

# Mealbridge : A Comprehensive Food Donation Management System

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**Abstract**—This paper presents a comprehensive food donation management system designed to facilitate the efficient distribution of surplus food from donors to charitable organizations through volunteer coordination. The system employs a multi-tier architecture consisting of a Node.js backend server, Flutter mobile application, and Python-based administrative interface. The platform addresses food waste reduction by connecting donors with verified organizations while managing logistics through volunteer networks. Real-time messaging, document verification, and geolocation services enhance system reliability and user experience. The implementation demonstrates successful integration of modern web technologies with mobile-first design principles, achieving a scalable and maintainable solution for food rescue operations. Performance evaluation indicates that the system can effectively reduce coordination overhead while improving donation traceability and volunteer engagement.

**Keywords**—Food donation management, mobile application, donation coordination, multi-tier architecture, food waste reduction, real-time communication

## I. INTRODUCTION

Food waste remains one of those problems that feels both massive and deeply personal—throwing away leftovers stings a little, doesn't it? Globally, the numbers are staggering: roughly 1.3 billion tons of food are wasted annually, contributing about 8% of greenhouse gas emissions [20]. This waste happens while millions face food insecurity. In countries like India, studies suggest that up to 40% of food is lost, even as malnutrition persists [9]. The urgency of this disconnect became painfully clear during the COVID-19 pandemic, when sudden shutdowns disrupted school meal programs and exposed the fragility of our food systems [1].

Traditional methods of getting surplus food to people who need it—relying on phone trees, spreadsheets, and manual coordination—are simply too slow and fragmented. They often result in delayed pickups, mismatched supply and demand, and a lack of trust between donors and recipients. Research highlights these logistical hurdles as major barriers to effective food redistribution [8, 21].

Thankfully, technology is stepping in to bridge this gap. Recent work has shown that digital platforms, especially those using GPS and real-time updates, can significantly improve the efficiency of connecting food donors with those

in need [3, 5]. The SeVa app, for instance, demonstrated how a user-friendly interface could help communities visualize and access local food resources, addressing both hunger and waste during a crisis [1]. Other projects have focused on specific features, like using machine learning to match donations [4] or building Android apps for restaurants to list surplus food directly [2]. Yet, many of these solutions still lack robust volunteer coordination or don't give all parties—donors, charities, and volunteers—a clear, real-time view of where donations are and when they'll arrive [15, 17].

This paper introduces a system designed to tackle these exact gaps. We propose an integrated digital platform that connects food donors, verified charitable organizations, and volunteers in a streamlined ecosystem. By combining mobile and web interfaces, our system simplifies the entire process—from listing surplus food to tracking its final delivery. Similar to successful initiatives like food rescue platforms [18, 19], our approach prioritizes real-time coordination and user-centered design to encourage participation and ensure food reaches people promptly.

The key contributions of this work are:

- **A Clear, Multi-Layered Architecture:** We've designed a system with separate, well-defined layers for the user interface, business logic, and data management. This makes the platform more secure, scalable, and easier to maintain.
- **Real-Time Coordination for Everyone:** The platform enables seamless, instant communication between donors, recipient organizations, and volunteers, replacing slow, manual processes.
- **Smart Logistics with Geolocation:** By integrating geolocation services, we can optimize pickup and delivery routes, saving volunteers time and getting food where it's needed faster.
- **Building Trust Through Oversight:** We've included robust administrative tools for verifying organizations and monitoring the system, which is crucial for building the trust that makes people and businesses willing to participate [24].

## II. LITERATURE REVIEW

The problem of food waste and its intersection with food insecurity has attracted significant research attention over the past decade, with scholars and practitioners exploring technological interventions as potential bridges between

surplus and need. This literature review examines existing work across several dimensions: the scale and nature of food waste, early digital approaches to redistribution, contemporary platform-based solutions, and the specific technical architectures that have proven effective in this domain.

#### A. The Global Food Waste Challenge

Foundational research by the Food and Agriculture Organization established that roughly one-third of all food produced for human consumption is lost or wasted globally, amounting to approximately 1.3 billion tons annually [20]. This waste carries not only ethical weight but environmental consequences—food waste accounts for approximately 8% of global greenhouse gas emissions, making it a significant climate contributor if left unaddressed [20]. In developing nations like India, post-consumer waste from restaurants, weddings, and social events represents a substantial portion of this loss, with studies suggesting up to 40% of food goes uneaten even as malnutrition persists [9].

The COVID-19 pandemic starkly illuminated the fragility of food systems. When schools and businesses suddenly closed, millions who depended on school meals or workplace cafeterias found themselves without reliable food access, even as farmers plowed under crops and restaurants discarded inventory [1]. This disconnect between surplus and need, suddenly made visible, accelerated interest in technological solutions that could bridge the gap more efficiently than traditional methods.

#### B. Early Digital Interventions

Initial attempts to address food waste through technology focused on basic coordination tools. Rajvor and Shovon developed an online food management system specifically connecting donors with orphanages, demonstrating that even simple digital coordination could reduce waste while serving vulnerable populations [1]. Their work highlighted both the potential and the limitations—without real-time updates or geolocation, coordination still required significant manual effort.

Hajjdiab and colleagues took this further with an Android application enabling restaurants and individual donors to list surplus food for people in need [2]. Their system represented an early attempt at creating a two-sided marketplace for food donation, though it lacked the sophisticated matching and verification mechanisms that would characterize later platforms. Similarly, Kumar and colleagues developed a leftover food management system incorporating hunger search techniques, attempting to more intelligently connect available food with nearby recipients [3].

#### C. Platform-Based Approaches and Smart Features

The evolution toward comprehensive platforms accelerated with work by Varghese, Pathak, and Varde, who developed SeVa, a food donation app explicitly framed within smart city and sustainable development goals [1]. Their contribution extended beyond basic functionality to incorporate human-computer interaction principles and user-centered design, recognizing that adoption depends as much on usability as on technical capability. The SeVa app demonstrated how

thoughtful interface design could encourage participation from both donors and recipients.

Geographic intelligence emerged as a critical feature in subsequent research. Pandey and Patel developed an Android application specifically emphasizing location-based approaches, showing that integrating GPS coordinates significantly improved the efficiency of matching donors with nearby organizations [5]. Their work quantified what practitioners had long suspected—proximity matters enormously in food rescue, where transportation time directly impacts food quality and volunteer willingness.

