



A Mobile-Based Application for Food Management Using QR Codes

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Introduction

Food waste has become a critical global issue, with tons of food wasted globally every year. The waste is a consequence of the fact that consumers cannot monitor expiration dates of their perishable foods. A FAO study revealed that at least one-third of the food that is produced globally is wasted. However, this situation could be improved with proper food management. Taking advantage of information technology, a mobile-based application developed for food management has the potential to reduce food waste. This study developed a mobile-based application that integrates QR code technology to validate food expiration dates. This mobile application will assist consumers in effectively managing their food inventory, alert them to approaching expiration dates, and ultimately reduce food waste by allowing the timely consumption of perishable items.

Methodology

The mobile application development follows an iterative process of software development that includes requirements gathering, design, development, and testing. The Software application was developed with Java and Kotlin programming languages, Firebase was used as the back-end solution for real-time database management. With the use of the open-source ZXing library, QR code functionality was easily implemented, which allowed easy scanning and processing of the product. The application underwent various phases of testing, including unit testing, integration testing, and user acceptance testing.

Results and Discussion

The application was successfully developed and will be deployed for testing among a proposed group of users. It is expected that the developed application will reduce food waste, improve food inventory management, and attract user engagement, among others. The development of a mobile-based food management application using QR codes to validate food expiration dates will optimize food management. QR code integration will enable users to promptly retrieve important product information, allowing for more accurate tracking of expiration dates. In households and businesses that may not have a fast turnover in inventory, this system offers an advantage as expired food items become more frequent.

Conclusion

An innovative and practical approach for reducing food waste is the use of a mobile-based application using QR codes to manage food expiration. The effectiveness of applying the application can be applied to improve food management, waste reduction, or increase user engagement. This system will communicate when certain foods expire so consumers have the opportunity to make informed decisions on their food inventory, thus aiding in sustainable food practices.

Keywords: Food and Agriculture Organization, Food management, Food security, mobile-based, QR codes



1. Introduction

Food waste has emerged as one of the most pressing global challenges of the 21st century. According to the Food and Agriculture Organization (FAO) of the United Nations, approximately one-third of all food produced globally, amounting to about 1.3 billion tons, is wasted each year. This waste occurs at various stages of the supply chain, but a significant portion comes from households, where consumers often discard perishable goods due to poor inventory management and the inability to monitor expiration dates effectively (Canton, 2021; Abdiju, 2019; Pernet, & Ribl Forclaz 2019; Joint, 2011). In many cases, food that could still be safely consumed is thrown away simply because it is forgotten or past its labeled expiration date. One promising solution to this issue lies in the effective use of digital technology to support food inventory management at the consumer level (Agya, 2025; Mahroof Omar & Kucukaltan, 2022). This study introduces a mobile-based application designed to combat food waste by utilizing Quick Response (QR) code technology to monitor and manage food expiration dates. The goal of this application is to assist individuals and households in tracking perishable food items, sending alerts before expiration, and encouraging timely consumption, thereby reducing avoidable food waste.

The proposed mobile application functions by scanning QR codes attached to food products. These QR codes contain key product information, including the expiration date, which is automatically stored in the application's database upon scanning. Users receive notifications as the expiration date approaches, ensuring they are reminded to use the items before spoilage occurs. This proactive alert system allows users to make more informed decisions, plan meals accordingly, and prioritize the use of items nearing expiration. The development of the mobile application followed an iterative software development life cycle (SDLC) model, comprising stages such as requirement analysis, system design, implementation, and rigorous testing. The front-end of the application was developed using Java and Kotlin, popular programming languages for Android development, while Firebase was integrated as the backend platform to handle real-time database management and user data synchronization. QR code scanning capabilities were implemented using the open-source ZXing (Zebra Crossing) library, which facilitated accurate and efficient QR code reading within the application.

A comprehensive testing phase was conducted to ensure the reliability and functionality of the system. Unit testing was performed to verify individual components, integration testing ensured seamless communication between modules, and user acceptance testing (UAT) involved real users interacting with the app to provide feedback on usability and performance. The feedback collected helped to refine the app interface, improve user experience, and enhance overall system stability. Following development and testing, the application is now ready to be deployed among a selected group of users for pilot testing. It is anticipated that this deployment will demonstrate measurable reductions in household food waste, improved food inventory organization, and increased awareness of expiration management. Furthermore, the application is designed to be scalable and adaptable, making it a viable tool not only for households but also for small businesses such as restaurants, grocery stores, and food vendors that manage perishable inventory.

