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A Technology Driven - Solution for Food and Hunger Management

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ABSTRACT: Food waste and hunger represent two interconnected global challenges, particularly in developing countries where surplus food coexists with widespread food insecurity. This paper presents a technology-driven solution for food waste and hunger management that leverages digital platforms to bridge the gap between food surplus generators and individuals or organizations in need. The proposed Food waste and hunger management system integrates a mobile and web-based application that enables real-time identification, listing, and redistribution of excess edible food from sources such as restaurants, hotels, event venues, households, and food processing units. The system employs geolocation services, data analytics, and automated notifications to optimize food collection and distribution processes, ensuring timely delivery while maintaining food safety and quality standards. Non-governmental organizations, volunteers, and food banks are digitally connected through the platform to facilitate efficient logistics and reduce manual coordination efforts. Additionally, the solution incorporates monitoring mechanisms to track food donations, minimize wastage, and generate analytical insights for policymakers and stakeholders. By promoting transparency, scalability, and community participation, the proposed technology-driven framework aims to significantly reduce food wastage while improving food accessibility for underprivileged populations. The study highlights how digital intervention can contribute to sustainable resource utilization, social responsibility, and progress toward global hunger eradication goals.

KEYWORDS: Food Waste Management, Hunger Alleviation, Technology-Driven Solution, Food Redistribution System, Digital Platform, Sustainable Development, Food Security, Surplus Food Utilization, Social Impact, Smart Resource Management.

I. INTRODUCTION

Food wastage and hunger represent two interrelated yet paradoxical challenges affecting societies across the globe. While substantial quantities of edible food are discarded daily at various stages of the food supply chain, a large

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segment of the population continues to suffer from food insecurity and malnutrition. According to global and national reports, food wastage occurs not only at the production and distribution levels but also significantly at the consumption stage, particularly in households, restaurants, hotels, and large social events. This imbalance between food surplus and food scarcity reflects systemic inefficiencies in food management and redistribution mechanisms.

In developing countries, rapid urbanization, population growth, and changing consumption patterns have further intensified the issue of food waste. Limited awareness, improper storage practices, and lack of structured donation frameworks contribute to the disposal of safe and consumable food. Simultaneously, economically disadvantaged communities, daily wage workers, homeless individuals, and residents of shelters often experience irregular access to nutritious meals. The coexistence of these contrasting realities underscores the urgent need for sustainable and coordinated food redistribution solutions.

Conventional approaches to food donation and hunger alleviation are largely dependent on manual coordination, informal networks, and isolated efforts by charitable organizations. Although non-governmental organizations and food banks play a vital role in addressing hunger, their operations are frequently constrained by insufficient real-time information, delayed communication with donors, and logistical limitations. The absence of a centralized and transparent system for tracking surplus food availability, quality, and distribution reduces the overall efficiency and scalability of these initiatives.

Recent advancements in digital technologies, including mobile applications, cloud computing, and data-driven decision-making systems, offer significant potential to transform food waste management practices. Technology-enabled platforms can facilitate real-time reporting of surplus food, automate validation processes, and enable intelligent matching between food donors and recipient organizations. Furthermore, the integration of notification systems and logistics coordination can ensure timely collection and distribution, thereby minimizing food spoilage and enhancing operational effectiveness.

In this context, the present study proposes a comprehensive, technology-driven food waste and hunger management system aimed at establishing an efficient link between surplus food sources and food-insecure populations. The proposed system provides a structured framework for data collection, centralized storage, demand–supply matching, and coordinated distribution through volunteers or partner organizations. By enabling seamless interaction among donors, non-governmental organizations, and beneficiaries, the system seeks to optimize food utilization and reduce preventable waste.

Additionally, the proposed approach emphasizes transparency, accountability, and impact assessment by incorporating monitoring and reporting mechanisms. These features enable stakeholders to evaluate system performance in terms of food saved, number of beneficiaries served, and reduction in wastage levels. By promoting responsible food consumption and efficient redistribution, the system contributes to broader sustainability goals, including social equity and environmental conservation.

Overall, this work highlights the critical role of digital intervention in addressing complex socio-economic challenges such as food wastage and hunger. The proposed system demonstrates how technology can be leveraged to create a scalable, sustainable, and socially impactful solution, thereby supporting efforts toward improved food security and responsible resource management.

