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# PANTRY-PAL CONCEPTUAL BUSINESS MODEL: AN INTEGRATED EXPIRY SCANNER AND RECIPE GENERATION PLATFORM

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***Abstract:*** **Current global food waste management faces significant challenges as households struggle to track food inventory and monitor expiry date efficiently leading to unnecessary food disposal and financial loss. Existing solutions are often manual and fragmented which create a need for an integrated and automated approach to support smarter food consumption. To address these challenges, this paper proposes PantryPal, an AI-powered platform designed to streamline food management through an automated ecosystem by utilizing barcode technology and AI system to automatically log items and monitor expiry date efficiently. The study involved conducting through literature review, competitive benchmarking and user interview to identify key challenges, followed by developing prototyping, Business Model Canvas (BMC), Value Proposition Canvas (VPC), Environmental Map (EM) and Strategy Canvas (SC). This research contributes to sustainability by aligning with United Nations Sustainable Development 12, responsible consumption and production and national digital transformation agendas which ultimately help users reduce financial waste and environmental impact through intelligent meal planning. In order to assist the actual implementation, scalability, and long-term sustainability of the PantryPal solution, further work will concentrate on creating a thorough business plan based on the verified Business Model Canvas (BMC).**

***Keywords:*** **PantryPal; Food Waste Management; Artificial Intelligence (AI); Barcode Scanning; Recipe Generator; Expiry Date Tracking; Business Model.**

## I. INTRODUCTION

Every year, the world faces a growing waste management challenge linked to unsustainable consumption patterns. According to the United Nations 2024 report, around 1.05 billion tonnes of food waste were generated in 2022, with households contributing a significant portion. This issue not only leads to financial losses but also negatively impacts the environment and resource sustainability. In response, global initiatives such as the United Nations Sustainable Development Goal 12 (SDG 12) emphasizes the importance of responsible consumption and production practices.

This study is focusing within the field of technology-enabled sustainability and smart consumer applications. Recent advancements in Artificial Intelligence (AI) and Internet of Things (IoT) have introduced technological approaches to reduce food waste. For example, AI-based systems can be adapted to real-world complexities in food management [18], while IoT-enabled smart kitchen solutions provide real-time monitoring of food conditions [17]. However, many existing applications still rely on manual input and lack integration between inventory tracking and recipe generation, resulting in inefficiencies [20], [21].

The purpose of this proposed system is to address this limitation by proposing an AI-powered integrated platform called PantryPal. This proposed system enables users to automatically create their inventory list by scanning their expiry dates directly using mobile phones and monitor their expiry date efficiently. The system generates personalized recipe suggestions according to inventory lists, which help in reducing waste and planning user meals efficiently. In addition, this proposed system provides personalized recipe recommendations based on available inventory to support meal planning and reduce food waste.

By serving as a central intermediary, this platform aims to connect users with charitable organizations through integrated ecosystem that facilitate food management, aligning its objectives with SDG which are SDG 12:Responsible Consumption and Production, SDG 2: Zero Hunger, SDG 13: Climate Action and SDG 11: Sustainable Cities and Communities as reducing food is not only improve availability of food but also minimize environmental impacts. By promoting technology innovation based on the Maqasid al-Shariah principle, PantryPal serves as a catalyst for sustainability lifestyles by streamlining the complexities of food management.

## II. OBJECTIVES

The main objective of PantryPal is to provide an AI-powered platform that integrates expiry date detection and recipe generation platform to reduce household food waste by managing meals efficiently and promote sustainable consumption practices. Specifically, this paper aims to:

a. Improve household food management by reducing the risk of forgotten or expired food, in alignment with SDG 12 (Responsible Consumption and Production)

b. Promote environmental sustainability by minimizing food waste at household level, supporting SDG 11 (Sustainable Cities and Communities)

c. Develop a technology-driven platform that supports the national digital transformation agenda outlined in MyDigital by promoting sustainable solutions in addressing food waste issues.

d. Design an integrated platform that supports sustainable and responsible consumption practices while embedding principles of Maqasid al-Shariah, particularly in preserving wealth and life.

e. To provide an integrated platform that connects service seekers with solution providers to facilitate efficient food management.

## III. METHODOLOGY

This study adopts the Design Thinking methodology which comprises empathize, define, ideate, prototype, and test stages to address the complexities in food waste and inventory management. In the empathize stage, a comprehensive literature review and competitive benchmarking were conducted to understand issues such as manual tracking and inefficient meal planning. The define stage identified key problems, including food wastage due to poor inventory monitoring. During the ideate stage, solution concepts were developed focusing on AI-powered barcode scanning and automated tracking. Next, the PantryPal conceptual model was developed using strategic frameworks including Business Model Canvas (BMC) and Value Proposition Canvas (VPC) to ensure the product specifically targets the pains of the customer segment while aligning with the national digital transformation agenda initiative MyDIGITAL and Sustainable Goals 12 Responsible Consumption and Production. Finally, the study involved evaluating the model's feasibility as a high-tech and low-cost alternative to smart appliances, ensuring the solution is accessible for everyday households while promoting a zero-waste lifestyle.

## IV. LITERATURE REVIEW

### *A. 4IR / MyDigital / 13MP*

The Fourth Industrial Revolution (4IR) integrates advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), and automation into daily life and business operations [8]. In response to this transformation, governments worldwide have accelerated digital initiatives to improve productivity and innovation. In Malaysia, MyDigital was introduced to strengthen digital transformation and encourage the adoption of emerging technologies, including AI [9].

The way people handle everyday chores like grocery shopping, cooking, and food storage has changed due to digital disruption, increasing the demand for smart technologies that provide real-time monitoring and automated notifications. Therefore, by delivering a digital solution that automates food expiry tracking and offers clever recipe recommendations, the suggested PantryPal system complements the 4IR goal. The system demonstrates how digital innovation can address practical challenges such as ineffective meal planning and food waste.

Furthermore, PantryPal aligns with the objectives of the Thirteenth Malaysia Plan (13MP), which highlights sustainability, efficient ways of resource utilization and waste reduction. These elements serve as essential foundations in order to achieve long-term environmental goals. This proposed system is aligned with Malaysia's agenda to promote responsible consumption practices and reduce overall waste generation. By minimizing food waste and optimizing food management, an individual can achieve greater cost savings and improved food security which enables more equitable access to food for communities in need.

