displays recipes based on the ingredient(s).
- Recipe Recommendations
 - Home page displays suggested recipes.
 - User clicks on a recipe to view:
 - Ingredients required.
 - Step-by-step cooking instructions.

5. Help and Support

- User selects "Help and Support" from the menu.
- Options displayed for:
 - Troubleshooting common issues.
 - Submitting an inquiry.
 - Contacting support.

6. Settings

- User selects "Settings" from the menu.

- Options available for:
 - Notifications (e.g., expiry alerts).
 - Themes (e.g., light or dark mode).
 - Account settings (e.g., update credentials).

7. Logout

- User clicks "Logout" from the menu.
- System logs out the user and redirects to the login screen.

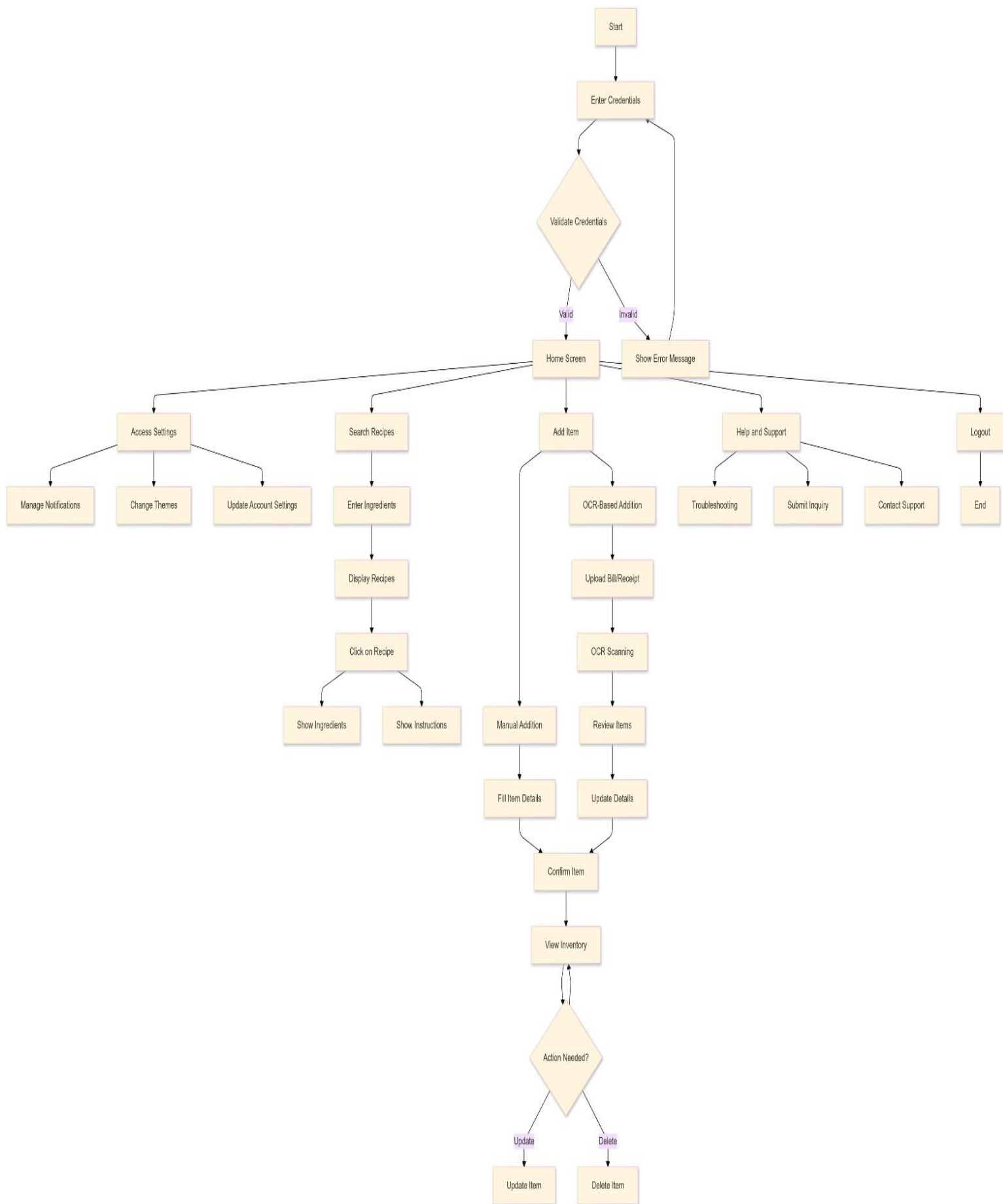


Fig. 5.3.1.1 Procedural Workflow

5.3.2 Algorithmic Approaches Used

The code utilizes Flutter and Dart for the frontend functionality, with sqflite employed for local data storage. sqflite is used to manage inventory details such as item names, quantities, and expiry dates, allowing for offline access and efficient querying of pantry data. Standard CRUD operations such as INSERT, UPDATE, DELETE, and SELECT are used to manage pantry items locally in the SQLite database, ensuring smooth inventory management even without internet connectivity.