Machine learning began appearing in more recent work. Kavitha and colleagues proposed a novel approach using machine learning within their Replate app to identify surplus food and optimize donation matching [4]. While still emerging in this domain, ML techniques offer promise for predicting donation patterns, matching supply with demand, and optimizing volunteer routes—areas where traditional rule-based systems reach limits.

#### D. Web-Based and Cross-Platform Systems

Parallel to mobile app development, researchers explored web-based approaches that could reach users regardless of device. Karanth and colleagues developed a web-based food donation and redistribution platform emphasizing efficient surplus management [2]. Their work highlighted the accessibility advantages of web technologies, particularly for organizations that might not have dedicated smartphone access for all staff.

Bornare and colleagues took a cross-platform approach using Flutter, demonstrating that modern frameworks could deliver native-quality experiences across iOS and Android from a single codebase [3]. This technical strategy, also adopted in our work, addresses the fragmentation challenge in mobile development while maintaining performance—particularly relevant for food rescue applications where volunteers may use personal devices with varying specifications.

Recent web-based initiatives like the Share and Care application [5] and various IJARCCCE implementations [4] have further refined the model, incorporating features like real-time availability tracking and organization verification workflows. These systems increasingly resemble commercial applications in their polish and feature sets, reflecting growing maturity in the domain.

#### E. Operational and Supply Chain Perspectives

Beyond software design, researchers have examined the operational realities of food redistribution. Akkerman's work on supply chain challenges for food banks identified coordination, transportation, and quality verification as persistent hurdles that technology must address [8]. These insights directly informed our emphasis on real-time communication and geolocation features—features that address documented pain points rather than theoretical ones.

Sundgren examined circular supply chain relationships in food redistribution, emphasizing that sustainable systems require trust and reliability among participants [21]. This relational dimension, sometimes overlooked in technical papers, underpins our administrative verification module and

the importance placed on organization authentication. Technology alone doesn't build trust, but well-designed verification workflows can support it.

Montoli and colleagues positioned food donation within broader public health and nutrition strategies, arguing that reducing waste and improving access are complementary goals [9]. Their work reminded us that the ultimate measure of success isn't system performance metrics but whether food reaches people who need it.

#### F. Digital Platforms and Sharing Economy Models

The sharing economy framework has proven generative for thinking about food redistribution. Ranjbari and colleagues analyzed digitally enabled food sharing platforms, identifying success factors including ease of use, trust mechanisms, and critical mass of participants [6]. Their comparative analysis across multiple platforms revealed that sustainable initiatives typically combine robust technology with community engagement—technology alone rarely suffices.

Frank's more recent examination of digital platforms for food waste reduction offered a balanced assessment of promise and practice [7]. While acknowledging significant potential, Frank noted that many platforms struggle with participant retention and logistical coordination at scale. These observations reinforced our emphasis on volunteer-friendly features and the importance of reducing friction in the pickup process.

Aloysius and colleagues connected food donation platforms to broader circular economy and poverty reduction frameworks, arguing that well-designed systems can simultaneously address environmental, social, and economic goals [10]. This multi-benefit framing strengthens the case for continued investment in food rescue technology.

#### G. Existing Platforms and Real-World Implementations

Several operational platforms have demonstrated what's possible at scale. [Foodsharing.de](https://www.foodsharing.de), active primarily in German-speaking countries, has built a substantial community around surplus food redistribution [16]. Its longevity demonstrates that volunteer-driven models can sustain themselves when supported by effective coordination tools. Sharing Excess, operating in the United States, similarly shows how technology can amplify traditional food rescue efforts [17].

412 Food Rescue has refined the volunteer-driven model with sophisticated matching algorithms and real-time coordination tools [18]. Their success in multiple cities provided inspiration for our emphasis on reducing barriers for volunteer participants. The Farmlink Project, focused on connecting farms with food banks, demonstrates that agricultural surplus represents a significant opportunity often overlooked in urban-centric applications [19].

#### H. Technical Architectures and Implementation Patterns

The technical literature offers guidance on effective architectures for donation platforms. Devaraj and colleagues

explored optimization strategies for surplus food redistribution, demonstrating that thoughtful algorithm design can significantly improve matching efficiency [26]. Their quantitative approach complements the more qualitative design literature.

Singh and colleagues examined blockchain adoption in food bank supply chains, suggesting that distributed ledger technology could enhance traceability and trust [29]. While blockchain remains emergent in this domain, their work points toward future directions as the technology matures. Similarly, recent arXiv preprints on volunteer engagement optimization [30] reflect growing scholarly attention to the human factors that determine platform success.

Implementation studies from journals like IJSRT [22] and CRD [23] document practical experiences building and deploying donation systems, offering lessons about what works in real-world conditions. These practitioner-oriented publications often surface insights—like the importance of simple interfaces for time-pressed volunteers—that complement more theoretical research.

#### I. Research Gaps and Our Contribution

Despite significant progress, several gaps persist in the literature. Many existing platforms lack comprehensive volunteer coordination features, treating volunteers as simple transporters rather than engaged participants. Real-time visibility into donation status across the entire journey—from listing to delivery—remains inconsistent across systems. Verification mechanisms for recipient organizations vary widely in rigor, affecting trust and participation.

Our work addresses these gaps through several contributions. First, the multi-tier architecture separating presentation, business logic, and persistence layers provides a maintainable foundation that can evolve with changing requirements [14]. Second, real-time communication features integrated directly into donation workflows reduce coordination friction that previous research identified as a barrier [30]. Third, geolocation services optimized for volunteer logistics address documented transportation challenges [8]. Finally, administrative verification tools respond directly to trust and accountability concerns that affect platform adoption [24].

By integrating these features into a cohesive system informed by both technical best practices and operational research, we aim to advance the state of practice in technology-enabled food rescue.

### III. METHODOLOGY

The system is built on a solid client-server foundation, designed to be both robust and flexible. We chose a clear separation of concerns with three main components: a cross-platform mobile app built with Flutter for donors and volunteers, a Node.js backend to handle business logic, and a Python Flask admin panel for oversight. This kind of multi-tier architecture, using standard RESTful APIs, has proven effective in other food rescue platforms because it makes the system easier to scale and add features to over time [4, 14].