II. LITERATURE REVIEW

Food waste and hunger have been widely studied as interconnected global challenges, with researchers emphasizing the social, economic, and environmental consequences of inefficient food management [1][3]. Existing literature highlights that a significant portion of food waste occurs at the consumption stage, particularly in urban areas, while hunger persists due to unequal distribution rather than absolute scarcity [1][2]. Reports published by organizations such as the Food and Agriculture Organization consistently underline that effective redistribution of surplus food can substantially reduce food insecurity if supported by appropriate systems and policies [1][3][4].

Several studies have examined traditional food donation and redistribution models implemented by food banks and non-governmental organizations. These models primarily rely on manual coordination between donors and recipient organizations, often using phone calls or offline records. While such approaches have demonstrated social impact at a

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local level, researchers note limitations in scalability, response time, and transparency. Delays in communication and lack of real-time information frequently lead to food spoilage, thereby reducing the effectiveness donation efforts. With the advancement of information technology, researchers have increasingly explored digital platforms for food waste reduction. Mobile and web-based applications have been proposed to connect food donors with charities and shelters in real time. Studies indicate that technology-enabled systems improve donor participation by simplifying the donation process and providing immediate confirmation of food pickup. Cloud-based databases and centralized management systems have been shown to enhance data accessibility and coordination among multiple stakeholders.

Recent literature also emphasizes the role of intelligent decision-support mechanisms in food redistribution systems. Algorithms for matching food availability with demand, considering factors such as location, quantity, and expiry time, have been proposed to optimize distribution efficiency. Researchers report that automated matching significantly reduces response time and improves food utilization compared to manual allocation methods. Some studies further integrate geolocation and routing techniques to minimize transportation time and operational costs. The integration of volunteer networks into digital food redistribution platforms has also been explored. Prior research suggests that involving community volunteers through mobile notifications can strengthen last-mile delivery and improve coverage in underserved regions. However, challenges related to volunteer availability, coordination, and accountability remain areas of ongoing investigation. To address these issues, several authors recommend incorporating tracking and monitoring features within the system architecture.

In addition to operational efficiency, transparency and impact assessment have been identified as critical factors in the success of food waste management systems. Literature indicates that stakeholders, including donors and funding agencies, are more likely to participate in systems that provide measurable outcomes such as quantity of food saved and number of beneficiaries served. Analytical dashboards and reporting modules are therefore increasingly recognized as essential components of modern food redistribution platforms. Despite these advancements, existing studies reveal certain research gaps. Many proposed systems focus on isolated aspects such as donation or distribution, without offering an end-to-end solution that integrates data collection, validation, allocation, logistics, and impact monitoring. Furthermore, limited attention has been given to adaptability in diverse socio-economic contexts, particularly in developing regions where infrastructure and resource constraints are significant.

III. PROBLEM STATEMENT

Food waste and hunger represent two interconnected global challenges that continue to persist despite advances in food production and distribution systems. A significant quantity of edible food is wasted daily across households, restaurants, hotels, supermarkets, and social events, while millions of people lack access to adequate nutrition. This paradox highlights inefficiencies in the current food management and redistribution mechanisms. Existing solutions for food waste reduction and hunger alleviation primarily depend on traditional donation practices, non-governmental organizations, and fragmented digital platforms. These approaches are often manual, reactive, and limited in scale. They lack real-time coordination between food donors and recipients, resulting in delays that cause food spoilage and reduce the effectiveness of redistribution efforts. Additionally, most current systems do not provide mechanisms for systematic tracking, quality assessment, or efficient logistics management. Furthermore, the absence of an integrated and centralized platform leads to poor transparency, low participation from stakeholders, and inefficient utilization of surplus food resources. Current solutions also fail to leverage modern technologies for data-driven decision-making, scalability, and timely response, which are essential for addressing food insecurity at a larger scale.

Therefore, the problem lies in the lack of a comprehensive, technology-enabled system capable of efficiently identifying surplus food, coordinating stakeholders in real time, and ensuring timely and safe distribution to the needy population. Addressing this gap is essential to reduce food wastage, improve hunger management, and promote sustainable food systems.