### *B. Food Waste Management in the Global and Local Marketplace*

Food waste is a significant worldwide problem that has an impact on household costs, environmental sustainability, and food security [10]. Food waste has become a major issue in Malaysia, especially in the food service industry where a lot of food is produced to satisfy a variety of customer demands, frequently leading to the discarding of extra food [26]. Millions of tons of food are reportedly wasted annually as a result of overpurchasing, poor inventory management, and forgotten expiration dates [10], [11]. Food waste contributes to environmental challenges, including the exhaustion of natural resources and the rise of greenhouse gas emissions [11]. Companies like Soup kitchens, Central kitchens, catering services and restaurant platforms for online meal delivery, and systems for managing household food have put in place a number of tactics to cut down on food waste, such as inventory management systems, portion control, and donation programs [12]. Mosque kitchens and other community-based food projects utilize shared facilities and resources to improve the efficiency of food distribution within local communities while providing food assistance [23]. These programs seek to reduce waste production while increasing resource efficiency and food accessibility. Additionally, research indicates that consumers are becoming more worried about food waste and are in favor of solutions that enable more efficient handling of excess food [26].

Nevertheless, a lot of current solutions solely address food waste or recipe recommendations without incorporating automatic alerts and expiration date tracking. So, to close this gap, the suggested system combines monitoring food expiration, creation of recipes, intelligent alerts and digital inventory control. SDG 12: Responsible Consumption and Production, which prioritizes minimizing food waste and encouraging sustainable consumption, is directly supported by this solution [13]. Reducing food waste also helps people save money and better control their grocery spending from a business standpoint [11]. As a result, both domestic and international markets have a high demand for digital solutions that facilitate effective food management [12]. The development of online systems for food services and resource management has been prompted by the rapid expansion of digital platforms, especially during the COVID-19 pandemic, underscoring the significance of technology-based solutions in resolving food-related issues [23].

### *C. Benchmark of Similar/ Competitors Business Models*

#### *I. Beep Expiry Tracking (https://www.beepscan.com/)*

Food inventory and expiration tracking functions are available in a number of current applications. The suggested digital platform is developed using these systems as benchmarks. One of similar business models include, Beep Expiry Tracking app which uses reminder notifications to assist consumers in keeping track of food expiration dates [14]. The software is well-known for its straightforward layout and easy-to-use design, which make it practical for people and households to effectively manage their food supplies.

Nevertheless, the application has certain drawbacks despite its value. For example, its restricted recipe suggestion features make it less useful for meal planning based on ingredients that are readily available. Additionally, users must manually enter meal information into the system, which can be inconvenient and time-consuming. These drawbacks emphasize the need for more complex systems that incorporate intelligent recipe generation features and automated scanning technology. The BMC of Beep Expiry is shown in Figure 1 below.

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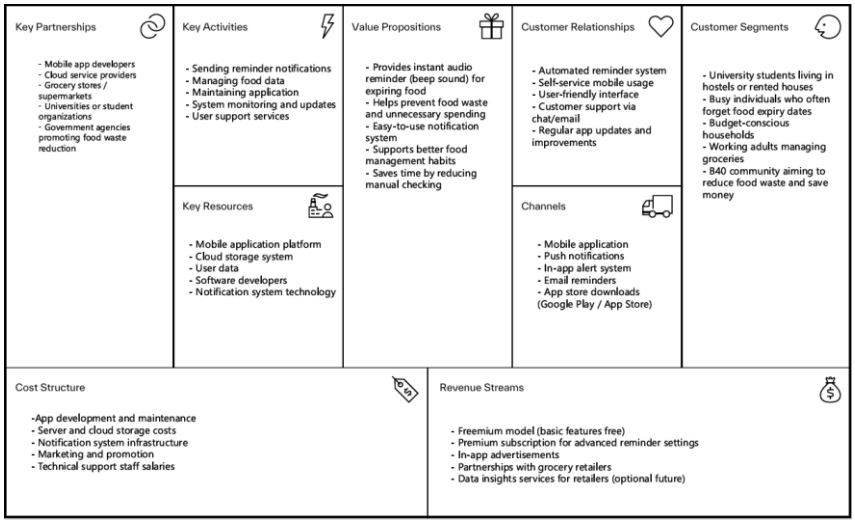


**Figure 1: Beep Business Model**

### *II. Expiry Alert*

Another similar business model includes the Expiry Alert application which helps users efficiently manage perishable goods and cut down on food waste by offering automated alerts and an easy-to-use interface. However, compared to more advanced systems, the system's effectiveness is limited due to its heavy reliance on manual input and absence of complex capabilities like barcode scanning and predictive analytics.

The Business Model Canvas (BMC) framework can be used to study the shared characteristics of rival business models. When it comes to consumer categories, the majority of food expiry tracking apps mainly target families, households, and students that require help with food inventory management. In order to help consumers keep an eye on food products and cut down on waste, their value proposition centers on offering food tracking and simple recipe recommendations. In terms of revenue streams, these apps usually make money from adverts and premium subscription services.

To guarantee the system runs smoothly, these companies also engage in data administration and application development. Mobile platforms and cloud storage systems that facilitate data processing and user access make up most of their primary resources. Additionally, food producers and grocery stores are frequently important partners, working together to offer promotional services or product information. Lastly, the cost structure of these applications typically includes costs for server hosting, application maintenance, and marketing initiatives necessary to maintain company operations. The BMC of Expiry Alert is shown in Figure 2 below.

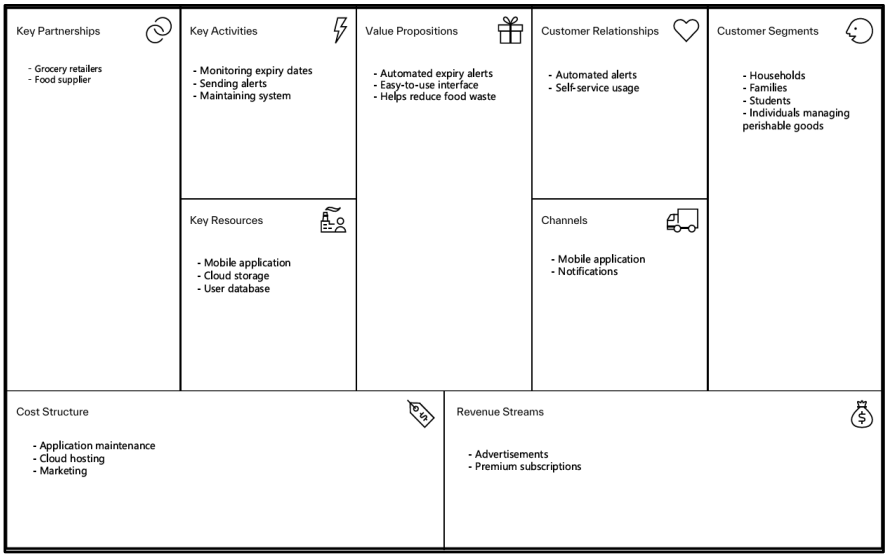


**Figure 2: Expiry Alert Business Model**

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### *D. Reskilling & Upskilling*

To increase employability among B40 and laid-off workers, the Malaysian government places a strong emphasis on reskilling and upskilling programs, especially in response to labor market problems and technological advancements. By increasing the income floor and bolstering high-value businesses, the government hopes to improve workforce productivity and lessen income disparity under the Thirteenth Malaysia Plan [15]. Sustainable Development Goals (SDG) 4: Quality Education and SDG 8: Decent Work and Economic Growth, which emphasize expanding access to skill development and fostering long-term job prospects, are in line with these approaches.