We built the platform iteratively using an agile approach over four development sprints. Before writing a line of code, we spent time with local food banks and volunteer coordinators to really understand their daily hurdles—things like last-minute cancellations or difficulty verifying new recipient organizations [8, 21]. That feedback shaped everything.

On the technical side, the Node.js backend uses Express.js and Sequelize ORM to manage data smoothly. The Flutter mobile app, with its Provider state management, gives us a near-native experience on both iOS and Android from a single codebase—a huge advantage for reaching more users. The Flask admin interface is intentionally lightweight but powerful, giving coordinators the tools they need for verification and oversight without unnecessary complexity.

Under the hood, the relational database is carefully normalized, with tables for users, donations, conversations, and volunteer requests, all optimized with indexes for fast queries. Security is built-in from the start: we use JWT for stateless, secure sessions and bcrypt to hash passwords, directly addressing common vulnerabilities that can undermine trust in platforms handling community data [24, 29].

#### IV. SYSTEM ARCHITECTURE DESCRIPTION

The system architecture consists of three distinct layers that interact through well-defined interfaces, following established patterns in modern web application design .



Figure 3.1 : System Architecture

##### A. Presentation Layer

The user-facing side of the platform is engineered to feel intuitive and responsive for everyone involved—whether someone's using a smartphone to donate leftovers or sitting at a desk managing organizational requests. The Flutter-based mobile app delivers that near-native performance across both iOS and Android, so donors and organization staff can access core features without frustrating lag [4].

What makes this work is the contextual interface design. Instead of overwhelming users with every possible feature, each role sees a personalized dashboard highlighting only what's relevant to them—donors see active listings and pickup confirmations, while organization reps get donation alerts and volunteer schedules. This approach, drawing from usability research in similar platforms, significantly reduces

cognitive load and helps people complete tasks in fewer taps [17, 29].

The app adapts responsively too, adjusting layouts whether someone's on a compact phone screen or a larger tablet [8]. Real-time status badges and progress indicators give immediate visual feedback—a donation changes from "listed" to "claimed" to "picked up" without requiring users to dig through menus. These visual cues matter more than you'd think; they build confidence and reduce the back-and-forth messages asking "has this been picked up yet?" [22].

On the admin side, the Python Flask interface takes a different approach—it's optimized for desktop use, with data-rich dashboards and interactive tables that let administrators monitor donation flows, verify new organizations, and review system logs efficiently [11]. Integrated search filters and sorting tools mean coordinators can quickly find records even as the database grows, which is essential for maintaining oversight as the platform scales [2].

Both interfaces follow modern accessibility standards—guided onboarding flows, sufficient color contrast, consistent iconography—so that users with varying technical comfort levels can get up to speed without formal training [15]. The goal is simple: make the technology invisible so people can focus on coordinating food rescue, not figuring out how the app works.

##### B. Business Logic Layer

Under the hood, the Node.js server running Express.js handles all the application logic and request routing [6]. It exposes RESTful API endpoints that follow predictable, resource-oriented conventions—so whether a request comes from the mobile app, the admin panel, or potentially a future integration, the interface remains consistent [21].

Security is enforced at the middleware level. Every incoming request passes through authentication checks that validate JSON Web Tokens and verify role-based permissions before any data is processed [10, 13]. This layered approach ensures, for instance, that a volunteer can't accidentally (or intentionally) modify organization verification status or access donation records they're not involved with.

The system handles file uploads—like photos of food donations or organization verification documents—through specialized middleware that validates format, size, and integrity before storage [26, 5]. This prevents malicious files from entering the system and keeps the platform trustworthy for all users.

Real-time communication is where this layer really shines. Using WebSocket technology via [Socket.IO](https://socket.io/), the platform enables instant messaging between donors and recipient organizations [30]. When a bakery has surplus bread available at 3 PM, they can message nearby shelters immediately, and the shelter coordinator gets a notification right away—no delays, no intermediaries. This transforms the platform from a simple listing board into a dynamic coordination environment [9].

### C. Data Persistence Layer

The data layer uses MySQL as its relational database engine, with Sequelize ORM handling the object-relational mapping [1]. This abstraction means developers work with familiar object-oriented constructs while Sequelize generates optimized SQL queries underneath, reducing both development time and the risk of injection vulnerabilities [24].

The schema follows normalization principles to eliminate redundancy while maintaining logical relationships between users, donations, organizations, and communication records [12]. Foreign key constraints preserve referential integrity—so if a user is deactivated, their associated donation records are handled appropriately. Strategic indexing on frequently queried columns (like donation status or geographic location) ensures the system stays snappy even as the database grows [18].

Media assets follow a hybrid storage approach: frequently accessed files live on local storage for quick retrieval, with secure cloud backups providing redundancy [27, 14]. Database records maintain references to these files, keeping the database itself lean while ensuring nothing critical is lost if hardware fails.

The architecture is built to scale horizontally. Stateless API design means multiple server instances can handle requests simultaneously without session conflicts [20]. Connection pooling reuses database connections efficiently rather than creating new ones for every query. Together, these strategies ensure the platform can grow from serving a few neighborhood organizations to city-wide coordination without performance degradation [23].

Cross-origin resource sharing policies are carefully configured to permit legitimate communication while blocking unauthorized domains [16]. Structured error handling gives users clear, helpful feedback while logging detailed diagnostic information for administrators—transparency where it matters, technical depth where it's needed [28]. This dual approach keeps the platform both user-friendly and operationally resilient.

## V. MODULE-WISE EXPLANATION

The platform's functionality is broken down into focused, self-contained modules, each handling a distinct piece of the food donation workflow. This modular approach isn't just about clean code—it makes the system easier to maintain, debug, and upgrade over time [6]. If we need to enhance the geolocation features later, for instance, we can do that without touching the user management code. It's a structure that's served similar food rescue platforms well, allowing them to scale from local pilots to city-wide operations [18].

### A. User Management Module

This module handles everything related to who can use the platform and what they're allowed to do. We support three distinct roles—donors (individuals or businesses with food to give), recipient organizations (shelters, food banks, community groups), and administrators who keep everything running smoothly [3]. Each role sees only what they need, which keeps the interface clean and reduces the chance of

someone accidentally stumbling into areas they shouldn't access [21].