Session management is handled through Firebase Authentication, where user data is securely stored and retrieved via token-based authentication. This ensures secure and personalized user access, enabling users to log in and manage their pantry with ease.

Iteration and looping mechanisms are employed to manipulate or retrieve specific data from the local sqflite database, such as checking if an item exists, updating its quantity, or removing expired products. Conditional statements are used to manage actions based on conditions like verifying ingredient availability, checking expiry dates, or validating user inputs.

The app also incorporates sorting and filtering functionalities to organize pantry items, allowing users to view their inventory based on criteria like expiry dates.

Algorithmic approach for recipe commendation model:

This model combines natural language processing techniques to analyze and categorize text data. It uses TF-IDF vectorization to represent documents as numerical vectors, followed by topic modeling using Latent Dirichlet Allocation (LDA) and Non-Negative Matrix Factorization (NMF)

to extract latent topics. Cosine similarity is applied for document ranking and recommendation.

TextRank identifies key terms by building a co-occurrence graph, while selected documents are ranked by topic relevance for further analysis. These steps enable efficient keyword extraction, topic summarization, and content-based recommendations.

```

# Step 1: Text Vectorization
For each document d in corpus:
    Compute TF-IDF scores for words in d

# Step 2: Topic Modeling
Apply LDA and NMF on TF-IDF matrix to extract topics

# Step 3: Keyword Extraction
Build co-occurrence graph for words
Apply TextRank to rank keywords

# Step 4: Document Ranking
For each topic:
    Compute relevance scores using cosine similarity
    Rank documents based on scores

# Step 5: Output Results
Return top keywords, topics, and ranked documents

```

Fig: 5.3.2.1 Pseudocode for recipe recommendation

5.3.3 Project Deployment

The Smart Pantry app is deployed on both Android and iOS platforms using Flutter for cross-platform compatibility. Firebase Authentication is used for secure user login and registration, while sqflite handles local storage for pantry data, ensuring offline access. The app integrates an external recipe API for suggesting meals based on available ingredients, and includes notifications for expiring items. Security protocols such as input validation, role-based access control, and secure data management are implemented to protect user information and ensure app stability.