By giving B40 workers chances for employment and the development of digital skills, the proposed PantryPal system advances these national objectives. For instance, people can be taught to manage food inventory data, or help with system maintenance and logistics. By offering hands-on expertise in digital technologies like data management and mobile applications, these positions aid in addressing the mismatch between current skills and labor market expectations [16].

Additionally, the PantryPal platform can work with community organizations and government training programs to offer unemployed or underemployed people short-term training in digital skills. The system promotes the national aim of equitable economic growth and sustainable employment, as well as workforce development, by facilitating income-generating possibilities and encouraging digital literacy.

## V. INITIAL BUSINESS MODEL - USING BMC & VPC FRAMEWORK

The initial Business Model was developed after conducting a through literature review and competitive benchmarking analysis of existing inventory management companies, as illustrated in Figure 3.

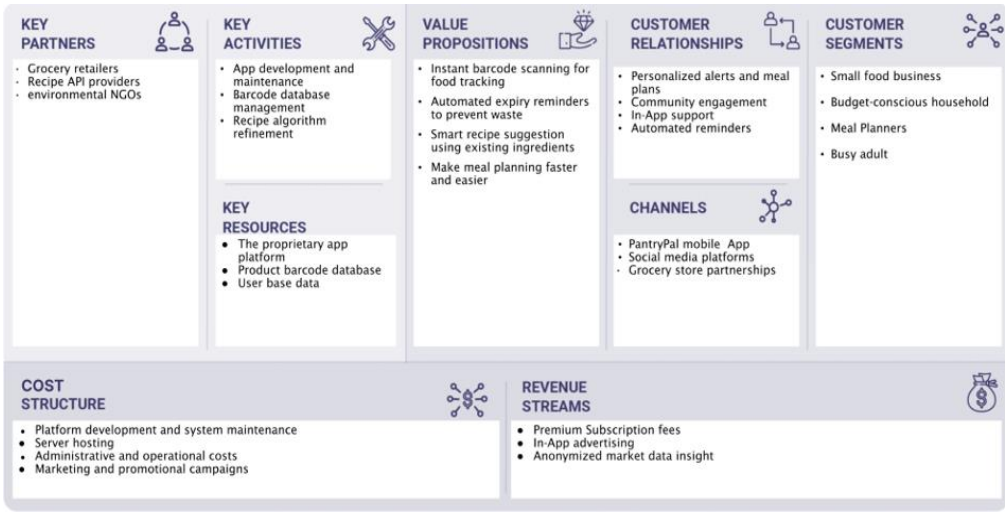


**Figure 3: Initial Business Model for PantryPal**

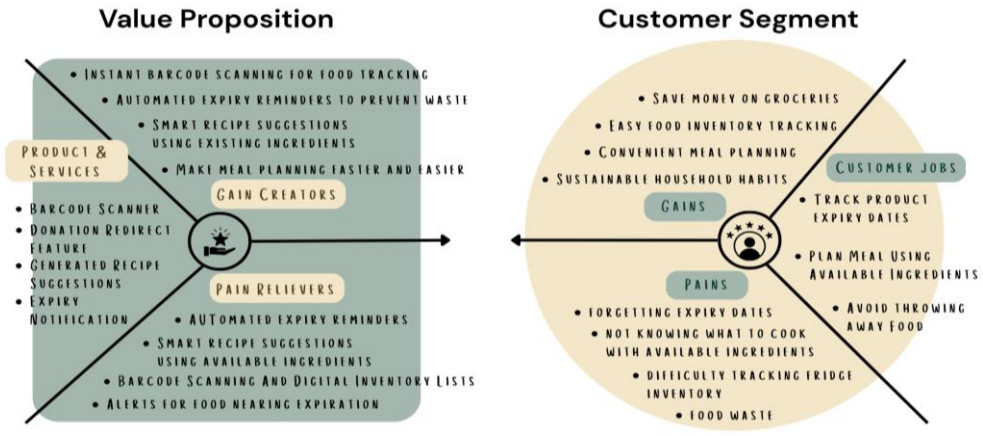


**Figure 4: Initial Value Proposition Canvas for Household Consumer**

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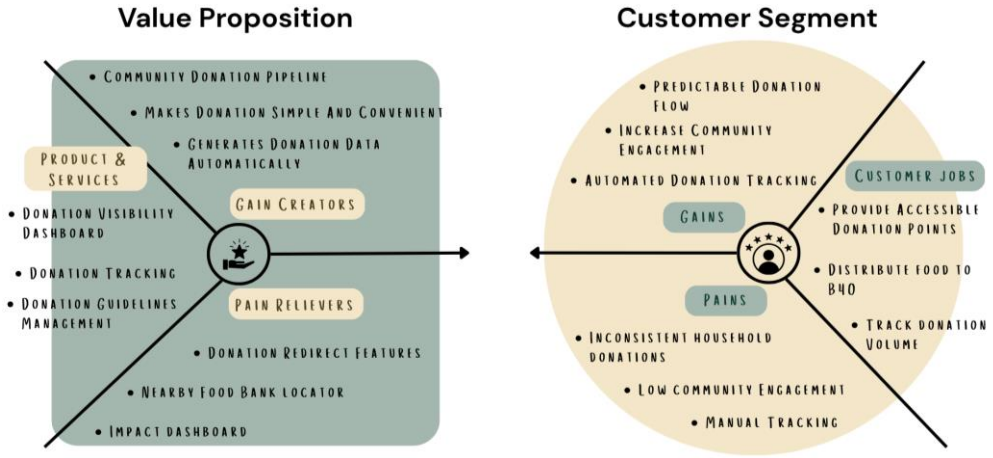