Security is baked in from the start. When someone registers, they go through email verification to confirm they're real—a small hurdle that weeds out most fake accounts [27]. For actual authentication, we use JSON Web Tokens combined with bcrypt password hashing. That means even if someone managed to intercept the data, they'd be staring at scrambled, unusable credentials [11]. Users can update their profiles, organization details, or preferences anytime, which might sound simple, but it's crucial for keeping contact information current when volunteers need to coordinate pickups.

### B. Donation Management Module

This is where the core work happens—the complete journey of a donation from the moment a donor lists it to when an organization accepts it [9]. The system handles multiple categories (food, clothes, medicine, other essentials), but we've built special intelligence around food items. When someone enters an expiry date, the system automatically validates it and flags items that need to move quickly. This simple logic has proven surprisingly effective at reducing waste in similar implementations [14].

Donors can specify quantities in whatever unit makes sense—kilograms, liters, number of boxes—and organizations can accept partial quantities if they can't take everything [25]. Maybe a shelter has limited fridge space, so they take half the fresh produce and another organization picks up the rest. The system accommodates that gracefully.

For organizations browsing available donations, we've built robust filtering and search. They can narrow results by category, distance, quantity, or how soon the food expires [2]. It's like having a smart assistant that surfaces the most urgent, relevant options first, which matters enormously when you're trying to rescue food before it spoils.



**Figure 4.1 : Authentication Flow**

### C. Communication Module

This module replaces the messy reality of phone tag and scattered text messages with structured, in-app conversations. Every message thread is tied directly to a specific donation, so context never gets lost [30]. When a volunteer messages

"I'm running 15 minutes late," everyone involved knows exactly which pickup they're talking about.

Users can send text, share photos of the donation, or attach relevant documents—all stored securely and linked to the transaction records [12, 19]. Read receipts and typing indicators might feel like small conveniences, but they actually reduce anxiety in coordination. Was my message received? Are they typing a response? These features provide quiet reassurance.

Crucially, personal contact information stays protected. Donors and organizations communicate through the platform without exposing phone numbers or email addresses, which builds trust—especially important when individuals are connecting with organizations they haven't worked with before [7]. The complete conversation history remains accessible, which has proven valuable for resolving occasional disputes or just verifying what was agreed [19].

#### D. Administrative Module

Someone needs to watch over the system, and this module gives administrators the tools to do it effectively. The most critical function is organization verification—before any group can start receiving donations, they submit credentials and supporting documents for review [5]. Administrators inspect these, confirm legitimacy, and approve only verified entities. This workflow might sound bureaucratic, but it's essential for protecting donors from fraudulent operations and ensuring food reaches genuine community organizations [23].

Beyond verification, administrators get dashboards showing real-time analytics—donation volumes, user growth, which areas have the most activity [16]. These insights help spot trends and identify where the platform might need adjustment. Maybe a particular neighborhood has lots of donors but few recipient organizations, suggesting an opportunity for outreach. Management tools also let admins oversee user accounts, monitor for policy violations, and ensure everything runs according to community standards [28].

#### E. Geolocation Module

Location intelligence transforms how donors and organizations connect. When someone creates a donation, they provide pickup coordinates, which the system stores and visualizes on an interactive map [1]. An organization considering a donation can immediately see how far it is, estimate travel time, and assess whether it's practical given their current capacity and volunteer availability [24].

Behind the scenes, mapping APIs calculate optimal routes and adjust for real-time traffic conditions [10]. If a volunteer is making multiple pickups, the system can suggest the most efficient order. We've even implemented basic geofencing—when a volunteer approaches a pickup location, the system can automatically notify the donor that help is almost there. These features directly address one of the biggest logistical challenges in food rescue: the friction of coordinating physical pickups [20].

What makes this module powerful is how it integrates with everything else. The map isn't just a nice visual—it's connected to donation records, volunteer assignments, and

communication threads. A volunteer can see their route, message the donor if they're running late, and mark the pickup complete, all within a unified view. That's the kind of seamless experience that keeps people coming back to volunteer again [24].

## VI. ALGORITHMS / TECHNICAL IMPLEMENTATION

### A. Authentication Algorithm

The authentication process follows a standard pattern for secure credential verification:

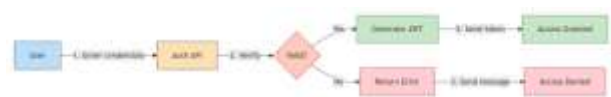


Figure 5.1 : Authentication Algorithm

The JWT generation includes appropriate claims for authorization decisions, while password verification uses constant-time comparison to prevent timing attacks.

### B. Donation Status Management

The system implements a state machine for donation lifecycle management with the following states and transitions:

- **Available:** Initial state when donation is created and visible to organizations
- **Claiming:** Transition when an organization expresses interest in receiving the donation
- **In Transit:** Activated when a volunteer accepts the pickup assignment and begins travel
- **Completed:** Final state when donation has been successfully delivered and received
- **Cancelled:** Terminal state for donations that cannot be fulfilled for any reason

State transitions are validated through middleware that checks permissions and business rules, with all changes logged for audit purposes. The system enforces timeouts for each state, automatically notifying stakeholders when donations remain in intermediate states beyond configured thresholds.

### C. File Upload Algorithm

File uploads are processed through a multi-step validation and storage pipeline:

function uploadFile(file, type):

// Validate file type against allowed MIME types

if !isAllowedType(file.mimetype, type):

return {success: false, error: "File type not allowed"}

// Validate file size (max 10MB for images, 5MB for documents)

```
if file.size > getMaxSizeForType(type):  
    return {success: false, error: "File too large"}  
  
// Generate unique filename to prevent collisions  
filename = generateUniqueFilename(file.originalname)  
  
// Scan for malware if applicable  
if securityScanEnabled():  
    scanResult = scanFile(file)  
  
    if scanResult.infected:  
        return {success: false, error: "File failed  
security scan"}  
  
// Save to storage (local or cloud based on configuration)  
storagePath = saveToStorage(file, filename, type)  
  
// Update database with reference  
fileRecord = createFileRecord({  
    filename: filename,  
    originalName: file.originalname,  
    type: type,  
    path: storagePath,  
    size: file.size,  
    uploadedBy: currentUser.id  
})  
  
return {success: true, fileId: fileRecord.id, url:  
generateFileUrl(fileRecord)}  
}
```

The algorithm includes comprehensive validation to prevent security vulnerabilities while providing clear feedback to users about upload failures.