5.3.4 System Screenshots



Fig: 5.3.4.1 Main Page

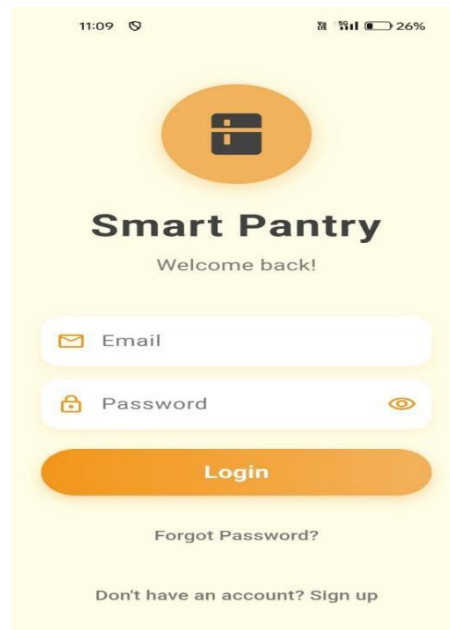


Fig: 5.3.4.2 Login Page

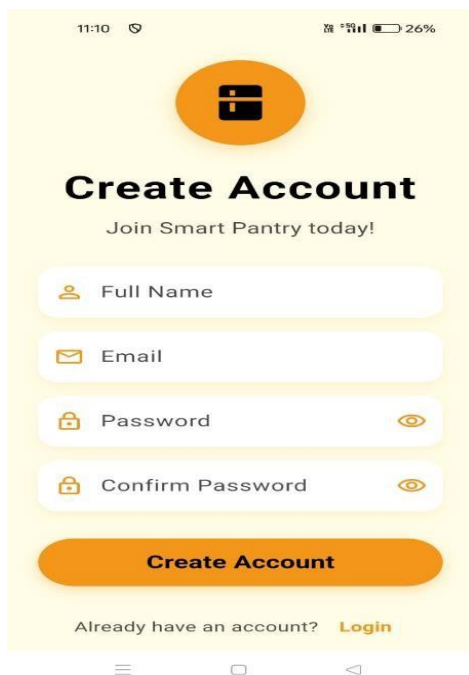


Fig: 5.3.4.3 Create Account

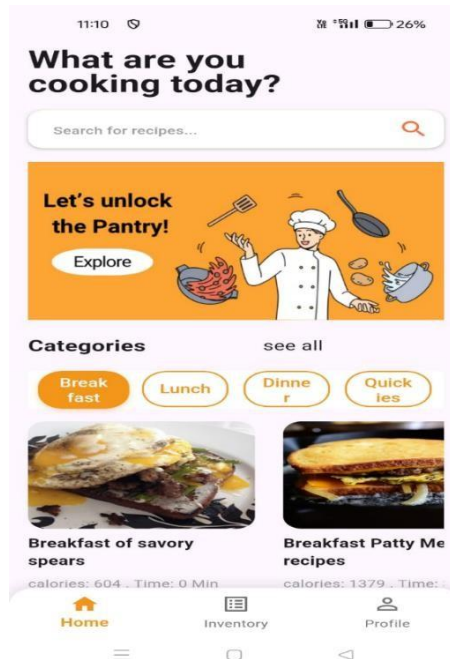


Fig: 5.3.4.4 Home Page

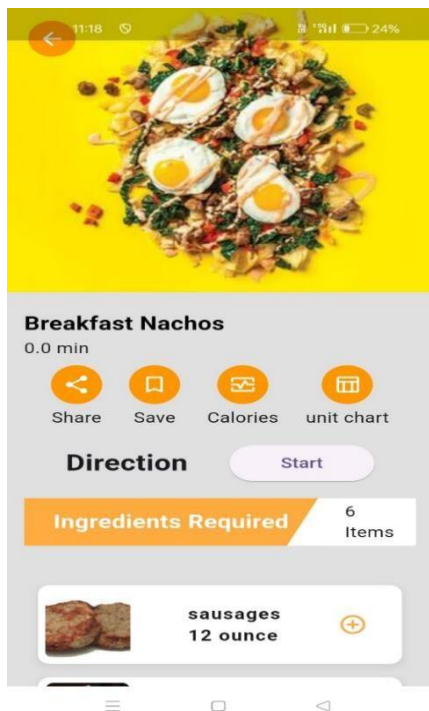


Fig: 5.3.4.5 Recipe

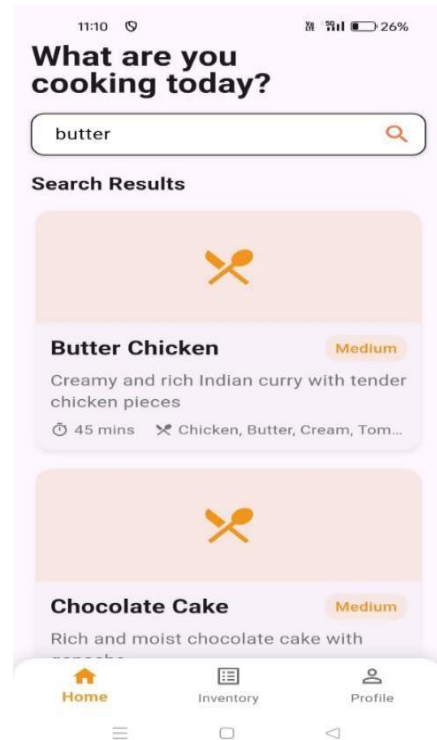


Fig: 5.3.4.6 Search Results

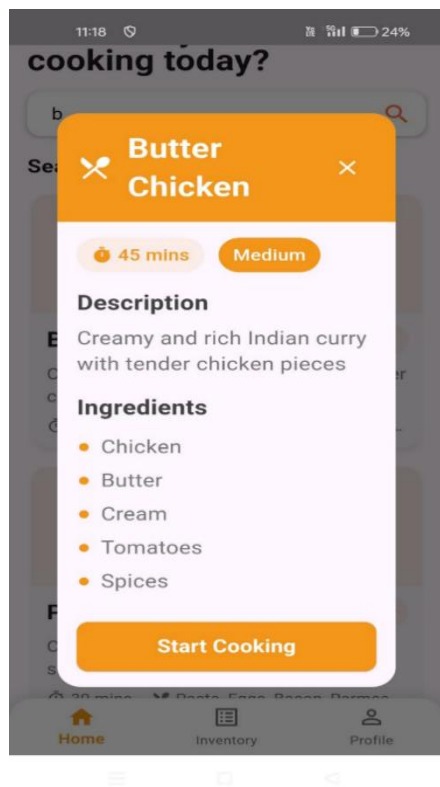


Fig: 5.3.4.7 Searched Recipe

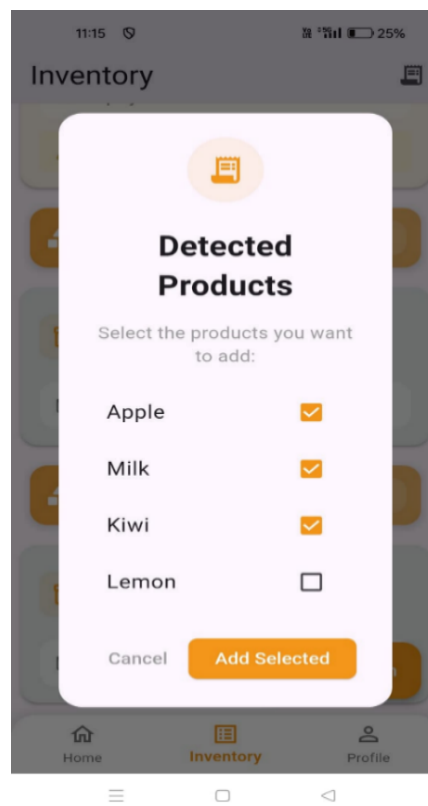


Fig : 5.3.4.8 OCR Output

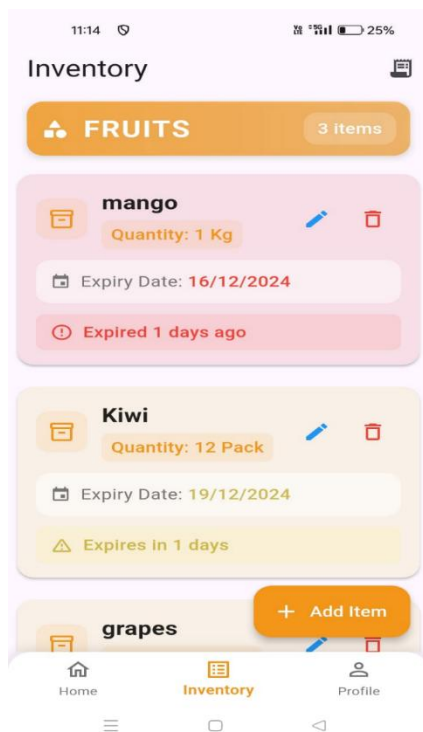


Fig: 5.3.4.9 Inventory Page

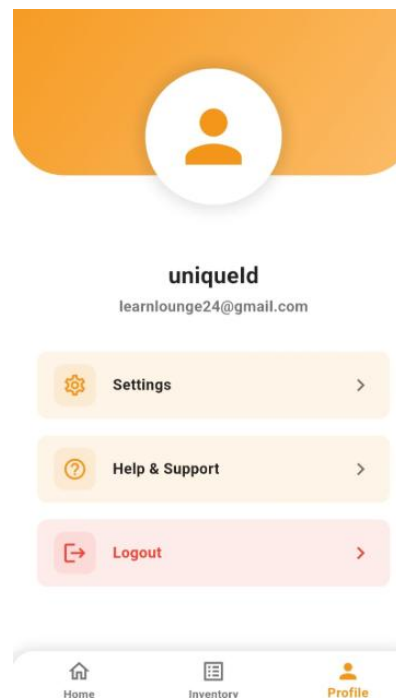


Fig :5.3.4.10 Profile Page

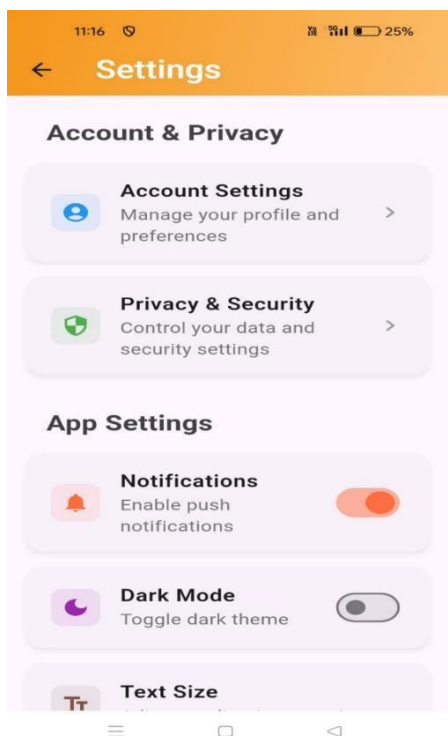


Fig: 5.3.4.11 Settings Page

5.4 Testing Process

5.4.1 Test Plan

The test plan for the Smart Pantry app includes validating OCR accuracy, the functionality of CRUD operations for pantry items, performance under load, and the accuracy of recipe suggestions. It also includes checking the security and privacy of user data and ensuring the app's responsiveness across different devices

5.4.2 Features to be tested

- **OCR Accuracy:** Verifying that the app accurately extracts item names from receipts.
- **CRUD Operations:** Ensuring that items can be successfully added, updated, and removed from the pantry.
- **Recipe Suggestions:** Checking that the app suggests correct recipes based on search pantry items.
- **Expiry date sorting:** Verifying that expiring items are denoted in red, near to expiry in yellow, and others in grey, also sorted based on near to expiry first under specific categories.
- **Cross-Platform Compatibility:** Ensuring that the app works smoothly on both Android and iOS.

5.4.2 Features to be Tested

For the Smart Pantry project, it is essential to evaluate performance and functionality thoroughly to ensure smooth operation. This includes validating individual features and their integration with others, guaranteeing that no malfunctions or performance bottlenecks occur. Performance testing will cover all aspects of the system, such as the accuracy of the recipe suggestions, the efficiency of the inventory management, and the responsiveness of sorting inventory based on expiry dates. These tests will ensure that the system meets the required standards of speed, accuracy, and user satisfaction.