**Figure 5: Initial Value Proposition Canvas for Charity Organizations**

## VI. CONDUCT VALIDATION OF INITIAL BM & KEY FINDINGS

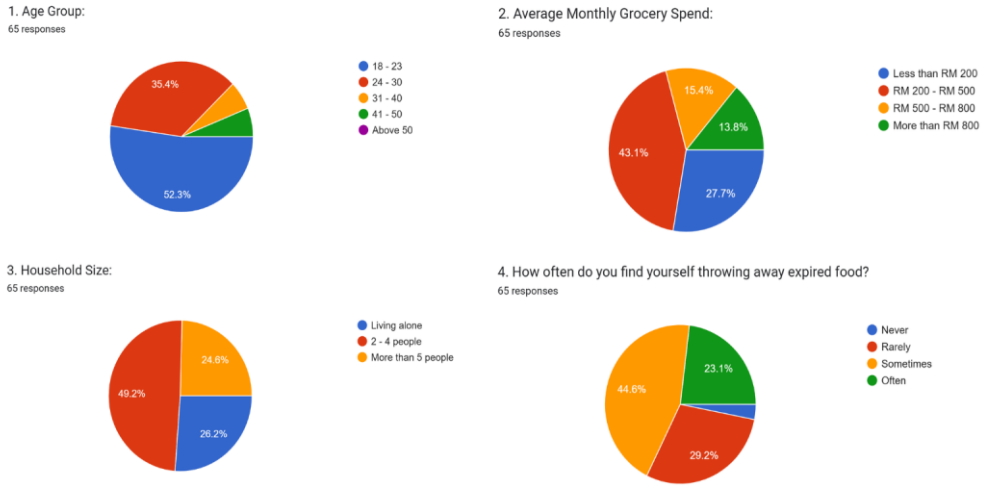


**Figure 6: Customer Demographics and Food Waste Behavior**

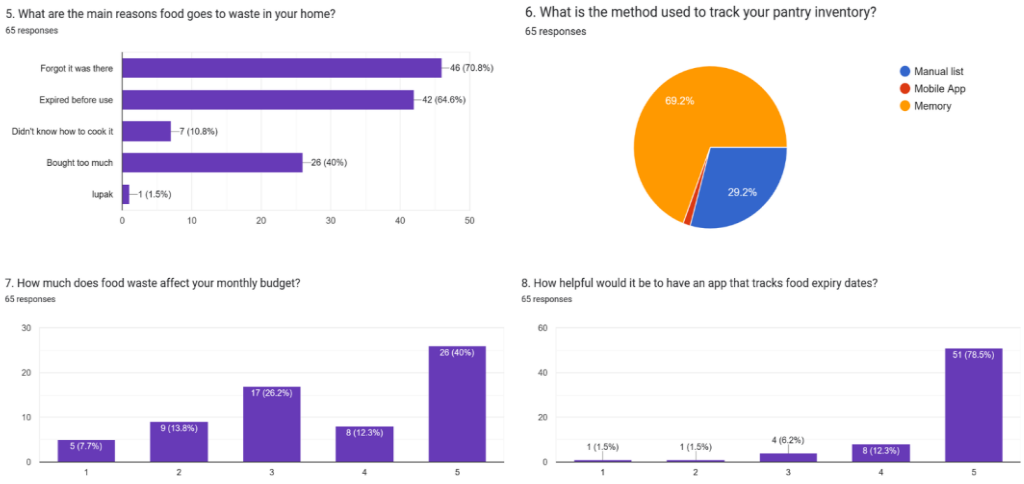


**Figure 7: Food Waste Causes and User Needs**

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The survey results strongly validate the initial Business Model of PantryPal by confirming the existence of real user problems and the relevance of the proposed solution. Firstly, the data shows that food waste is a widespread issue, with 23.1% of respondents frequently discarding expired food along with 44.6% occasionally discarding expired food (Figure 6). The main causes of food waste show that the user often forgetting the existence of food by 70.8% followed by 64.8% user state expiry before usage directly (Figure 7) . This supports the need for PantryPal's barcode scanning and expiry tracking features. Secondly, the findings reveal that most users currently rely on memory rather than systematic tracking methods (Figure 7). This highlights a clear gap in the market and justifies the introduction of a digital solution that automates inventory management. Furthermore, the survey indicates that food waste has a noticeable financial impact on users, aligning with PantryPal's value proposition of reducing unnecessary spending. The strong positive response in which 78.5% rating it as very helpful toward an expiry tracking app confirms high user interest and potential adoption (Figure 7).

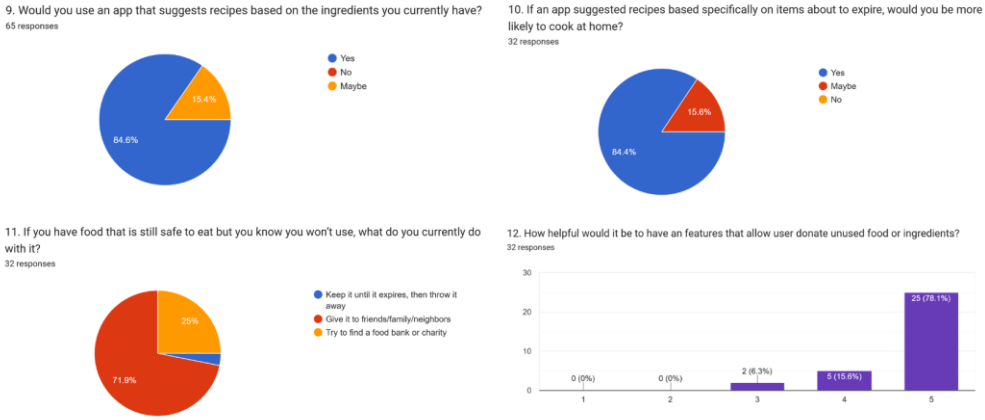


**Figure 8: Initial Value Proposition Canvas for Charity Organizations**

In addition, the results from Figure 8 further strengthen the validation of PantryPal's extended features. A large majority of 84.6% expressed willingness to use an app that suggests recipes based on available ingredients, while 84.4% indicated they would be more likely to cook at home if recipes were recommended based on items nearing expiry. This confirms the relevance and effectiveness of the AI-generated recipe feature in promoting better food utilization. Moreover, current user behavior shows that 71.9% of respondents already give unused food to friends or family, and 25% attempt to find food banks or charities. This demonstrates an existing willingness to share or donate food but highlights the lack of a structured and convenient system. This gap is further validated by the finding that 78.1% of respondents rated a food donation feature as "very helpful" (Figure 8), confirming strong demand for PantryPal's location-based donation functionality. These findings indicates that users are not resistant to changing their behavior, in fact they are willing to take small steps to reduce food waste, This suggest that PantryPal can help facilitate the user to reduce food waste by providing a structured that integrate recipe suggestions and donation features into easy to use platforms.