The use of QR codes offers a low-cost, accessible, and efficient solution for managing food information (Rotsios *et al.*, 2022; Zhang *et al.*, 2021; Qian *et al.*, 2021). Unlike manual entry systems, QR codes eliminate human error and simplify the process of logging food items into an inventory system (Balaji *et al.*, 2024). This is particularly useful in settings with slow inventory turnover, where items may remain unused for extended periods and are more susceptible to spoilage. By automatically tracking expiration dates, the application helps reduce the occurrence of expired or forgotten items in storage. The integration of mobile technology with QR code functionality also encourages user engagement (Paul & Naikar, 2024; Pérez-Sanagustín *et al.*, 2016). By offering an intuitive interface and features such as reminders, notifications, and inventory overviews, users are more likely to interact regularly with the application. In the long term, such engagement can foster behavioral changes that promote sustainable consumption and reduce food-related waste.

2. Methodology

The methodology adopted for the development of the mobile-based application for food management using QR codes involves a systematic and iterative process that encompasses problem analysis, system design, implementation, testing, and evaluation. This methodology integrates principles from both software engineering and user-centered



design to ensure that the application is not only technically sound but also practical and user-friendly. The following subsections describe each phase of the methodology in detail.

Research and Requirement Analysis

The study commenced with comprehensive background research to understand the scope of food waste and the gaps in current household food management practices. Literature was reviewed to explore existing food management systems, food tracking applications, and the integration of QR code technologies in similar domains. This phase helped in identifying the functional and non-functional requirements of the proposed solution. The functional requirements identified are User registration and authentication, QR code scanning and data extraction, food item listing with expiration dates, notification alerts for upcoming expiration, manual data entry (optional for non-QR items), editing and deleting items, and a Dashboard with food inventory overview. The non-functional requirements include cross-device compatibility (Android phones), real-time performance, cloud-based data storage, an intuitive and user-friendly interface, and scalability and maintainability.

System Design

This phase involved the architectural design of the system, user interface (UI) design, and database schema development. The system was modeled using Unified Modeling Language (UML) diagrams, including case diagrams, class diagrams, and activity diagrams to visualize the application's behavior and structure.

Application Architecture

The application was designed using a client-server model with the frontend (Client Side) built using Java and Kotlin for Android. This layer manages the user interface and interactions, including QR code scanning and notification handling. The backend (Server Side) Firebase was used as the backend-as-a-service (BaaS) platform to manage user data, food inventory, and expiration tracking in real-time. The database uses the Firebase Realtime Database to store user-specific data, food items, and expiration dates. The QR Code Scanner ZXing (Zebra Crossing) open-source library was used for scanning and decoding QR codes.

User Interface (UI) Design

Wireframes and mockups were created to design a clean, responsive, and easy-to-navigate interface. User feedback during the prototype stage informed several UI refinements.

Data Flow and Processing

The data flow involves QR codes being scanned via the smartphone camera, with extracted data parsed (e.g., item name, expiration date). The information is stored in Firebase under the user's inventory, and a background service tracks dates and sends notifications as expiration approaches.

Figure 1 is the system architecture consisting of seven modules. The user interface (Android app) includes the home screen, inventory list, QR scanner, manual entry, and notification screens. which is built using Java/Kotlin in Android Studio. The QR Code Scanner Module makes use of the device camera and ZXing library to scan QR codes on packaged food items. Data Extraction & Parsing Decodes QR data: food name, expiration date, category, and prepares data to be stored or edited by the user. Local Validation Module allows users to review/edit scanned data before final saving, and it also enables manual entry for non-QR items. Firebase Realtime Database stores inventory linked to each authenticated user and ensures data persistence and real-time updates. Notification Scheduler triggers based on expiration date thresholds and use Android's AlarmManager or Firebase Cloud Messaging (FCM). Finally, the Notification System sends push alerts to the user and helps users take timely action.

