

UCS503 - Software Engineering

Project Report



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1. Executive Summary

Project Name: Second Serving

Team: Team BlackBirds

Vision: Bridging the gap between EXCESS and ACCESS. To digitalize and automate the entire food donation process to significantly reduce food waste.

Second Serving is a web-based platform designed to address the disconnect between food surplus and food insecurity. While India is largely food-sufficient, distribution issues lead to significant wastage. This project provides a structured service for non-profit organizations to automate their workflow, utilizing a hyper-local volunteer network to retrieve donations from households and restaurants. The system utilizes a modern tech stack (MERN), AI integration for food categorization, and geospatial tracking to facilitate rapid, low-friction food rescue operations.

2. Need Analysis and Problem Statement

Hunger is a pervasive problem, but it's not a food shortage—it's a distribution issue.

Various Households, restaurants, grocery stores, and food service providers have excess food that often goes to waste.

At the same time, food banks and non-profit organizations work tirelessly to feed millions of people who are food-insecure.

These organizations are heroes, but they're stretched thin with limited resources.

2.1 Some Key Sources :

One of the key strategies to achieve zero hunger is strengthening India's public food distribution system. [Source - KPMG Report \(Dated February 20, 2025\)](#)

A food-sufficient India needs to be hunger-free too. Source - [The Hindi Article](#) (Dated October 16, 2024)

In India, 40% of the food wasted is worth nearly Rs. 92,000 crore/year. This is equivalent to nearly 1% of the GDP which is depleted in the form of food wastage in India. Each person in India wastes 55 kg of food per year as per [UN Environment Programme's report](#). Source - [Times of Agriculture Article](#) (Dated May 29, 2024)

2.2 Donor Friction Analysis:

Google Form Created :

Food Waste & Logistics Survey

Hi! We are a student team developing **Second Serving**, a platform designed to bridge the gap between excess food and those in need.

We are conducting this survey to understand about **some metrics of logistical and operational barriers** (9 in this form) that stop households and small businesses from donating food. Your insights will help us build a faster and more convenient solution to fight hunger.

This survey is anonymous and takes less than 2 minutes to complete. Thank you for your support!

shreyansh.rawal23@gmail.com [Switch accounts](#) 

 Not shared

* Indicates required question

Which age group do you belong to? *

Younger than 18
 18-25
 26-40
 Older than 40

Frequency: How often do you have excess food that goes to waste? *

Daily
 Weekly
 Rarely

Primary Barrier: What is the main reason you don't donate today? *

Lack of logistics
 Too much coordination efforts
 Don't know who to call

Logistics: If a volunteer could pick up food from your doorstep within 30 mins, would you donate?

Yes
 No
 Maybe

Time Constraint: How much time are you willing to spend to list a donation? *

Less than 1 minute
 Between 1 to 5 minutes
 More than 5 minutes

Friction: Do you find the requirement to download and register on new apps a barrier to using them for occasional tasks? *

Yes
 No
 Maybe

Communication: How important is "real-time confirmation" (knowing exactly when someone is coming) for you? *

Very important
 Neutral
 Not important

Distance: If no pickup is available, how far would you travel to drop off food? *

Not willing
 Less than 3 km
 More than 3 km

Incentive: Would a "Social Impact Certificate" or government-recognized badge encourage you to donate more? *

Yes
 No
 Maybe

Food Type: What category of food is most commonly wasted in your setting? *

Cooked Meals
 Packaged Foods
 Raw Ingredients

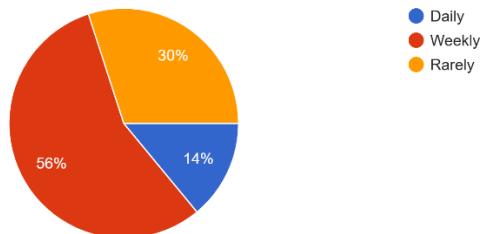
Submit **Clear form**

Responses:

We surveyed around 50 potential donors and following was the response:

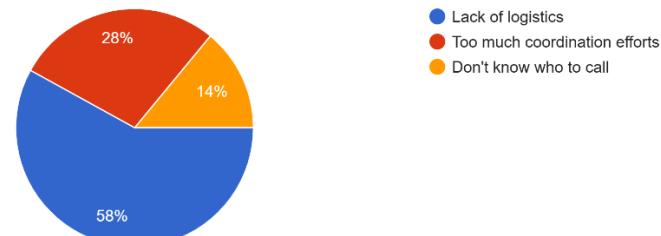
Frequency: How often do you have excess food that goes to waste?