## VII. VALIDATED BUSINESS MODEL

### *A. Business Model Canvas*

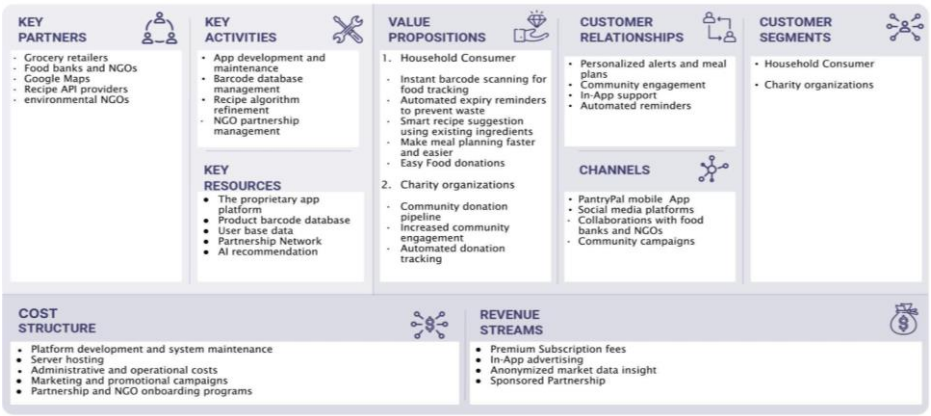


**Figure 9: Validated Business Model for PantryPal**

### I. Customer Segments

The customer segments for PantryPal represent the diverse groups of individuals that struggle with food inventory management and waste. We have identified four primary segments:

- **Household Consumer**: This segment includes individuals and families who experience difficulty in tracking food inventory, managing expiry dates, and planning meals effectively. Many users often forget items in their pantry or fridge, leading to unnecessary food spoilage and increased expenses. PantryPal supports these users by providing an automated and structured system to monitor and utilize their food more efficiently.
- **Charity Organizations**: This segment includes food banks and non-governmental organizations that aim to reduce food insecurity. PantryPal connects these organizations with users who have surplus or unused food, enabling a smoother and more efficient donation process.

### II. Value Propositions

PantryPal provides a complete and seamless food management lifecycle solution, guiding users from tracking to action.The process begins with barcode scanning, allowing users to quickly add items into their inventory. The system then tracks expiry dates automatically, ensuring users are aware of food that is nearing expiration. Next, PantryPal supports decision-making through AI-generated recipe suggestions, which recommend meals based on available ingredients, helping users utilize food efficiently. If users choose not to use certain items, especially those nearing expiry, the app provides a donation option, where users can locate the nearest food banks or donation points and contribute their surplus food.

### III. Customer Relationship

To build long-term engagement, PantryPal combines automation with meaningful user interaction. The app delivers personalized alerts to notify users about upcoming expiry dates and provides tailored recipe suggestions based on their inventory. These features ensure a highly relevant and helpful experience with minimal user effort. Additionally, PantryPal encourages community-driven behavior by promoting food donation and sustainable habits. Users are not only managing their food but also contributing to society. A built-in support system ensures continuous feedback and improvement of the platform.

### IV.Channels

PantryPal delivers its value through a strategic mix of digital and physical touchpoints designed to meet users where they shop and cook. The primary channel is the PantryPal mobile application, which is available on both iOS and Android, which serves as the central hub for inventory tracking and recipe discovery. To expand our reach, we utilize social media platforms like TikTok and Instagram for educational marketing on food waste. We also collaborate with food banks and NGOs, allowing the app to provide accurate locations for nearby donation points. Not only that, PantryPal also uses the mosque as a place for B40 individuals to collect their free food while also utilizing the mosque community to further enhance awareness and adoption for our application [23], [24], [25].

### V. Key Activities

The core operational focus of PantryPal is the continuous refinement and maintenance of our technological infrastructure to ensure a seamless user experience. This involves intensive software development to keep the app responsive, alongside the critical task of barcode database management to ensure a vast library of local and international products can be recognized instantly. Additionally, we dedicate resources to refining our recipe algorithms, ensuring that the AI-driven suggestions are accurate, diverse, and prioritize items that are nearest to their expiration dates. Another critical activity is managing the donation system, including integrating location-based services to connect users with nearby food banks and coordinating partnerships with NGOs.

### VI. Key Resources

Our competitive advantage lies in our proprietary app platform and an extensive, high-quality product barcode database that stores vital shelf-life and nutritional information. These assets, combined with anonymized user consumption data, allow us to maintain a high-performing ecosystem that can scale and adapt to changing consumer food habits. In addition, PantryPal depends on its network of partners, including food banks and NGOs, to support its donation feature and expand its ecosystem.

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### VII. Key Partners

We collaborate with grocery retailers for data integration, recipe API providers for culinary content, and environmental NGOs to boost our credibility in the sustainability space. These partnerships are essentail for expanding our product library, reaching new user demographics, and aligning our mission with broader national goals for food waste reduction. Most importantly, food banks and charity organizations are essential partners, as they enable the donation feature by receiving and distributing surplus food from users.

### VIII. Cost Structure

Our primary financial obligations include software engineering salaries for platform maintenance and the cloud hosting fees required to store real-time inventory data. Additionally, PantryPal invests in marketing campaigns to attract users and partnership onboarding to expand its network of NGOs and food banks.

### IX. Revenue Stream

PantryPal generates income through a freemium model where users pay subscription fees for advanced features like AI generated recipe recommendation. Additional revenue streams include in-app advertising, sponsored partnerships, and anonymized market data insights. These ensure financial sustainability while maintaining accessibility for a wide user base.