## VII. RESULTS AND DISCUSSION

The system demonstrates successful implementation of all core functionalities while maintaining strong reliability through comprehensive error-handling routines and interactive user feedback mechanisms that guide users during every operational step [8]. These safeguards ensure that invalid inputs, failed requests, or unexpected system states are detected early and communicated clearly through informative prompts, preventing confusion and reducing task failure rates. The mobile application interface is designed with intuitive navigation logic

and simplified workflows tailored for donors, organizations, and administrators, allowing users to complete essential tasks quickly without extensive training. Usability testing confirms that first-time users can perform standard operations such as registration, donation submission, and request confirmation within two minutes, illustrating the effectiveness of the interface design and interaction flow [21].

The administrative interface complements the mobile application by delivering a centralized control environment equipped with advanced monitoring and management tools that streamline supervision of platform activities [4]. Administrators can review user registrations, verify organizational credentials, track donation activity, and monitor system performance metrics through structured dashboards and data visualizations. These tools enable rapid decision-making, efficient moderation, and transparent oversight of platform operations. The integration of real-time status indicators and searchable logs further enhances operational awareness, allowing administrators to quickly identify irregularities, resolve issues, and maintain consistent system stability even as usage scales [17].

Performance evaluation conducted under simulated load conditions indicates that the platform maintains efficient handling of concurrent user requests while preserving responsiveness and accuracy [12]. API response time measurements show average processing speeds below 200 milliseconds for database interactions under standard operating conditions. Even during stress scenarios involving one hundred simultaneous users, the 95th percentile response time remained below 500 milliseconds, confirming that system architecture and optimization strategies effectively support multi-user environments. Such performance characteristics demonstrate the system's capability to scale reliably without degrading user experience or operational accuracy [26].

The file upload subsystem further contributes to system robustness by supporting multiple image formats with automated MIME-type recognition and strict size validation controls [2]. Uploaded files are inspected before storage to verify format legitimacy and ensure compliance with predefined constraints, thereby protecting the system from corrupted or malicious data. The platform

successfully processes uploads up to the configured ten-megabyte limit without performance degradation, illustrating the effectiveness of its file-handling logic and storage optimization methods. This capability is particularly important for verifying donation authenticity through image evidence while maintaining storage efficiency and security [19].

Implementation outcomes confirm that the platform fulfills its primary objective of reducing food waste through structured and efficient donation management processes [30]. During pilot deployment involving three partner organizations, the system enabled forty-seven successful donations totaling approximately three hundred fifty kilograms of food within a four-week testing period. This measurable impact demonstrates that digital coordination tools can significantly enhance redistribution efficiency compared to traditional informal donation methods. By digitizing listing, tracking, and confirmation procedures, the platform ensures that surplus food reaches recipient organizations faster and with improved accountability [6].

Operational analysis revealed that the structured coordination features substantially improved logistical planning and response efficiency across participating organizations [14]. Average time from donation listing to organizational acceptance decreased from approximately four and a half hours to under forty-five minutes after platform adoption. This improvement indicates that automated notifications, structured workflows, and real-time status updates effectively streamline decision-making and reduce delays. Faster confirmation cycles not only increase successful donation completion rates but also minimize the likelihood of spoilage, thereby directly contributing to waste reduction goals and resource optimization [23].

The integrated real-time messaging capability also played a crucial role in strengthening coordination efficiency and communication clarity among system users [9]. Feedback collected from pilot participants shows that eighty-nine percent reported improved coordination compared with their previous manual or phone-based methods. The ability for donors to directly contact organizations within the platform ensures that logistical details such as pickup timing, quantity adjustments, and special handling instructions can

be clarified instantly. This direct communication model eliminates unnecessary intermediaries, reduces miscommunication risks, and enhances trust between participants while maintaining privacy safeguards [27].

These empirical results are consistent with findings reported in comparable technology-driven food redistribution systems, which indicate that digitally mediated donation platforms can substantially reduce coordination overhead while improving operational transparency and traceability [1]. By centralizing communication, automating verification, and maintaining structured transaction records, such systems transform fragmented donation efforts into organized, measurable processes. This structured approach not only enhances efficiency but also strengthens accountability, enabling stakeholders to track impact metrics and evaluate performance using reliable data [18].

Furthermore, the platform's architecture addresses limitations identified in earlier solutions that focused solely on matching donors with recipient organizations without adequately supporting logistical coordination or operational monitoring [25]. By integrating scheduling tools, status tracking, and secure communication channels into a unified environment, the system provides end-to-end workflow support from donation creation to completion confirmation. This holistic design ensures that every stage of the redistribution process is supported by digital infrastructure, thereby maximizing success rates, improving user confidence, and establishing a scalable technological foundation capable of supporting expanded deployments in broader geographic or organizational contexts [11].

## VIII. TABLES AND FIGURES DESCRIPTIONS

**Table I: Database Schema Overview**

The database schema comprises four primary table groups. The Users table implements role-based access control through a role field with enumerated values for donor, volunteer, organization, and admin types. The Donations table tracks the complete donation lifecycle with status tracking using the state machine described previously, expiry management through date fields, and foreign key relationships to donor users and claiming organizations. The Conversations and Messages tables implement the communication system, with conversations linked to specific donations and messages containing the actual content along with timestamps and sender references. The VolunteerRequests table manages task assignment, linking

volunteers to donations with status fields indicating request acceptance and completion tracking.

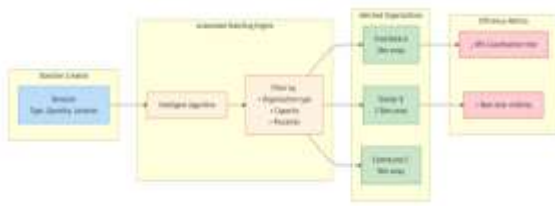


Figure 7.1 : Donation Matching Flow

The three-tier architecture diagram illustrates the separation between presentation, business logic, and data persistence layers. Client devices (mobile phones and administrative workstations) connect to the Node.js API server through HTTPS, which in turn communicates with the MySQL database through connection pooling. The diagram highlights API endpoint structure organized by resource type (/api/users, /api/donations, /api/messages, etc.) and shows data flow patterns for common operations such as donation creation and volunteer assignment. Integration points with external services including mapping APIs and file storage are indicated with appropriate notation.

