

## Food Donation Platform

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**Abstract** - The concurrent challenges of global food waste and localized food insecurity necessitate innovative, technology-driven solutions. This paper presents a systematic review of the literature concerning the design and implementation of digital platforms that connect food donors with non-governmental organizations (NGOs), community kitchens, and individuals in need. The primary objective is to synthesize existing knowledge on system architectures, key functionalities, and evaluation frameworks to propose a robust design for a comprehensive food donation platform. The review scope encompasses an analysis of existing platforms, the application of Geographic Information Systems (GIS) for logistics, blockchain for transparency, and models for donor engagement. Significant gaps are identified, including challenges in last-mile logistics for remote areas, handling perishable goods, and integrating with public policy. The paper subsequently outlines critical system design considerations, including functional and non-functional requirements, a proposed modular architecture, and algorithms for matching and routing. Furthermore, a framework for evaluating platform success is proposed, incorporating metrics such as matching success rate, quantity of food recovered, and donor retention. The review concludes that a well-designed, multi-stakeholder platform can significantly reduce food waste and enhance food security, provided it addresses logistical, technological, and ethical concerns through thoughtful design and strategic partnerships. **Keywords:** Surplus Food Donation, Mobile Application, GIS Mapping, Blockchain Transparency, Impact Evaluation.

**Key Words:** Food Waste Reduction, Digital Donation Platform, Logistics Optimization, Donor Incentive Models, Social Impact Assessment.

## 1.INTRODUCTION

The scale of global food waste represents a critical failure within modern food systems, with an estimated one-third of all food produced for human consumption lost or wasted annually. This wastage occurs alongside persistent food insecurity, affecting millions of individuals and families worldwide. The environmental impact is equally profound, as food waste contributes significantly to greenhouse gas emissions when decomposing in landfills. While a considerable portion of this waste originates from supply chains, a significant amount is surplus edible food from retailers, restaurants, hotels, and households that could be redirected to those in need. This paradox of surplus and scarcity highlights an urgent need for efficient redistribution mechanisms.

Traditional methods of food donation often rely on informal networks, phone calls, and ad-hoc arrangements, which are inefficient, non-scalable, and lack transparency. These methods struggle with timely communication, optimal routing for collection, and verifying the final impact of donations. Digital platforms, particularly mobile applications and web portals, offer a transformative potential to bridge this gap by enabling real-time connection, coordination, and tracking between donors and recipient organizations. The core problem addressed in this review is how to architect such a platform to ensure efficient, reliable, and scalable redistribution of surplus food, thereby converting a logistical challenge into a social opportunity.

The objectives of this review are fourfold. First, it synthesizes the current state of digital food redistribution platforms, categorizing their architectures and identifying strengths and weaknesses. Second, it examines critical technological components, including GIS-based logistics, matching algorithms, and blockchain-based audit trails. Third, it analyzes models for sustaining user engagement through incentives and partnerships. Finally, the review

proposes a comprehensive system design and an evaluation framework to guide future implementations and research. The scope is limited to platforms designed for surplus prepared and non-prepared food, excluding dedicated agricultural gleaning or commodity-specific systems.

The importance of this topic extends beyond technological innovation. Effective digital redistribution platforms can directly support national food security programs and strengthen the operational capacity of the existing NGO ecosystem. By providing data on surplus patterns and redistribution flows, such platforms can also inform public policy, leading to more targeted and effective interventions against both food waste and hunger. This review aims to consolidate knowledge and provide a roadmap for developers, policymakers, and social entrepreneurs seeking to harness digital technology for social good.

## 2. Methodology of the Review

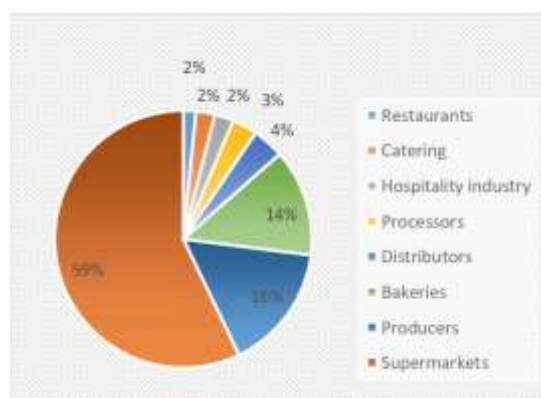
This review was conducted following a systematic approach to identify and analyze relevant literature. A comprehensive search was performed across major academic databases, including IEEE Xplore, ACM Digital Library, Scopus, and Web of Science. The primary search keywords included combinations of terms such as "food donation platform," "surplus food redistribution," "mobile app for food waste," "NGO coordination," "GIS food logistics," and "blockchain food traceability." The inclusion criteria focused on peer-reviewed journal articles, conference proceedings, and published case studies from the last decade (2013-2023) that described the design, implementation, or evaluation of digital food redistribution systems. Literature not available in English or describing non-digital systems was excluded.