## *B. Environment Map*

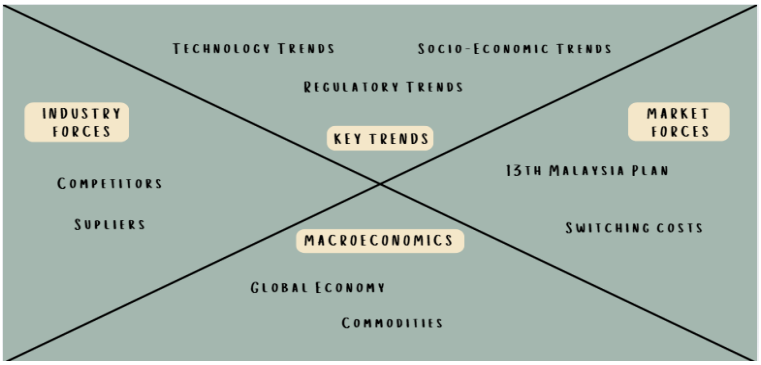


**Figure 10: Environment Map for PantryPal**

### I. Key Trends

The success of PantryPal is driven by the rapid development of prediction-based computing as outlined in the National AI Action Plan (2026-2030), which transforms digital tools from reactive trackers to proactive household assistants. Under the National 4IR Policy, the integration of advanced computer vision allows our platform to automate inventory logging through receipt and refrigerator scanning, directly supporting Malaysia's goal of increasing sectoral productivity by 30% by 2030 [1] [2]. Socioeconomically, the 13th Malaysia Plan (13MP) emphasizes raising the economic floor, a directive that aligns with the growing Zero-Waste Living megatrend as M40 and B40 households adopt digital gudgeting to combat persistent food inflation [3], [4]. Furthermore Budget 2026 provides a supportive regulatory environment by offering a 50% additional tax deduction for MSMEs investing in AI, while the Digital Trust & Data Security Strategy ensures a secure framework for our cloud-based synchronization [5].

### II. Market Forces

The Malaysian Digital Economy Blueprint (MyDIGITAL), specifically entering its mature phase 2026, aims to pivot Malaysia as a regional leader in AI-driven innovation. According to Phase 3 of the Blueprint, the government is emphasizes Industrial Empowerment through technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI) to increase household productivity and improve livelihoods [6]. The 13th Malaysia Plan (13MP) identifies food security as a national priority, which encourages the development of Public-Private Partnerships and digital solutions that help citizens manage resources more effectively. According to the National Entrepreneurship Policy 2030, there is significant strategic support for innovation-driven enterprises that address social challenges like food waste, which remains a multi-billion dollar drain on the global economy. As digital literacy reaches its peak under these national inclusivity goals, the switching costs for user have decreased, provided the application offers immediate pain relief by reducing monthly grocery spending

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### III. Industry Forces

This part identifies the competitive landscape where Industry Competitors like Beep and Expiry Alert are already digitizing food operations for businesses. While these competitors focus on basic expiry alerts, PantryPal occupies a unique gap through the Industrial Empowerment pillar of MyDigital Phase 3, offering high-value features like AI-driven recipe generation and integrated usage planning. Our operational efficiency is further bolstered by the Data Sharing Act 2025, which simplifies access to localized product databases, and the government's push for 80% cloud storage migration in Budget 2026, which lowers hosting costs for startups. By offering a low-cost, high-tech alternative to expensive smart appliances, PantryPal successfully counters the threat of hardware-based substitutes while maintaining superior, localized software logic

### IV. Macroeconomics

The macroeconomic environment for PantryPal is shaped by extreme volatility in global supply chains, specifically influenced by the geopolitical conflict in West Asia. This situation has disrupted shipping through the Strait of Hormuz, causing a surge in global energy prices and a fertilizer shock that has directly inflated the retail price of meat, vegetables, and eggs in Malaysia [7]. As the Ringgit's purchasing power faces pressure from imported inflation, the economic cost of failure for wasting food has reached an all-time high, making inventory management a critical financial strategy. Budget 2026 responds to these pressures with a total allocation of RM419.2 billion focused on structural reforms and technology-driven resilience, positioning waste-reduction tools as a strategic economic asset for the MADANI economy.

### *C. Strategy Canvas*

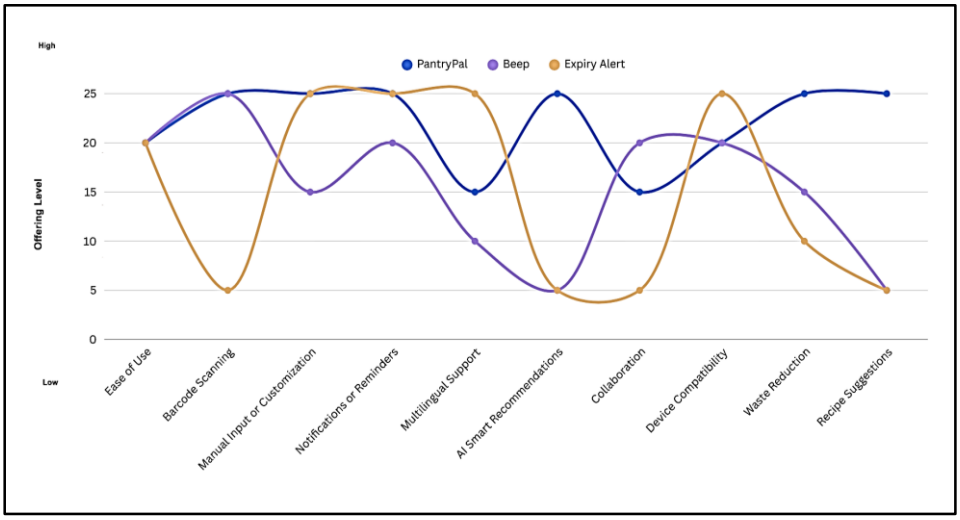


**Figure 11: Strategy Canvas for PantryPal**

The Strategic canvas illustrates the comparison of PantryPal to its existing primary competitors in the food management and inventory tracking market which are Beep and Expiry Alert by continuing to provide at a dominant level in almost every important value factor. PantryPal stands out by achieving a high score of 25 in Barcode Scanning, which successfully matches Beep while much exceeding Expiry Alert's labor-intensive approach score 5, even though all three platforms offer strong Notifications or Reminders with score 25. In AI Smart Recommendations and Recipe Suggestions, where both competitors fall to the lowest offering level to Score 5, while PantryPal achieves a maximum score of 25, highlighting a significant competitive gap, according to the canvas. PantryPal evolves from a passive tracking tool into a comprehensive kitchen helper that actively promotes Waste Reduction with score 25 through AI-driven meal planning by giving priority to these high-tech, practical solutions over more general categories like Collaboration or Multilingual Support. This exemplifies PantryPal's Blue Ocean Strategy (BOS) and "Purple Cow" factor, whereby the platform sets itself apart from traditional expiry-tracking applications by integrating food donation integration, automated barcode scanning, and AI-powered recipe generation into a single intelligent ecosystem. By turning food management into a proactive, sustainable, and user-centered digital experience, PantryPal delivers a distinct value innovation in contrast to Beep and Expiry Alert that simply concentrate on reminders and manual tracking.