System Architecture / Pipeline Overview

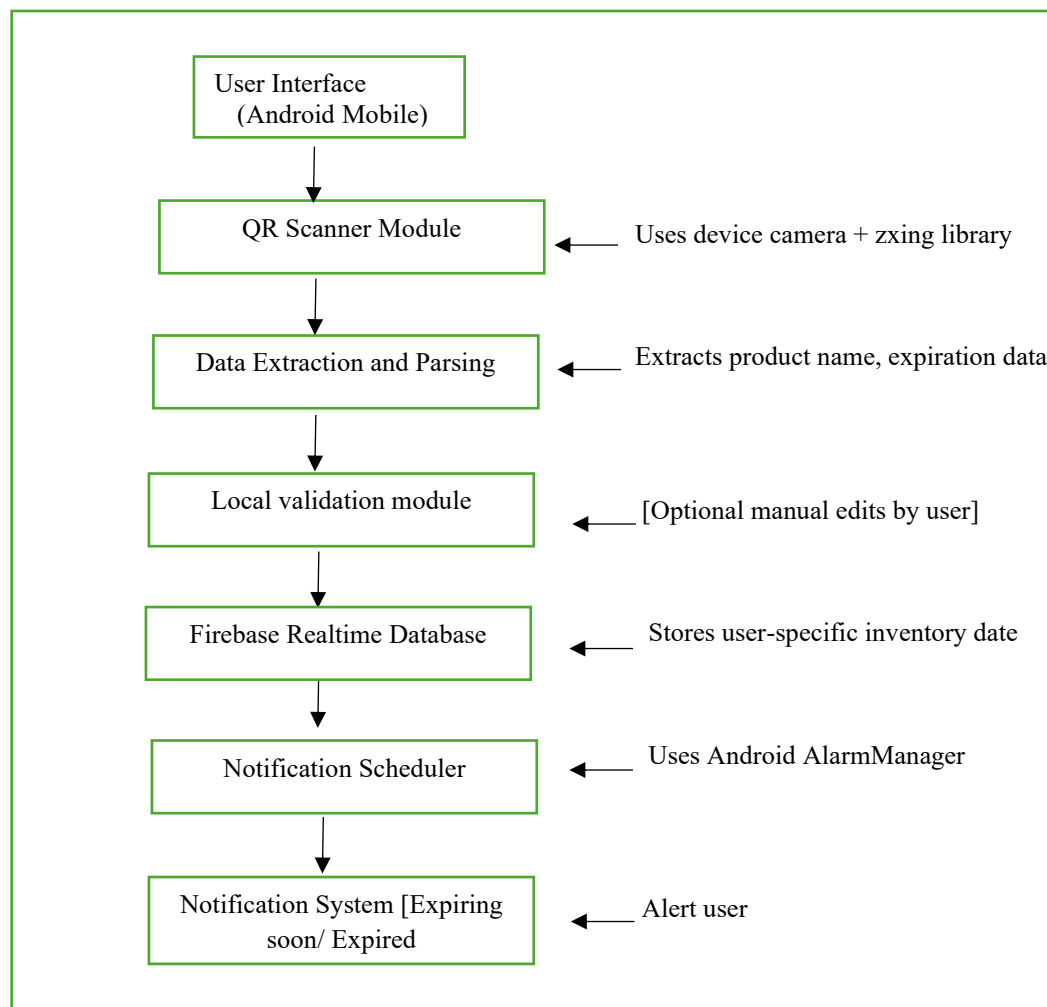


Figure 1. System Architecture / Pipeline Overview

Results and Discussion

Application Performance and Functionality

The mobile-based food management application was successfully developed and deployed for initial testing. The system was designed to help users monitor expiration dates of perishable food items by scanning QR codes, storing data in real time, and providing timely expiration alerts. The implementation achieved all key functionalities which include the ZXing library integrated seamlessly, enabling quick and accurate scanning of product QR codes. Testing showed a high recognition rate for standard food packaging; users were able to retrieve and store expiration dates effectively. The system automatically scheduled notifications based on the dates entered or retrieved from QR codes, Android's AlarmManager, and Firebase Cloud Messaging (FCM) were used to notify users of approaching or passed expiration dates. Alerts were delivered reliably across all test devices. Also, for food items without QR codes, users could manually input expiration dates, which expanded the usability of the application across more product types. The dashboard categorizes items into "Fresh," "Expiring Soon," and "Expired," providing a clear view of food status and helping users prioritize usage.

Testing

Testing was critical to ensure functionality, reliability, and usability of the application. A combination of testing techniques was used throughout the development lifecycle. Each module and function (e.g., QR scanner, notification scheduler) was tested individually to validate its correctness. Test cases were executed to verify the interaction between various modules such as the database, scanner, and UI components. System testing was carried out on the completed application under different scenarios, including scanning different QR formats, entering multiple food items, simulating time-based notification triggers, and testing under a poor internet connection. User acceptance testing (UAT) was done using a small group of test users (N = 15) to evaluate the application over two weeks. Feedback was gathered using a structured questionnaire and informal interviews. The summary of feedback from the users is tabulated in Table 1.