S.No	Scenario Being Tested	Module Being Tested
1	Verify that the user authentication system accurately authenticates valid user credentials and ensures proper access control.	User Authentication (Firebase)
2	Validate the functionality of login and sign-up across different platforms (iOS, Android) and devices (smartphone, tablet) to ensure cross-platform compatibility.	User Authentication (Firebase)
3	Test the accuracy of inventory management by verifying that items added through OCR are correctly categorized and stored in the pantry database.	OCR Integration, Inventory Management
4	Test the functionality of recipe suggest feature based on search ingredients in the search bar, ensuring the api provides relevant and feasible recipes.	Recipe Suggestion
5	Ensure that the expiration date tracking feature triggers accurate notifications for products nearing expiry, and verify that notifications are sent on time.	Expiry Date Tracking, Notifications
6	Test the real-time updates of pantry stock, verifying that product quantities and details are updated immediately after changes, such as addition or removal of items.	Inventory Management
7	Validate the ability to successfully update product details (name, quantity, unit, expiry date) and ensure that changes reflect in the app immediately.	CRUD Operations
8	Confirm that the OCR integration correctly recognizes and processes receipts in the supported Canva format for efficient inventory update.	OCR Integration
9	Test the overall performance and response time of the app, including navigation speed, feature load times, and any lag during interactions with the user interface.	App Performance
10	Verify that the app's user interface is intuitive and user-friendly, particularly for non-technical users, ensuring ease of use for managing pantry items.	UI/UX Design