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### *D. Mock-up of the Proposed Mobile Application*

#### I. Get Started Page

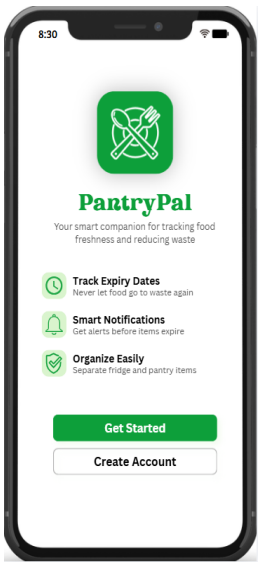


**Figure 12: Get Started Page of PantryPal**

The Get Started page shown in Figure 12 above is the primary starting point for the PantryPal mobile application. It is designed to introduce users to the system's main purpose and core features, which include food inventory management and waste reduction. The user interface (UI) provides a brief description of the application's primary capabilities, such as expiry date tracking, smart notifications and efficient food item organization. These capabilities are visually supported with symbols and brief explanations, allowing users to quickly understand the advantages of making use of the program.

In terms of navigation, the page provides two main options: Get Started and Create Account. The "Get Started" button allows users to get into the application instantly, either as a guest or a returning user, while the "Create Account" option leads new users through the registration process. The design is purposefully straightforward and user-friendly, ensuring clarity and ease of use for the first-time users. Overall, this page plays an important part in user onboarding by providing a clear introduction and guiding users to the following steps when accessing the application.

#### II. Login and Register Pages

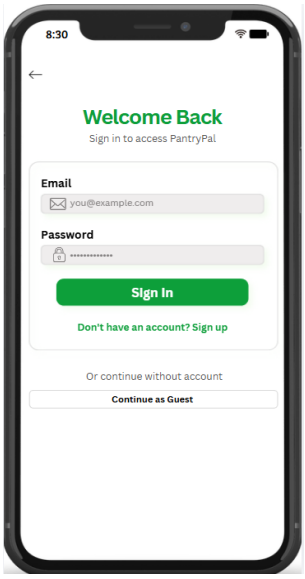


**Figure 13: Login Page of PantryPal**

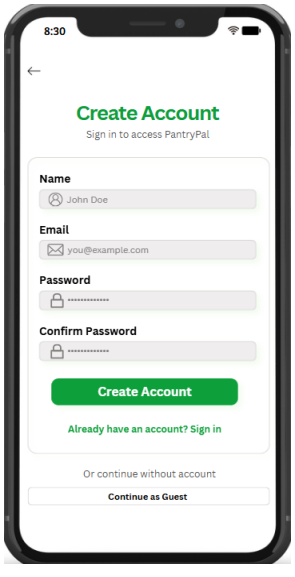


**Figure 14: Register Page of PantryPal**

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The Login page shown in Figure 13 above is designed to provide existing users secure access to their PantryPal accounts. Users must enter their registered email address and password into related areas. Before giving access to the application, the system performs authentication checks to ensure that the credentials are accurate. This ensures that user data, particularly food inventory information, remains secure and protected. The page has a "Sign In" button, which users may select to initiate the login process. Additionally, users who do not yet have an account can conveniently navigate to the registration page by selecting the Sign Up option. To improve accessibility and user convenience, the "Continue as Guest" function is also accessible. This option allows users to explore the application without registering, although certain functionality may be limited. The Login page's overall design focuses on simplicity, clarity and usability, allowing users to access their accounts quickly and effectively with minimal effort.

The Register page shown in Figure 14 above allows new users to create an account and have access to all of the features available in the PantryPal application. The page has a structured form that asks users for basic personal information, including their name, email address, password and password confirmation. These input fields are required to generate a unique user identification and ensure safe account creation. Validation mechanisms may be implemented to ensure that the data entered fulfills the necessary criteria, such as valid email format and password consistency. Once all essential information has been entered correctly, users may click the "Create Account" button to finish the registration process. In addition, the page includes a "Sign In" option for those who already have an account, allowing for easy navigation back to the Login page. Similar to the Login page, a "Continue as Guest" option is accessible for those who decide to make use of the program without registering right away. Overall, the Register page is intended to support an effortless and quick onboarding process while maintaining data quality, security and usability.

## III. Homepage (Dashboard) and Recipe Suggestions Pages

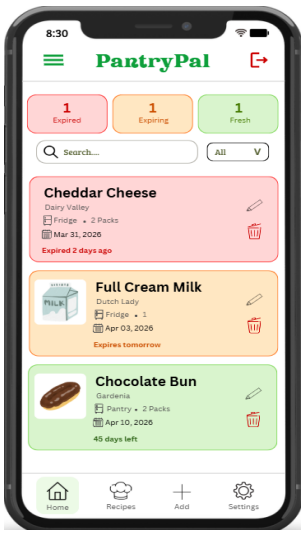


**Figure 15: Homepage (Dashboard) of PantryPal**

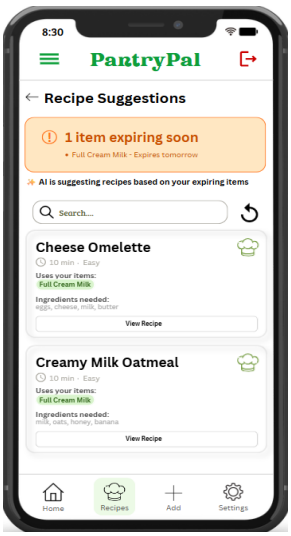


**Figure 16: Recipe Suggestions Page of PantryPal**

The Homepage of the PantryPal application shown in Figure 15 above serves as the main interface for managing food inventory. Items are displayed in three categories according to their expiry status: Expired, Expiring Soon and Fresh. Each item is represented as a card containing information such as the name, storage location, quantity, expiry date and current status. This organization allows users to identify items that require immediate attention in order to reduce potential food waste. The page also includes a search bar and filter options for efficient item retrieval. Additionally, edit and delete functions are provided for individual items. A bottom navigation bar facilitates access to other sections of the application, including Recipes, Add Item and Settings. Overall, the dashboard provides a comprehensive view of inventory status and can generate notifications for items approaching expiration.