The initial search yielded over 150 publications. After screening titles and abstracts for relevance, 68 documents were selected for full-text review. These were categorized into five thematic areas for synthesis: (1) descriptions of existing digital platforms and their architectures; (2) studies on mapping, routing, and logistics optimization; (3) proposals and implementations concerning transparency and trust mechanisms, notably blockchain; (4) analyses of user engagement and incentive models; and (5) frameworks for sustainability and impact assessment. The findings from these categories are synthesized in the following literature review to present a cohesive overview of the field and identify salient research gaps.

## 3. Literature Review

### 3.1 Existing Digital Food-Donation Platforms

Digital platforms for food redistribution have emerged in various forms, primarily as mobile applications and web portals. These can be broadly categorized into centralized models, often managed by a single NGO or social enterprise, and decentralized or peer-to-peer (P2P) models that connect donors directly with individuals. Centralized platforms, such as the system described in the SeVa case study, act as an intermediary, coordinating pickups by verified volunteers or logistics[1]. partners and ensuring food safety standards before distribution to recipient agencies. This model offers greater control and quality assurance but can suffer from scalability limitations. In contrast, P2P platforms like those inspired by food-sharing initiatives enable direct donor-to-recipient matching, which can be faster and more scalable but raises concerns about safety, verification, and potential misuse.



A

review of several representative systems reveals common architectural patterns. Most employ a three-tier architecture consisting of a frontend client (mobile/app), a backend server for business logic and data management, and a database. For instance, the FoodShare application was reported to have facilitated the redistribution of over 5,000 kg of food within a six-month pilot in an urban setting, demonstrating the potential of mobile technology. However, its evaluation also highlighted challenges in sustaining volunteer participation. A key weakness across many existing platforms is their limited geographical scope, often being designed for dense urban environments with high internet penetration and a concentration of food businesses, thereby neglecting semi-urban and rural areas.

In India, initiatives like **Feeding India by Zomato** [2] have demonstrated significant scalability by leveraging the existing logistics network of a food-tech giant. This partnership model connects a wide base of restaurant

donors with numerous NGO partners, effectively bridging the gap between commercial surplus and organized distribution networks [2].

### 3.2 Mapping, Location Services and Logistics

The effective matching of donors and recipients is fundamentally a geospatial problem. Consequently, the integration of Geographic Information Systems (GIS) and location-based services is a critical component of most platforms[4]. These services are used for multiple purposes: displaying nearby donation opportunities to volunteers, allowing recipients to find distribution points, and, most importantly, optimizing collection routes. Research indicates that efficient routing can reduce fuel consumption and pickup times by up to 20%, significantly impacting the operational viability of donation networks. Algorithms such as the Vehicle Routing Problem (VRP) with time windows are often adapted to schedule pickups from multiple donors in a single trip, considering factors like volunteer availability and time-sensitive perishability.

However, the reliance on real-time GIS presents a significant limitation for operation in remote or low-connectivity areas. Platforms designed for high-income urban contexts often fail to account for challenges such as poor network infrastructure, inaccurate mapping data, and limited smartphone access among potential volunteers or recipients in rural communities. Proposed solutions include the use of offline-capable mapping applications that sync data when connectivity is available and the implementation of SMS-based or USSD (Unstructured Supplementary Service Data) systems for basic notification and coordination, though these fallback methods offer limited functionality compared to full-featured apps.

### 3.3 Transparency and Trust

A significant barrier to donor participation, particularly from corporate entities, is the lack of transparency regarding the final destination and use of donated food. Concerns over liability and the desire for Corporate Social Responsibility (CSR) reporting necessitate robust audit trails. Recently, blockchain technology has been proposed as a solution to create an immutable, transparent, and decentralized ledger for tracking donations from source to final distribution. Smart contracts could theoretically automate steps like confirming pickup and delivery, triggering the generation of digital tax receipts for donors.

The primary advantage of blockchain is the creation of a trustless system where all stakeholders can verify transactions without relying on a central authority. A prototype system described by demonstrated the feasibility of using blockchain to record donation details, creating an audit trail that increased donor confidence. However, the practical trade-offs are considerable. The complexity and computational cost of maintaining a blockchain can be prohibitive for small NGOs. Furthermore, data privacy concerns arise when recording potentially sensitive information about recipients on a permanent ledger. Hybrid designs, where bulk data is stored off-chain (e.g., in a conventional database) with only cryptographic hashes stored on-chain for verification, are often suggested as a more feasible compromise.