11	Confirm that security measures like input validation, and password strength enforcement are correctly implemented to protect against unauthorized access and vulnerabilities	Security Measures
----	--	-------------------

Table 5.4.2.1: Test Scenarios

These test scenarios are designed to comprehensively evaluate the functionality, security, and performance of the Smart Pantry app, ensuring that each feature works as expected and meets user expectations.

5.4.3 Test Strategy

The testing approach aims to conduct comprehensive evaluations of the entire system through individual and collective tests on each module, utilizing various assessment strategies.

It includes detailed testing of individual components, incorporating manual and automated methods, diverse techniques, and integration testing. End-user involvement and robust defect tracking ensure project success.

5.4.4 Test Techniques

Integration Testing:

Integration testing ensures smooth data flow and interaction between components, such as

the front-end and sqllite local database, verifying that all integrated modules function cohesively.

Acceptance Testing:

Acceptance testing validates that the app meets user requirements by assessing features like recipe search, pantry management, and notifications for expiring items, ensuring it aligns with project objectives and user expectations.

Usability Testing:

The app undergoes usability testing to evaluate the intuitiveness of the user interface and overall experience, ensuring accessibility and ease of use for the target audience.

5.4.5 Test Cases

S.No.	Test Case	Input	Expected Result
T001	Valid User Login	Valid username and password for registered user	Successful login and access to user's personalized pantry data
T002	Invalid User Login	Incorrect username or password	Login failure with appropriate error message
T003	Inventory Update via OCR or Manual Addition	Receipt in supported Canva form with pantry items listed	Successful OCR extraction and pantry items added/updated in the inventory
T004	Recipe Search	A list of ingredients	Relevant recipe suggestions based on ingredients
T005	Expiry Date Sorting and assigning colours based near to expiry date	Items added with expiry dates	Sorting for items based on approach expiry
T006	User Authentication Integration	User logs in to access their pantry data	Seamless integration of login and pantry functionalities
T007	User-Friendly Interface	User accesses inventory, recipe suggestions, and shopping list	Intuitive interface with clear and easy-to-use features
T008	Security and Authorization Check	User login with valid credentials, access restricted functions	Secure login with restricted access to unauthorized users
T009	End-to-End Scenario	User login, inventory management, OCR scan, and recipe suggestions	Seamless flow with no errors across login, inventory, and recipe features

Table 5.4.5.1: Test Cases

5.4.6 Test Results for Smart Pantry

After performing the test cases outlined above, the following results were observed:

1. **User Login Functionality:** All login tests passed successfully, both for valid users (T001) and invalid users (T002). The application ensured proper access control and appropriate error messaging for failed login attempts.
2. **Inventory Management via OCR or Manual Addition:** OCR functionality for updating the pantry inventory was verified with receipt formats supported by Canva (T003). Items were successfully added to the pantry inventory with accurate details extracted from the receipts and some details added manually.
3. **Recipe Search:** The recipe search algorithm provided relevant recommendations based on the available pantry ingredients (T004).

4. **Expiry Date Sorting and assigning colours based near to expiry date:** Sorting for items based on approaching expiry, ensuring that users are aware of near to expiry and expired items (T005).
5. **User Interface:** The user interface was intuitive and provided easy access to all pantry management features, with no issues reported in terms of navigation or usability (T007).
6. **Security Measures:** The login functionality restricted unauthorized users from accessing sensitive features, such as pantry management and recipe suggestions (T008).
7. **End-to-End Scenario:** The full user journey from login to inventory management, OCR scan, recipe suggestions, and shopping list creation worked seamlessly with no errors (T009).

Conclusion: All test cases passed successfully, confirming that the Smart Pantry application meets functional and security requirements across various scenarios. The application was found to perform well in terms of usability, security, and integration of all core features.

5.5 Results and Discussions for Smart Pantry

The Smart Pantry application is a comprehensive solution for managing household pantry items. The system leverages multiple technologies such as Flutter for dynamic UI development, Firebase for user authentication, Google ML kit for OCR, and recipe api for recipe suggestions. The application aims to improve the user's pantry management experience by offering real-time inventory tracking, recipe suggestions, and sorting inventory based on items nearing expiry.

Future Improvements:

- **Cross-Device Synchronization:** Currently, the pantry data is stored locally, but future iterations may include synchronization across multiple devices to allow users to access their pantry information from different devices.
- **Performance Improvements:** Optimizing the backend to handle a larger number of pantry items and user accounts without performance degradation.
- **Additional Functionalities:** Future versions could include advanced meal planning features, integration with online grocery stores for automatic purchasing, and enhanced machine learning algorithms for more accurate recipe suggestions.