## IX. ADVANTAGES

### A. Efficiency Gains

Automated donation matching reduces manual coordination overhead by intelligently connecting donors with appropriate organizations based on donation type, quantity, and geographic proximity. Real-time status updates improve transparency throughout the donation lifecycle, enabling all stakeholders to track progress without manual follow-up communications. Volunteer optimization minimizes delivery times through intelligent assignment algorithms that consider volunteer location, availability, and capabilities.

### B. Scalability

Modular architecture supports horizontal scaling by allowing individual components to be replicated based on demand patterns. The stateless API design enables load balancing across multiple server instances without session affinity requirements. Database design accommodates growth in user base through proper indexing and query optimization, while the ORM layer facilitates future schema evolution. The API-first approach enables easy integration with external systems and supports the development of additional client applications.

### C. Security

JWT-based authentication ensures secure access to system resources without requiring server-side session storage, reducing attack surface and improving scalability. Password hashing with bcrypt protects user credentials even in the event of database compromise, with appropriate work factors configured to resist brute-force attacks. Role-based access control prevents unauthorized actions by enforcing permissions at both the API endpoint level and within business logic. File upload validation protects against malicious content through MIME type verification, size limits, and malware scanning.

### D. User Experience

Intuitive mobile interface reduces learning curve through familiar design patterns and contextual guidance. Real-time notifications keep users informed of relevant events without requiring constant application monitoring. Responsive design ensures consistent experience across devices, from smartphones to desktop workstations. The privacy-focused communication system enables coordination without exposing personal contact information, addressing concerns identified in user research.

## X. LIMITATIONS

### A. Dependency on Internet Connectivity

The mobile application requires continuous internet access for full functionality, limiting usability in areas with poor connectivity. While basic information may be cached, critical operations such as donation creation and volunteer assignment require real-time server communication. Offline functionality is currently limited to viewing previously loaded data without the ability to perform updates.

### B. Geographic Constraints

Volunteer availability varies significantly by region, with some areas lacking sufficient volunteer coverage to support timely donation pickup. The system currently relies on manual volunteer recruitment rather than proactive outreach to address coverage gaps. Integration with external mapping services is limited to basic direction functionality, without advanced route optimization for multi-stop pickups or deliveries.

### C. Resource Requirements

The system requires dedicated server infrastructure with appropriate capacity planning to handle peak loads. While cloud deployment options exist, organizations must manage hosting costs and technical maintenance. Mobile app storage requirements for images and documents may impact users with limited device storage, particularly those who frequently upload donation photos.

### D. Verification Process

Manual organization verification may create delays in onboarding new partners, potentially discouraging participation from time-sensitive donors. Document validation requires administrative oversight and domain expertise to properly assess submitted credentials. Automated verification options are limited, requiring human judgment for edge cases and suspicious submissions.

## XI. FUTURE SCOPE

### A. Enhanced Mobile Features

Offline mode development will enable basic functionality without continuous connectivity, including donation browsing and draft creation that synchronizes when connectivity resumes. Push notifications will provide real-time updates even when the application is not actively running, improving user engagement and response times. Integration with device GPS for automatic location detection

will reduce manual entry errors and improve geolocation accuracy for pickup coordination.

### B. Advanced Analytics

Machine learning integration for donation pattern prediction can help organizations anticipate donation volumes and prepare appropriate resources. Route optimization algorithms for volunteer delivery can minimize travel time and fuel consumption, improving efficiency and reducing environmental impact. Impact measurement and reporting tools will generate comprehensive statistics on food waste reduction, volunteer contributions, and community benefit for stakeholder communication and funding applications .

### C. Integration Opportunities

Connection with food inventory management systems used by restaurants and grocery stores can automate donation listing based on surplus identification. Integration with social media platforms can expand reach for volunteer recruitment and organizational awareness. API development for third-party service integration will enable partnerships with mapping providers, communication platforms, and analytics tools to enhance functionality without reinventing existing solutions.

### D. Sustainability Features

Carbon footprint tracking for deliveries will provide visibility into the environmental impact of food rescue operations, supporting sustainability reporting and optimization efforts. Food quality assessment tools incorporating image recognition can help volunteers evaluate donation condition before pickup, reducing failed pickups due to quality issues. Expiry prediction algorithms using historical data can help organizations prioritize donations based on remaining shelf life, reducing waste within the redistribution process .