50 responses



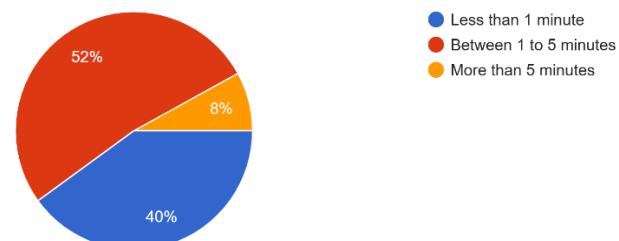
Primary Barrier: What is the main reason you don't donate today?

50 responses



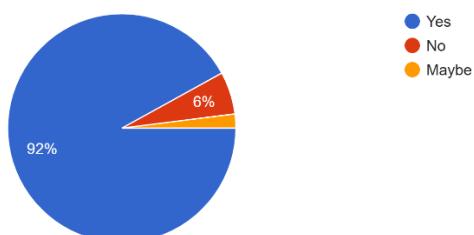
Time Constraint: How much time are you willing to spend to list a donation?

50 responses



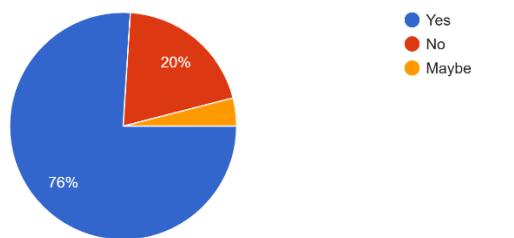
Logistics: If a volunteer could pick up food from your doorstep within 30 mins, would you donate?

50 responses



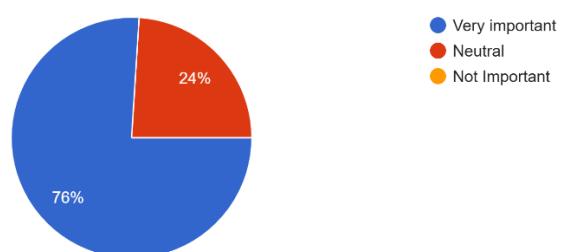
Friction: Do you find the requirement to download and register on new apps a barrier to using them for occasional tasks?

50 responses



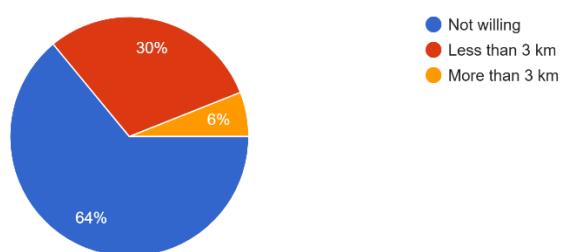
Communication: How important is "real-time confirmation" (knowing exactly when someone is coming) for you?

50 responses



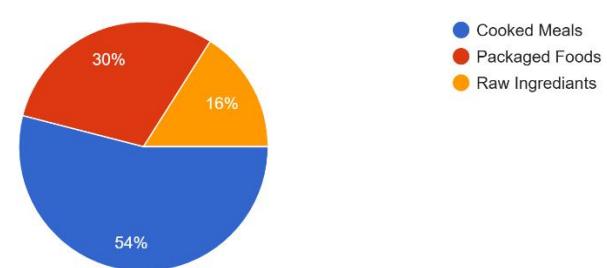
Distance: If no pickup is available, how far would you travel to drop off food?

50 responses



Food Type: What category of food is most commonly wasted in your setting?

50 responses



Critical Insights:

86% cited "Lack of Logistics" as the #1 barrier.

40% stated they would donate if the process took <1 minutes.

92% stated they would donate if the process took <5 minutes.

76% find downloading complex apps for one-off donations a deterrent.

2.3 Problem Statement

1. Manual Processes

Non-profit organizations are often overwhelmed by the sheer volume of manual work involved in their operations.