The Recipe Suggestions page shown in Figure 16 above assists users in planning meals using ingredients available in their inventory. A summary banner highlights the number of items nearing expiry, enabling users to prioritize these ingredients. AI algorithms generate recipe suggestions based on the current inventory, with each recipe card displaying a brief description, a list of ingredients and an option to view the complete recipe. Users can also search for recipes or filter them according to ingredients. Additionally, a "Redo" button allows users to generate alternative recipe suggestions, giving flexibility and more variety in meal planning. The AI continuously updates suggestions as inventory changes, promoting the use of items before they expire and reducing food waste.

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## IV. Add Items and Add New Item Detail Pages

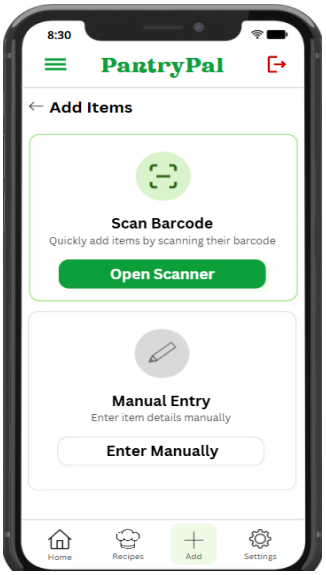


**Figure 17: Add Items Page of PantryPal**

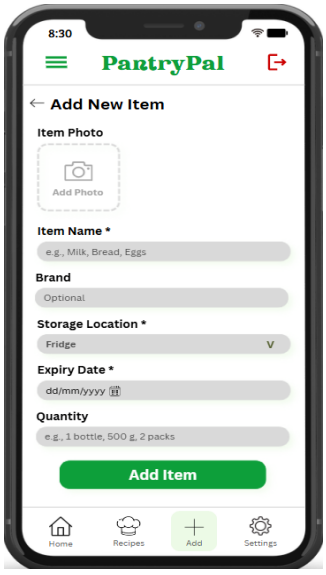


**Figure 18: Add New Item Detail Page of PantryPal**

The Add Items page shown in Figure 17 above allows users to update their inventory efficiently. Two methods are provided: barcode scanning and manual entry. The barcode scanner automatically captures product information, including name, brand and expiry date in order to reduce the likelihood of errors. Manual entry is available for items that do not have a barcode or in case the scanner fails or cannot read the barcode correctly. This ensures that all products can be added accurately. Overall, this page helps maintain inventory records that are complete, accurate and up-to-date, supporting effective food management.

The Add New Item Detail page shown in Figure 18 above provides a detailed form for entering or editing individual food items. Users can upload a photo of the item, input the item name and brand, select the storage location (either Fridge or Pantry), set the expiry date and specify quantity and units. There is also a calendar icon next to the date field which the users can tap the calendar icon and a calendar view will appear. This allows them to select the date easily instead of typing the date manually. Once submitted, the item is added to the digital inventory and reflected on the dashboard. The system may include validation checks to prevent incorrect data entry.

## V. Settings Pages

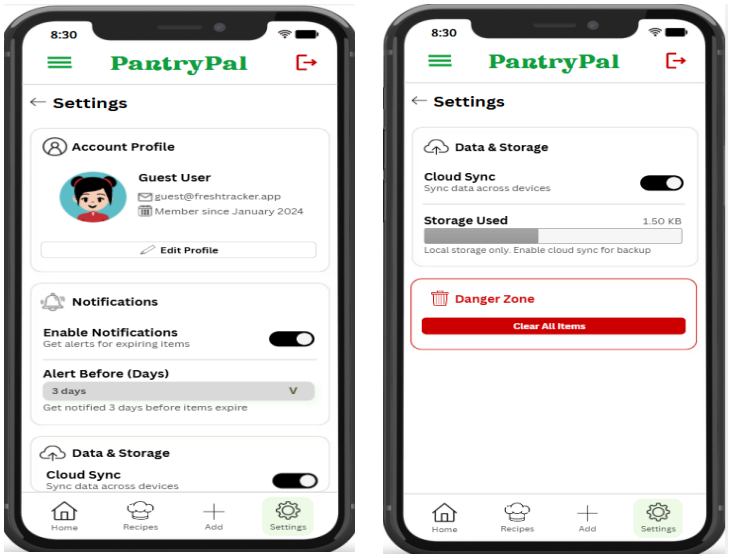


**Figure 19: Settings Page of PantryPal**

The Settings page shown in Figure 19 above allows users to manage their account information, application preferences and data settings in a single user interface. It is intended to provide users more control over how the program works while maintaining a simple and straightforward interface. At the top of the page, the "Account Profile" area displays basic user information such as name, email address and registration status. An "Edit Profile" button is offered, allowing users to edit their personal information as needed. The "Notifications" section includes settings for managing expiration alerts. A toggle switch allows users to turn on or off alerts. Furthermore, the "Alert Before (Days)" setting allows users to choose how many days in advance they want to be alerted when an item expires. This allows users to be informed of approaching expirations and take appropriate action. The "Data & Storage" section features a Cloud Sync option, which, when activated, allows users to sync their data across various devices. It also shows the amount of storage that is currently in use, offering users insights into their data usage and backup status. The "Danger Zone" section at the bottom of the page has a "Clear All Items" button. This application enables users to delete all stored inventory data at once. This action is irreversible, hence it is placed separately to avoid accidental use. Overall, the Settings page supports customization, efficient data management and more control for users, resulting in a more adaptable and user-friendly application experience.

## VIII. CONCLUSION

The startup is deemed feasible because it addresses a practical issue that households, especially families and students who frequently miss expiration dates or find it difficult to plan meals effectively, encounter. The concept encourages ecological living and conscientious consumption in addition to helping users save money on groceries. Additionally, by reducing food waste and promoting improved resource management, the application promotes global sustainability goals like SDG 12 which is Responsible Consumption and Production. The suggested platform is a promising digital solution in the expanding food sustainability and smart home technology sector since it provides both economic and environmental value. Significantly, the PantryPal solution supports national digital transformation projects and a number of important objectives of the 13th Malaysia Plan (13MP). By assisting households in lowering food costs, encouraging digital adoption through AI-based technologies, and providing possibilities for B40 and unemployed workers to reskill and upskill in digital positions like data administration and system support, the system helps raise the economic floor. These contributions support national goals for increased employment, productivity, and sustainable resource management.

Additionally, PantryPal's verified Business Model Canvas (BMC) will be further developed to facilitate the conversion of an idea into a workable business solution. Subsequent efforts will concentrate on creating a comprehensive business strategy that incorporates operational planning, partnering strategies, and financial sustainability metrics, all based on the proven business model. For PantryPal to successfully serve its target clients through the right digital channels while preserving scalability and long-term economic viability, strategic planning and ongoing system development are crucial.

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