Conclusion:

The Smart Pantry project successfully addresses the need for efficient household inventory management, providing a user-friendly, secure, and functional application. Through comprehensive testing and rigorous development, the application is well-positioned for future enhancements and scaling to a broader user base.

5.6 Inferences Drawn

The Smart Pantry app focuses on user-centric features such as pantry inventory management, receipt scanning via OCR, recipe search based on search ingredients, and sorting inventory based on expiry date. It employs secure authentication through Firebase and utilizes sqflite for local data storage, ensuring offline accessibility and efficient CRUD operations. The app delivers a personalized user experience by offering ingredient-based recipe searches.

While the app provides robust functionality, it lacks cross-device synchronization and relies solely on local storage for inventory data. Security measures include secure login and data encryption, but further enhancements in input validation and error handling can improve data integrity and user experience.

Usability and accessibility could benefit from refining the user interface and adding features like guided tutorials or tooltips for new users. Scalability considerations, such as integrating cloud-based inventory sharing, may be necessary for broader adoption but could increase pricing.

Future enhancements include expanding the app's features to support cross-device data sharing, integrating additional APIs for recipe suggestions, refining the OCR functionality for greater accuracy, and optimizing the notification system. Overall, the project demonstrates a strong foundation in household inventory management but has room for growth in scalability, usability, and advanced features to enhance user satisfaction.

5.7 Validation of Objectives

S. No.	Objectives	Status
1	Streamline pantry inventory management	Successful
2	Provide a user friendly interface	Successful
3	Integrate OCR for automated updates	Successful
4	Provide recipe search results	Partially Successful
5	Enable real-time expiry based sorting of inventory	Successful

Table 5.6.1: Validation of Objectives

6 Conclusions and Future Directions

6.3 Conclusions

The Smart Pantry App has exhibited significant potential as a transformative solution for addressing the challenges associated with household pantry management. By offering a comprehensive suite of features, including efficient inventory tracking, OCR technology for automated inventory updates, real-time tracking of expiration dates, and intelligent recipe recommendations, the app has demonstrated its capability to optimize food utilization and minimize waste. Overall, the Smart Pantry App has established itself as a valuable tool for individuals seeking to streamline their kitchen operations, reduce food waste, and make informed dietary choices.

6.4 Environmental, Economic, Societal Benefits

The **Smart Pantry App** is a multifaceted tool that not only enhances pantry management but also promotes **environmental sustainability**, **economic efficiency**, and **societal well-being**. By tackling food waste, resource mismanagement, and overconsumption, the app addresses critical issues at the household and community levels.

Environmental Impact

The Smart Pantry App directly combats food waste, which is one of the leading contributors to environmental degradation.

- **Reduction in Landfill Waste:** By tracking expiration dates and sending timely notifications, the app ensures that users consume food before it spoils. Recipe suggestions using ingredients close to expiry further minimize food disposal. This helps reduce the volume of food sent to landfills, where decomposing organic waste releases methane, a greenhouse gas significantly contributing to climate change.
- **Conservation of Resources:** The production of food demands significant resources, including water, land, and energy. When food is wasted, these resources are squandered as well. By enabling efficient inventory management and reducing overbuying, the app prevents the unnecessary use of natural resources and helps minimize the environmental footprint of households.
- **Sustainable Consumption:** The app fosters sustainable habits by encouraging mindful grocery shopping and optimal food usage, aligning with global sustainability goals to

reduce food wastage and conserve the environment.

Economic Benefits

The Smart Pantry App helps households achieve significant cost savings through efficient pantry management.

- **Reduction in Unnecessary Purchases:** By providing a clear inventory of pantry items, the app prevents overbuying and redundant grocery shopping. Users can avoid purchasing items they already own, saving money and time.
- **Maximizing Grocery Budgets:** With features like real-time expiry notifications and recipe recommendations, users make full use of their pantry items, ensuring groceries are consumed before they spoil. This eliminates waste and helps maximize the value of their grocery spending.
- **Cost-Efficient Planning:** The app's features, such as tailored shopping lists and meal plans, promote systematic purchasing, enabling users to better manage their budgets while reducing impulsive or excess purchases.
-

Societal Benefits

The Smart Pantry App fosters a culture of conscious consumption and shared environmental responsibility within communities.

- **Awareness and Education:** By highlighting food waste and its consequences, the app encourages individuals to adopt responsible food management practices. Over time, this raises awareness about sustainability and its broader impact on society.
- **Empowerment Through Technology:** The app empowers users to actively track and manage their food consumption, reducing waste at the household level. This small but impactful action contributes to larger societal goals of food security and environmental well-being.
- **Community Impact:** By reducing food wastage and promoting mindful consumption habits, the app encourages sustainable living practices, fostering a shared commitment to combatting food waste across families and communities.

The Smart Pantry App serves as a vital solution for addressing food waste, resource inefficiency, and overconsumption. Its features empower individuals to make a meaningful environmental impact, achieve economic savings, and promote sustainable habits within society. By helping households track inventory, reduce waste, and optimize grocery

consumption, the app contributes to building a more sustainable and responsible future.