- **Operational Bottlenecks:** The workflow involves manually tracking donations, coordinating with volunteers, and managing the distribution of food to those in need.
- **Inefficiency and Error:** These manual tasks are time-consuming and prone to human error, which creates inefficiencies in the system.
- **Capacity Limitations:** Consequently, these operational burdens limit the total capacity of food donations that an organization can successfully handle.

2. Under-Utilization of Resources

Despite having access to personnel, organizations struggle to maximize their potential due to a lack of technological infrastructure.

- **Lack of Tools:** Even though non-profits often possess large volunteer networks, they lack the necessary tools and resources to manage incoming food donations effectively.
- **Resulting Waste:** This disconnect results in a significant portion of excess food going to waste instead of reaching the hungry.
- **Inability to Scale:** This under-utilization hinders the organizations' ability to scale their operations and ultimately restricts their reach to fewer people in need.

3. The Solution

1. Core Vision and Approach

The solution is designed to digitalize and automate the entire food donation process to significantly reduce food waste.

- **Structured Service:** The platform acts as a structured service for non-profit organizations to automate their workflow, covering everything from coordination to distribution.
- **Web-Based Access:** To address the friction of downloading complex apps, the live version is web-based (accessible at vlib.eu.org), ensuring fast access without installation barriers.
- **Philosophy:** The core design philosophy centers on "Speed and Simplicity," targeting a "Time to List" of less than 60 seconds.

2. The "HyperLocal Pod" Strategy

The architecture relies on a decentralized operational model called the "HyperLocal Pod".

- **Service Radius:** The platform operates on independent "pods" defined by a 3km service radius around a specific donation.
- **Instant Networking:** It uses geospatial querying (MongoDB's \$near operator) to instantly create a temporary network connecting the nearest donor, volunteer, and hunger spot.
- **Scalability:** This logic allows the platform to launch in new cities without code changes; it simply requires users to register in the new location.

3. Key Functional Modules

The solution is divided into specific dashboards tailored to the user's role:

A. Donor Dashboard

- **Rapid Listing:** Donors can list food, quantity, and expiry time quickly.
- **Location Accuracy:** To solve the issue of vague addresses (e.g., "Near the blue gate"), the system uses browser-based GPS fetching and an interactive map where users can pin their exact location.
- **Self-Delivery Option:** Based on user feedback, a toggle was added for "I can deliver myself," allowing donors with vehicles to bypass the volunteer network for faster delivery.

B. Volunteer Dashboard

- **Real-Time Alerts:** Volunteers receive notifications about donations near their location.
- **Conflict Resolution:** The system prevents race conditions (two volunteers accepting the same job) by using atomic database updates to check availability before assignment.
- **Status Tracking:** Volunteers can update the status of a donation (e.g., "In Transit," "Delivered").

C. Hunger Spot Dashboard

- **Management Center:** Facilities like community kitchens can view active donations and the volunteers assigned to them.
- **Incoming Alerts:** They receive details on incoming donations, including category, quantity, and donor contact info.

4. Technical Innovations & AI Integration

The solution incorporates specific technologies to handle logistics and categorization automatically.

- **Smart Sorting (AI):** The platform integrates the Groq SDK (Llama 3) to analyze food descriptions. It auto-tags food (e.g., "Young" vs. "Everyone") to route it to the appropriate shelter based on age-group preferences.

- **Geospatial Indexing:** To handle perishable food where speed is critical, the backend uses 2dsphere indexing to find volunteers within the tunable 3km radius.
- **Communication:** User authentication and coordination are handled via WhatsApp integration using the Twilio API, leveraging a platform users already trust.

5. Deployment and Security

- **Containerization:** The entire application is Dockerized (including Frontend and Backend) for consistent deployment.
- **Security:** Sensitive API keys are managed using Docker Multi-stage builds and Environment Variable management to ensure secure production builds.

4. Technical Architecture

4.1 Tech Stack

The project is built on a full-stack JavaScript environment.

- **Frontend:** React.js, Vite.
- **Backend:** Node.js, Express.js, Mongoose.
- **Database:** MongoDB Atlas (utilizing \$near operator for geospatial querying).
- **AI/ML:** Groq SDK (Llama 3.3) for intelligent categorization.
- **Maps/Location:** React-Leaflet & OpenStreetMap.
- **Communication:** Twilio API for WhatsApp.