Table 1. Summary of User Feedback

Variables	Satisfaction Level (Avg Rating out of 5)
Ease of Use	4.6
QR Scanning Speed/Accuracy	4.4
Usefulness of Notifications	4.8
Overall Satisfaction	4.7
Manual Entry Feature	4.5
Visual Design & Layout	4.3

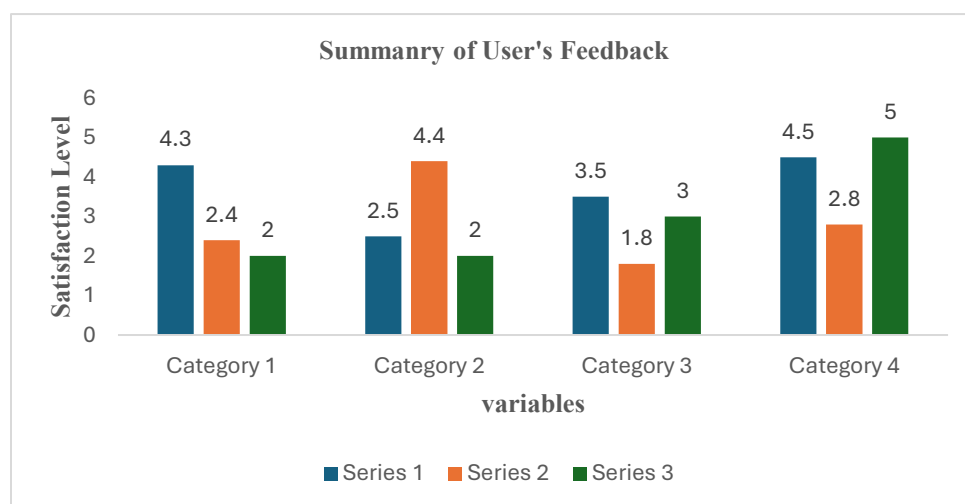


Figure 2. User's Feedback

Figure 2 shows that users found the application intuitive and effective in reminding them about food items nearing expiration. Most participants reported a noticeable reduction in their household food waste during the test period. Also, in evaluating the practical effectiveness of the application, two key outcomes were tracked: reduction in food wastage and increase in awareness and planning. Participants were asked to estimate how many food items they would normally waste in a week and compare this to the test period.

- Before the App: Average of 5 items/week wasted
- During Testing: Average dropped to 2 items/week
- Estimated Reduction: ~60%



Users indicated that they were more aware of what food they had at home and were better able to plan meals around expiration dates.

- 87% of users said the app helped them “plan better.”
- 73% said they would “continue using the app after testing”

The strength of the application is real-time monitoring with Firebase that allows for efficient, real-time updates to inventory, accessible from any Android device. There are automated alerts in the form of scheduled notifications that reduce the need for users to check manually, promoting consistent usage. Low barrier to entry with the simple interface and support for manual input made the app accessible to a wide range of users, regardless of their tech proficiency. Also, the backend infrastructure can easily be scaled to support more users or additional features (e.g., shopping list integration, analytics). However, some of the limitations faced by this application are the fact that not all food products have QR codes with standardized expiration data. The app relied heavily on manually entered information for such items. The effectiveness of the app is dependent on users actively scanning or inputting new items upon purchase. The current version only supports Android devices. iOS users were not able to participate in testing. Firebase requires an internet connection; offline functionality was limited.

Conclusion

The development of a mobile-based food management application integrating QR code technology has proven to be an effective solution for addressing household food waste. The application successfully leverages real-time data management, expiration date tracking, and automated notification systems to help users monitor their perishable food inventory more efficiently. Testing and user feedback indicated that the application was user-friendly, functionally sound, and had a positive impact on reducing food waste. Key features like QR code scanning, inventory categorization, and timely alerts ensured that users were informed about the status of their food items, enabling better consumption planning. Despite some limitations, such as dependency on user input and the lack of QR data standardization on food packaging, the system offers a scalable and practical approach to promoting sustainable food usage practices. With further development, including features like OCR scanning and multi-platform support, the application can be expanded to meet broader user needs and contribute meaningfully to global food sustainability goals.

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