6.5 Reflections

Developing Smart Pantry to address real-world problems faced by individuals in managing their food supplies has been a journey of great learning. The process has revealed the importance of integrating technology with everyday tasks, making it easier for users to stay organized and reduce waste. Through features like receipt scanning and expiry tracking, the app offers a practical and user-friendly approach to food management. There are, however, areas for improvement, especially in enhancing its scalability and adding more personalized features. The user feedback has been invaluable in refining the app's functionality and ensuring that it meets the needs of a diverse audience.

6.6 Future Work

To further advance the capabilities of the Smart Pantry App and increase its value to users, the following areas of development are proposed:

- **Ingredient Recognition:** We plan to implement advanced image recognition technology that can automatically identify and categorize pantry items from images. This feature will simplify the process of adding items to the inventory, making the app more user-friendly and reducing manual input.
- **Gamification and Rewards System:** By implementing features such as daily check-ins, points accumulation for reducing food waste, and completing pantry management tasks (e.g., updating inventory or consuming items nearing expiry), users can be rewarded with redeemable points. These points could be exchanged for grocery coupons, discounts, or exclusive offers in partnership with retailers. Gamifying the experience with challenges like “Zero Waste Weeks” or milestone achievements for sustainable practices will motivate users to adopt mindful habits while making the app more interactive and enjoyable. This approach not only boosts user retention but also reinforces the app's goal of promoting sustainable and responsible consumption.
- **Nutrition Analysis:** Incorporating nutritional information into the app is a key focus for future development. This feature will enable users to access detailed nutritional data for their pantry items, helping them make healthier food choices. Users will be able to track their dietary intake, aligning the app with health-conscious living.
- **Shopping List Integration:** Developing a dynamic shopping list feature is another

priority. This addition will automatically generate shopping lists based on pantry inventory, highlighting items that are low or out of stock. This will streamline the grocery shopping process, ensuring users maintain a well-stocked and balanced pantry.

- **Social Sharing:** To foster a sense of community and collaboration, we plan to introduce a social sharing feature. Users will be able to share recipes, pantry management tips, and experiences with others, creating a platform for knowledge exchange and mutual support.
- **User Preference Learning:** Refining the app's recommendation system through machine learning is essential for providing a more personalized experience. By learning from user interactions and preferences, the app will offer increasingly tailored meal suggestions and pantry management advice, adapting to individual dietary restrictions and tastes over time.
- **Integration with Smart Appliances:** Exploring the integration of the app with smart kitchen appliances represents a significant opportunity for future development. This could include syncing with smart fridges, ovens, and other devices to enhance functionality and automate tasks like tracking expiration dates or adjusting cooking settings based on pantry inventory.

By pursuing these future enhancements, the Smart Pantry App aims to become an even more comprehensive and valuable tool for sustainable living and efficient household management, continually evolving to meet the changing needs of its users.

7 Project Metrics

7.3 Challenges Faced

The development of Smart Pantry presented several challenges. A key challenge was ensuring the accuracy of the Optical Character Recognition (OCR) feature, particularly when scanning receipts. Variations in receipt formats, fonts, and print quality led to occasional misreads, requiring fine-tuning of the OCR algorithm for better reliability. Another challenge was optimizing the app's performance as users added more items to their pantry, particularly when large quantities of data were involved. Ensuring better integration between the receipt scanning feature, inventory tracking, and expiry notifications while maintaining smooth app performance was a critical task. Additionally, the recipe suggestion algorithm required ongoing refinement to provide more accurate and personalized recommendations based on available ingredients.

7.4 Relevant Subjects

Subject Code	Subject Name	Description
UML501	Machine Learning	Machine Learning techniques help in creating models which helps in predicting output based on some dataset through training and testing. The quality and quantity of historical data determine the accuracy of a machine learning model.
UCS672	Data Science Applications: NLP	A branch of artificial intelligence that allows computers to understand, interpret, and manipulate human language. NLP uses machine learning to analyze patterns in natural language data to improve a computer program's language comprehension.
UCS503	Software Engineering	Software Engineering is a study in which we study the design of the structure. With the help of UML diagrams it is easy to interpret the logic of developer

UCS542	UI/UX	User interface (UI) design refers to the aesthetic elements by which people interact with a product, such as buttons, icons, menu bars, typography, colors, and more. User experience (UX) design refers to the experience a user has when interacting with a product.
UCS677	Data Engineering	Data engineering refers to the building of systems to enable the collection and usage of data. This data is usually used to enable subsequent analysis and data science, which often involves machine learning. Making the data usable usually involves substantial compute and storage, as well as data processing.

Table: 7.2.1 Relevant Subjects

7.5 Interdisciplinary Knowledge Sharing

Smart Pantry's development required collaboration across multiple disciplines. Mobile app development was combined with OCR technology to enable the receipt scanning feature, while machine learning & relevant APIs helped improve recipe recommendations. We gained insights into food waste management, ensuring the app aligned with environmental goals. Additionally, user experience experts contributed to refining the interface, ensuring the app was intuitive and easy to use. This interdisciplinary approach allowed the development of a holistic app that addressed both technological and societal needs.