4.2 Deployment & DevOps

- **Containerization:** The entire application is Dockerized (Frontend + Backend) to ensure reproducibility.
- **Hosting:** Currently deployed on Heroku.
- **Security:** Uses Docker Multi-stage builds and environment variable management to protect API keys.

5. Feasibility Analysis

The feasibility of the Second Serving platform is high, primarily due to its strategic approach of digitizing existing operations rather than creating a new one from scratch.

Technical Feasibility :

- The system uses WhatsApp for user authentication and coordination, geospatial tracking for volunteer assignments, and automates tasks like donor and volunteer management. WhatsApp integration is handled through Twilio API.
- The system's ability to categorize food by age group preference is also technically plausible. Age Group categorization is achieved through Groq-SDK.

Operational Feasibility :

- The platform's success hinges on its ability to integrate with and be adopted by existing non-profit organizations and their volunteer networks.
- By streamlining their current manual workflows, it promises to make their operations more efficient, which is a strong incentive for adoption.

- The platform also enables organizations to handle a wider range of donations, including smaller ones, which increases its operational value.

Market Feasibility :

- BlackBirds identifies a clear and widespread problem: a significant amount of food is wasted annually in India while millions of people are food-insecure.
- The platform directly addresses this by providing a solution for the key bottleneck—distribution.
- There's a definite market for a tool that helps bridge this gap efficiently.

Economical Feasibility :

- The platform is being built at absolutely zero-cost.
- All resources used are public and free of cost hence the system is highly feasible economically.
- All external APIs and Services are being used under provisional free tiers.

6. Proof of Concept (POC)

Key Features :

Authentication & Security

- **OTP-based verification** via Twilio WhatsApp integration
- **JWT-based authentication** with secure token management
- **Role-based access control** (Donor, Volunteer, Hunger Spot)
- **Phone number normalization** supporting multiple formats
- **Password encryption** using bcryptjs
- **Forgot password** with OTP verification
- **Resend OTP** functionality with cooldown timer
- **WhatsApp sandbox join** popup for new users

Location Services

- **Interactive maps** using Leaflet and React-Leaflet
- **Geospatial queries** for finding nearest hunger spots and volunteers
- **GPS integration** for automatic location detection
- **Google Maps integration** for navigation
- **Real-time coordinate tracking** with dragable map pins

AI-Powered Matching

- **Intelligent food categorization** using Groq AI (Llama 3.3)
- **Target group detection** (young/everyone) for optimal hunger spot matching
- **Automatic category assignment** based on food description

Real-Time Notifications

- **WhatsApp notifications** via Twilio for:
 - OTP delivery
 - Donation acceptance requests
 - Status updates
 - Delivery confirmations

7. User Feedback and Evolution

The product evolved significantly after beta testing with 10 users.

1. Self-Delivery Feature:

- *Feedback:* Donors with vehicles felt the system forced unnecessary volunteer searches.
- *Evolution:* Added a "I can deliver myself" toggle, reducing load on the volunteer network.

2. Location Control:

- *Feedback:* Users were unsure if fetched coordinates were correct or wanted to set a pickup location different from their current one.
- *Evolution:* Added a visible interactive map with a movable pin.

8. Future Scope and Sustainability

8.1 Monetization Model

To move beyond the "sandbox" phase, the project plans a sustainable revenue model:

- Freemium: Remains free for individuals.
- Corporate Subscriptions: "CSR Reporting-as-a-Service" for corporates to help them achieve Green Certificates.
- Data Licensing: Sharing anonymized food waste data with government and research institutions.

8.2 Roadmap

- Mobile App: Converting the web platform to a mobile application.
- Route Optimization: Automating routes to enable multi-donation pickups for a single volunteer.
- Verification: Moving to SMS/Email verification to reduce dependency on WhatsApp.

9. Conclusion

Second Serving successfully validates the friction involved in food donation—specifically logistics—and provides a technical solution that is fast, secure, and scalable. By digitizing existing manual workflows rather than creating new infrastructure, the platform ensures high operational feasibility and adoption potential among existing NGOs.