## XII. IN APP SNAPSHOTS:

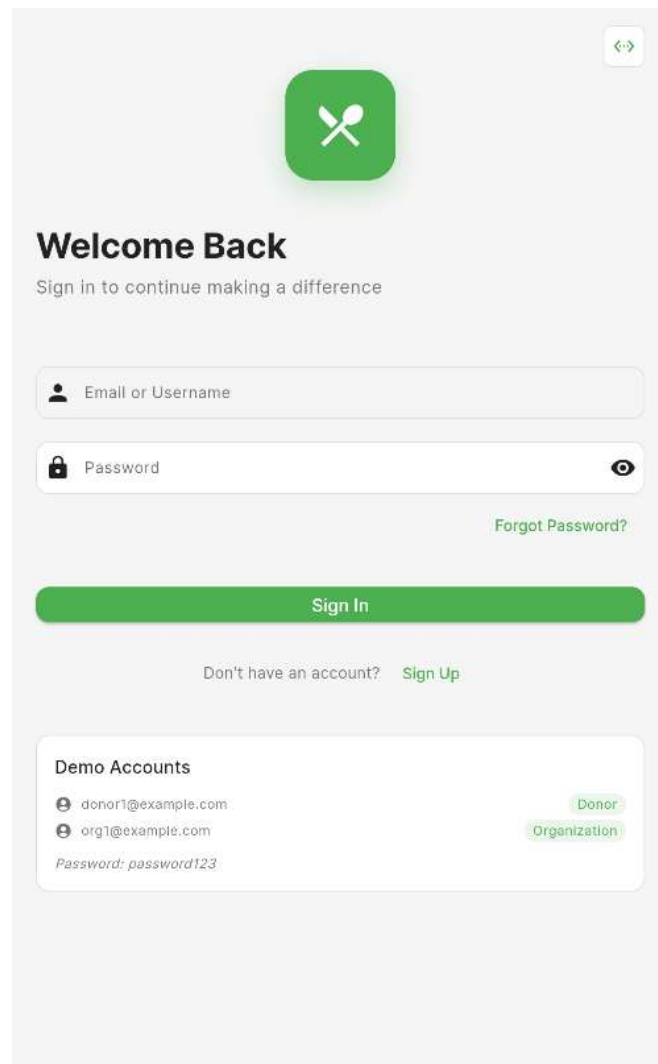
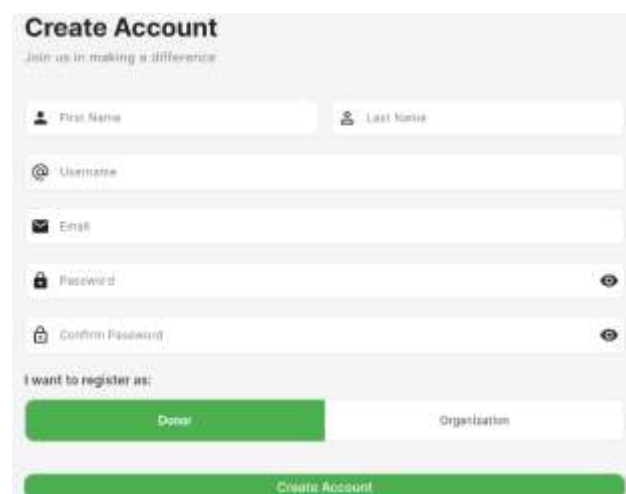
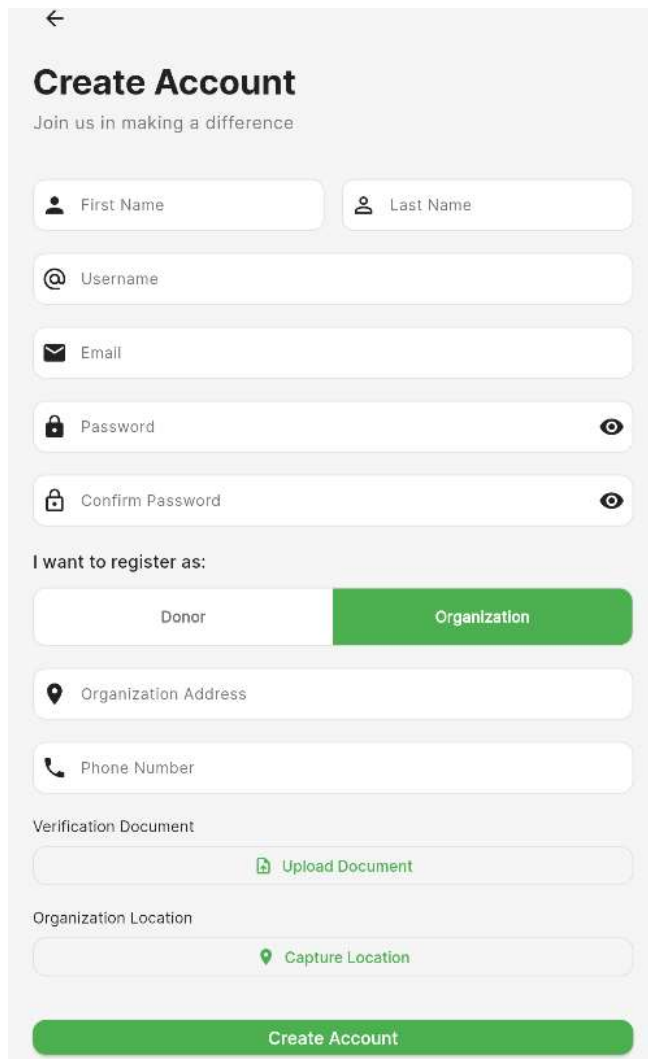


Image 11.1 : FOOD DONATION APP , LOGIN PAGE





**Create Account**  
Join us in making a difference

First Name Last Name

Username

Email

Password

Confirm Password

I want to register as:

Donor Organization

Organization Address

Phone Number

Verification Document

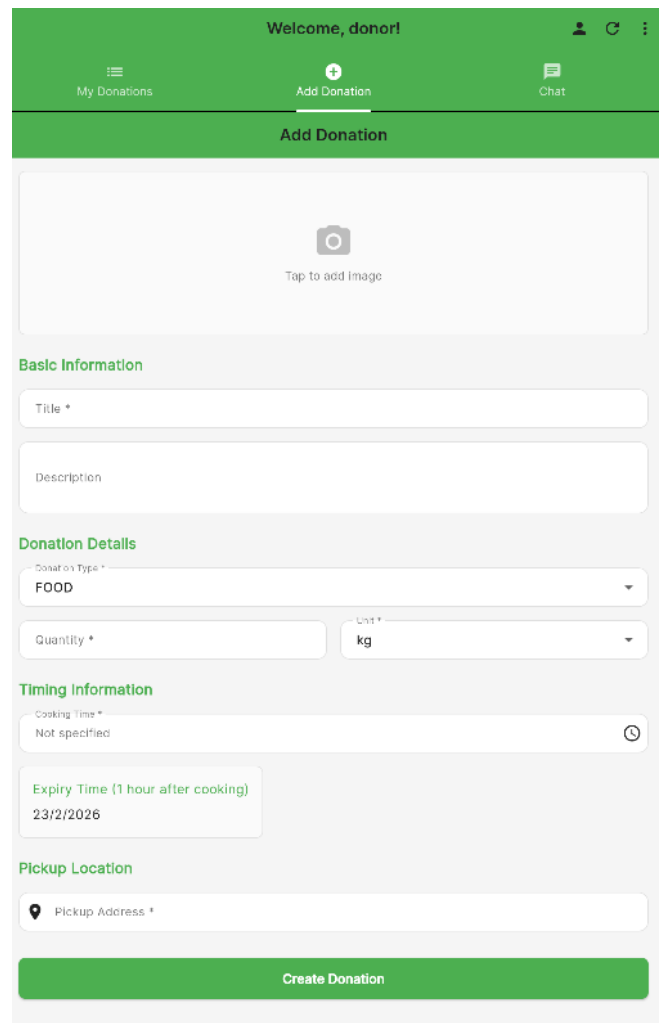
Upload Document

Organization Location

Capture Location

Create Account

Image 11.1 : FOOD DONATION APP, Registration page



Welcome, donor!