7.6 Peer Assessment Matrix

		Evaluation of			
		Chetna Sharma	Prachi Kumar	Anchal	Sukhmajot Kaur
Evaluation By	Chetna Sharma	5	5	5	5
	Prachi Kumar	5	5	5	5
	Anchal	5	5	5	5
	Sukhmanjot Kaur	5	5	5	5

Table: 7.4.1 Peer Assessment Matrix

7.7 Role Playing and Work Schedule

The project followed a structured approach with clear roles and a well-defined work schedule. The project manager ensured effective coordination, setting deadlines and managing team communication. Two team member worked on creating the U/UX to create a user friendly app. The other members focused on creating OCR and worked on refining the scanning and recipe recommendation features. The development was done as a group. The team followed a milestone-based schedule, completing tasks like initial prototype development, feature integration, and user testing, which helped ensure smooth progress. Regular meetings were held to discuss challenges, share progress, and make adjustments to the work schedule as needed

7.8 Student Outcomes Description and Performance Indicators (A-K Mapping)

SO	SO Description	Outcome
1.1	Ability to identify and formulate problems related to computational domain	Identified the challenge of managing food inventory and tracking expiry dates efficiently while maintaining a smooth user experience.
1.2	Apply engineering, science, and mathematics body of knowledge to obtain analytical, numerical, and statistical solutions to solve engineering problems.	Used OCR and image processing techniques to extract food items from receipts and optimize the database for tracking expiry dates.
2.1	Design computing system(s) to address needs in different problem domains and build prototypes, simulations, proof of concepts, wherever necessary, that meet design and implementation specifications.	Designed Smart Pantry to automate inventory management with OCR, expiry tracking, and recipe suggestions, ensuring it met user needs.
2.2	Ability to analyze the economic trade-offs in computing systems.	Balanced app performance with computational costs of OCR and recipe recommendations, ensuring speed without sacrificing accuracy.
3.1	Prepare and present variety of documents such as project or laboratory reports according to computing standards and protocols.	Created clear, comprehensive documentation detailing features, algorithms, and user interface design for the app.
3.3	Able to communicate effectively with peers in well organized and logical manner using adequate technical knowledge to solve computational domain problems and issues.	Effectively communicated technical solutions to the team, ensuring smooth collaboration and decision-making.
4.1	Aware of ethical and professional responsibilities while designing and implementing computing solutions and innovations.	Ensured Smart Pantry adhered to privacy standards, securely handling user data and syncing pantry information across devices.
4.3	Evaluate computational engineering solutions considering environmental, societal, and economic contexts.	Promoted sustainability by reducing food waste and supporting mindful consumption through efficient inventory management.
7.1	Able to explore and utilize resources to enhance self-learning.	Explored resources on OCR, machine learning, and inventory management to improve the app's features and performance.

Table: 7.5.1 A-K Mapping

7.9 Brief Analytical Assessment

In terms of performance, Smart Pantry was successful in achieving its core goals of reducing food waste, improving pantry organization, and streamlining meal planning. User feedback and engagement data indicated that features like receipt scanning and expiry date tracking were particularly. The app's performance is generally stable across devices, although user testing highlighted areas for optimization, particularly in database management and search functionality. From a technical perspective, the OCR feature saw marked improvements over time, and the recipe suggestion algorithm was continually refined for better accuracy. The app fulfilled its primary objectives, but future work will focus on enhancing the personalized recommendation system and integrating with smart home devices for more seamless functionality.

Q1. What were the information sources explored by your group to reach at the stated possible project problems?

We explored research papers, online articles, and existing apps to understand challenges in food inventory management and reducing waste. After brainstorming and discussing with a mentor, we chose to build Smart Pantry, which solves problems like expiry tracking and recipe suggestions.

Q2. What were the analytical and/or experimental methods that were used to gather solutions to the issues in the project?

We experimented with different OCR libraries and selected the most accurate one for extracting food items. We tested expiry date management using a calendar system and refined recipe suggestions with machine learning and APIs like EDAMAM.

Q3. Was the proof of knowledge of fundamentals, engineering principles required in the project? If so, how was it done?

Yes, knowledge of mobile development, OCR, and machine learning was essential. We applied engineering principles in structuring the app, ensuring smooth data flow, and securing user data.

Q4. How was the responsibility shared among the group members and what medium was used to communicate the information of schedule with others in order to coordinate

design?

Responsibilities were divided based on expertise: one member handled OCR, another focused on UI, and another on recipes and database. We used Trello for task tracking and Google Docs/Slack for communication and scheduling.

Q5. What were the various means that you have used to learn different subjects that were not in your course during this project?

We learned about OCR, Flutter and APIs through online tutorials, Stack Overflow, and documentation. We also consulted peers with experience in these areas to solve technical challenges.

Q6. Is the final result appreciable according to you and does it cater to solve real life problems and does it help you to be skilled in different software development tools or not during development of projects?

Yes, the app addresses real-life issues like food waste and pantry management. It improved our skills in Flutter, OCR, and database management, and exposed me to new tools, enhancing our software development expertise.

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