### 3.4 Incentive and Engagement Models

Sustaining an active user base is critical for the long-term viability of any platform. For food donation platforms, this involves engaging three key groups: food donors, volunteers, and recipient organizations. Evidence suggests that simply providing a technological tool is insufficient; explicit incentive models are required to encourage repeated use. For corporate donors, the primary incentives often involve streamlined processes for generating tax deduction receipts and detailed impact reports that can be used for CSR documentation.

For individual donors and volunteers, gamification elements—such as points, badges, and leaderboards—have been shown to increase participation frequency. One study found that volunteers on a platform with a simple points-based recognition system completed 30% more pickups than those on a platform without such features. Social recognition, through features that allow donors to share their contributions on social media, also serves as a powerful motivator. Partnerships with local businesses to offer discounts or rewards to top volunteers represent another effective engagement strategy, creating a virtuous cycle of community involvement.

### 3.5 Sustainability and Impact Assessments

Evaluating the success of a food donation platform requires a multi-dimensional set of metrics. The most direct metrics quantify the volume of food waste diverted from landfills and the subsequent social impact. Commonly reported figures include the weight of food recovered (e.g., kilograms per month) and the estimated number of meals provided or beneficiaries served[5]. The environmental

impact is often estimated in terms of carbon dioxide equivalent (CO<sub>2</sub>e) emissions avoided by preventing food waste.

Beyond these output metrics, process-oriented metrics are crucial for assessing platform efficiency. These include the average time between a donation being posted and being claimed (matching speed), the percentage of successfully completed pickups (fulfillment rate), and user satisfaction scores gathered through surveys. The methodological rigor of impact assessments varies widely, ranging from simple pre-/post-pilot comparisons to more sophisticated controlled studies that compare regions with and without platform access. A common challenge is accurately attributing outcomes solely to the platform, as other external factors can influence food donation volumes and recipient access.

### 3.6 Gaps Identified in Literature

The literature reveals several consistent gaps. First, there is a pronounced urban bias, with few platforms designed to address the unique logistical challenges of remote or rural areas, where food insecurity may be most acute. Second, while routing algorithms are discussed, the integration of real-time constraints related to food perishability and cold-chain requirements is often superficial. Third, legal and liability concerns, particularly around food safety, are frequently acknowledged but rarely addressed with concrete technological or procedural solutions. Finally, there is a lack of research on the sustainable integration of these platforms with larger government food security schemes, which is essential for achieving scale and long-term funding[3].

## 4. Functional Requirements

A comprehensive platform must support distinct user flows for each stakeholder type. For donors, core functions include the ability to easily list surplus food (including type, quantity, location, and pickup-by time), view pending and past donations, and receive digital receipts. Recipient organizations (NGOs, community kitchens) require functionality to browse or receive notifications of available donations, schedule pickups, and manage their inventory. Volunteers need a interface to view available pickup tasks near their location, accept assignments, and confirm task completion. An administrative dashboard is essential for

user verification, monitoring system health, resolving disputes, and generating analytics reports.

### 4.1 Non-functional Requirements

To ensure real-world utility, the platform must be designed with stringent non-functional requirements. **Scalability** is paramount to handle a growing user base and donation volume without performance degradation. **Availability** and **low-latency notifications** are critical, as donation opportunities are time-sensitive. **Security** and **privacy** must be foundational, ensuring that sensitive user data (especially of recipients) is protected through encryption and strict access controls. The system should also exhibit **offline resilience**, allowing volunteers in areas with poor connectivity to access critical task information and log completions that sync once connectivity is restored.

### 4.2 Core Components and Interactions

The proposed system architecture is modular, comprising several interconnected components:

1. **Multi-platform Frontends:** Native mobile applications (for Android) for donors, volunteers, and recipients on-the-go, complemented by a responsive web portal for administrative tasks and detailed reporting.
2. **Backend API Server:** A central server application handling business logic, user authentication, and data processing.
3. **Matching & Routing Engine:** The core algorithmic module that identifies optimal donor-recipient-volunteer matches based on proximity, time windows, and food type.
4. **Notification Service:** A dedicated service for sending push notifications, SMS alerts, and emails.
5. **Audit Ledger Module:** A component responsible for creating tamper-evident records of transactions; this could be implemented as a traditional database with strict logging or integrate with a blockchain network.
6. **Analytics Dashboard:** A module for aggregating data and visualizing impact metrics for administrators and donors.