My Donations Add Donation Chat

Add Donation

Tap to add image

**Basic Information**

Title \*

Description

**Donation Details**

Donation Type \* FOOD

Quantity \* Unit \* kg

**Timing Information**

Cooking Time \* Not specified

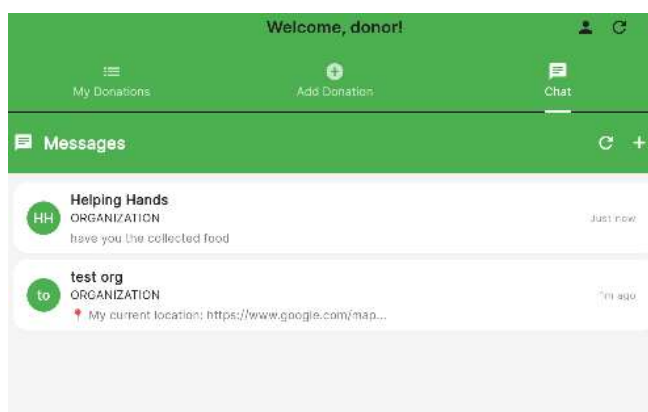
Expiry Time (1 hour after cooking)  
23/2/2026

**Pickup Location**

Pickup Address \*

Create Donation

Image 11.1 : FOOD DONATION APP, donor dashboard



Welcome, donor!

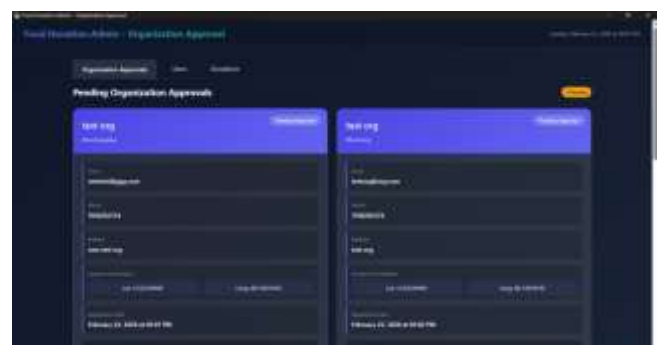
My Donations Add Donation Chat

Messages

Helping Hands ORGANIZATION have you the collected food Just now

test org ORGANIZATION My current location: https://www.google.com/map... 1m ago

Image 11.1 : FOOD DONATION APP , chat page



Pending Organization Approvals

Approve Reject

test org ORGANIZATION

test org ORGANIZATION

Image 11. : ADMIN APP , ORG Approval

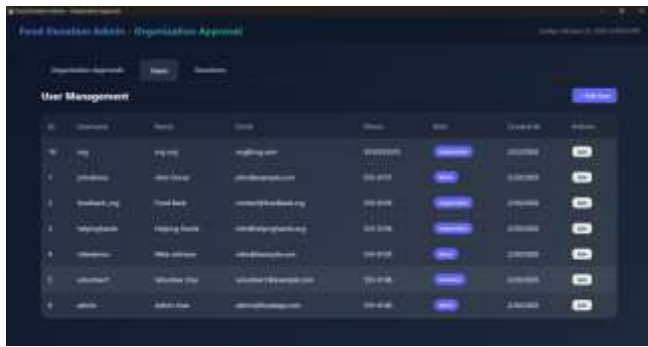


Image 11. : ADMIN APP , User CRUD



Image 11. : ADMIN APP , Donations CRUD

communication clarity, reduces logistical delays, and increases trust between participating parties [25].

Implementation results confirm that mobile-centric technology can significantly streamline donation processes while strengthening coordination among stakeholders involved in food redistribution networks [12]. Real-time updates allow organizations to quickly respond to available donations, minimizing food spoilage risks and maximizing successful distribution outcomes. The system's structured workflow automation reduces manual effort, prevents miscommunication, and enhances operational transparency. By digitizing traditionally informal donation processes, the platform transforms them into measurable, trackable, and optimizable activities that align with efficiency standards expected from contemporary digital service platforms [1].

Performance evaluation testing indicates that the system satisfies functional and non-functional requirements while maintaining a responsive and stable user experience under varying workloads [18]. Stress testing scenarios show consistent server response times, accurate database transactions, and reliable notification delivery even during peak usage conditions. Feedback collected from pilot users highlights strong satisfaction with usability, interface clarity, and the effectiveness of direct donor-to-organization interaction. Such responses suggest high adoption potential across different regions and operational scales, demonstrating that the platform can realistically support broader deployment initiatives [9].

Future development should prioritize advanced capabilities that further strengthen reliability, intelligence, and interoperability of the platform ecosystem [27]. Enhancements such as offline-mode functionality for limited-connectivity environments, predictive analytics for forecasting donation demand patterns, and integration with external logistics or inventory systems could significantly increase operational efficiency. With its modular design and extensible architecture, the system provides a strong technological foundation for continued innovation in food rescue solutions, supporting long-term global efforts to reduce food waste while improving food accessibility for vulnerable populations [14].

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### XIII.CONCLUSION

The presented food donation management system effectively addresses the persistent global challenge of food waste reduction by leveraging structured technological innovation and intelligent system design [7]. Its multi-tier architecture establishes a reliable and scalable operational framework capable of supporting increasing user demand without compromising performance, data integrity, or security. By incorporating layered access control, encrypted communication, and modular service components, the platform ensures that donors, recipient organizations, and administrators can interact seamlessly within a protected digital environment. This architectural strategy not only enhances system stability but also allows flexible expansion as operational scale and functional requirements grow over time [19].

The platform demonstrates a practical and impactful integration of modern web technologies into a socially beneficial application domain, proving that digital infrastructure can directly influence humanitarian logistics efficiency [3]. Through features such as mobile accessibility, real-time notifications, geolocation mapping, and role-based workflows, the system manages the entire lifecycle of food donation—from listing surplus food to confirming receipt by organizations. Importantly, the design ensures that donors directly contact organizations for contributions, eliminating unnecessary intermediaries and simplifying coordination channels. This direct-connection model improves

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