### 4.3 Data Model and Privacy

The data model should adhere to the principle of data minimization. Essential entities include User (with roles: Donor, Volunteer, NGO\_Admin), Donation\_Listing, Pickup\_Request, and Transaction\_Record. Personally Identifiable Information (PII) should be stored separately and encrypted. The platform must be designed for compliance with relevant data protection regulations (e.g., GDPR, or local equivalents), requiring explicit user consent for data collection and providing mechanisms for data access and deletion. Impact reporting should use anonymized and aggregated data to protect beneficiary privacy.

### 4.4 Handling Coordination Challenges in Remote Areas

To address the digital divide, the system design must incorporate low-tech fallbacks. This includes an SMS/USSD gateway for users with feature phones, allowing them to report donations or receive pickup notifications via text. For volunteers, the mobile app should have an offline mode that downloads task details when connected and allows for navigation and status updates offline, syncing data later. Operational strategies, such as establishing centralized volunteer hubs in semi-urban areas that serve surrounding villages with scheduled cluster-based pickups, can also mitigate connectivity issues.

## 5. Blockchain & Transparency

The decision to integrate blockchain technology should be driven by specific use cases where its properties are most beneficial. For this platform, blockchain is most appropriate for creating an immutable chain of custody for donations, providing donors with verifiable proof that their contribution reached an intended recipient. This can be achieved through smart contracts that automatically generate a cryptographically signed receipt upon volunteer confirmation of delivery. This audit trail can enhance donor trust and simplify compliance with food donation laws that offer liability protection.

However, a full-scale, permissionless blockchain implementation may be impractical due to transaction costs and performance limitations. A more feasible approach is a hybrid or private, permissioned blockchain. In this model, details of each donation transaction are hashed, and only the hash is stored on the blockchain. The actual data (donor info, food details, photos) remains in a conventional, secure database. This provides the tamper-evidence of blockchain

without the overhead of storing large amounts of data on-chain, making it more accessible for NGOs with limited technical resources.

## 6. Partnerships, Policy & Incentives

The platform's success is contingent on strategic partnerships rather than technology alone. Formal partnerships with established NGOs and community kitchens are crucial for beneficiary verification, distribution, and ensuring compliance with local food safety standards. Collaboration with municipal corporations or national food security agencies can integrate the platform into existing social safety nets, providing legitimacy and potential public funding.

Incentive models must be tailored to different user segments. For corporate donors, seamless integration with tax receipt generation systems is paramount. For individual donors and volunteers, a points-based system that can be redeemed for discounts from partner businesses (e.g., cafes, supermarkets) or converted into charitable gifts can foster sustained engagement. Clear governance frameworks must be established to address legal liabilities, potentially building on "Good Samaritan" laws that protect donors from liability when donating in good faith.

## 7. Limitations and Ethical Concerns

Several limitations and ethical concerns must be proactively addressed. Foremost is **food safety**; the platform must incorporate clear guidelines for donors on what is acceptable to donate and include simple checklists for volunteers to perform visual checks. While technology can facilitate connections, it cannot replace basic safety protocols. **Verification of recipients** is another concern to prevent exploitation; partnering with registered NGOs is a key mitigation strategy. **Geographic bias** is an inherent risk, as the platform may naturally expand in well-connected urban areas, potentially widening the digital divide in access to food aid. To counter this, proactive efforts are needed to design for and deploy in underserved regions from the outset. Finally, the **privacy of beneficiaries** must be rigorously protected, ensuring that their data is not exposed to other users or used for purposes beyond the platform's core mission.

## 8. Future Research Directions

Future research should explore advanced technological and operational integrations. **Predictive analytics** could forecast surplus food generation based on factors like season, day of the week, and local events, enabling proactive volunteer scheduling. **Machine learning** techniques could refine the matching algorithm over time, learning from successful matches to improve future recommendations. Research into **low-cost IoT sensors** for monitoring temperature and humidity during transportation could enhance the handling of perishable goods. From a policy perspective, long-term studies on the **economic sustainability** of such platforms and their **integration with national food policy** are critical to understand how to achieve impact at scale. Finally, exploring **decentralized autonomous organization (DAO) models** for community-led governance of the platform presents a novel research direction.

## 3. CONCLUSIONS

This review has synthesized the current landscape of digital food donation platforms, highlighting both their potential and their limitations. The analysis confirms that a well-architected system combining efficient matching algorithms, thoughtful incentive models, and strategic partnerships can significantly enhance surplus food redistribution. The proposed system design emphasizes modularity, offline capability, and a hybrid approach to transparency to address key gaps in existing solutions. The accompanying evaluation framework provides a roadmap for measuring success beyond simple volume metrics, focusing on efficiency, user engagement, and overall impact. By addressing the identified logistical, technological, and ethical challenges, future implementations of such platforms hold substantial promise for creating a more efficient and equitable system for reducing food waste and alleviating food insecurity.

## ACKNOWLEDGEMENT

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