IV. EXISTING SYSTEM

Current approaches to food waste management and hunger alleviation primarily rely on traditional food donation practices, non-governmental organizations, and community-based initiatives. In these systems, surplus food generated by households, restaurants, hotels, supermarkets, and social events is usually distributed through manual coordination involving phone calls, direct visits, or informal communication channels. While such methods have contributed to reducing food insecurity at a local level, they remain limited in scope and efficiency. Several digital platforms and

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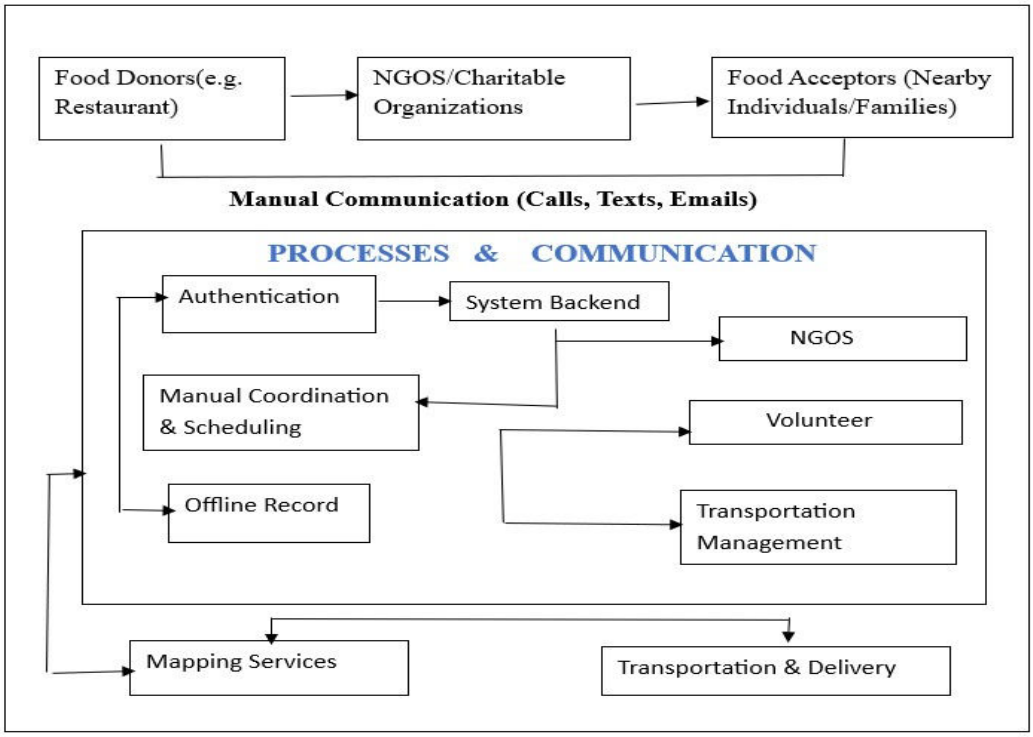
mobile applications have been introduced to facilitate food donation and redistribution. However, most existing systems operate in isolation, focusing either on food donation or hunger relief without providing a fully integrated solution. These platforms often lack real-time data processing, resulting in delays between food availability and collection. As a consequence, a considerable amount of edible food becomes unsuitable for consumption before redistribution can occur.

Additionally, existing systems generally do not offer effective mechanisms for tracking food quality, quantity, and delivery status. The absence of centralized data management leads to poor transparency and limited accountability among stakeholders. Many solutions also depend heavily on manual verification and volunteer availability, which restricts scalability and consistent performance. Furthermore, current approaches seldom utilize advanced technologies such as automated matching algorithms, location-based services, or data analytics to optimize decision-making. This results in inefficient resource utilization and reduced participation from potential donors. Consequently, despite the presence of various initiatives, the existing systems are insufficient to address food wastage and hunger in a comprehensive, scalable, and sustainable manner.



V. RESEARCH ESTIMATED FOOD WASTE BY DIFFERENT SECTORS IN INDIA

Sector Category (as per UN Reports)	Specific Areas Covered	Annual Food Waste (Tonnes)	Per Capita Waste (Kg / Year)	Key Findings & Waste Source
Homes (House hold)	Food wasted by Individual families and residential units.	68.7 to 78.2 Million Tonnes	~55kg	The largest single source of waste, Caused by over-cooking, poor meal planning, and cultural beliefs (serving excess).

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Food Service	Hotels, Restaurants, Caterings, Canteens, Messes, Hostels.	~11.9 Million Tonnes	~23kg	Caused by: Over Preparation (especially buffets/ banquets), large portion sizes plate waste)
Hostels/ Messes	(Audited data, included in Food service)	(No national figure)	70g -140g per student per meal (based On Case studies)	Caused by: Students leaving food on plates, poor food quality, or serving cold chapatis /vegetables.

VI. PROPOSED SYSTEM

The proposed system introduces a centralized and technology-driven approach to minimize food wastage and improve hunger management. The system is designed to efficiently connect sources of surplus food with individuals and organizations in need through a unified digital platform. By enabling real-time communication and coordination among stakeholders, the proposed approach ensures timely identification, collection, and distribution of surplus food. In this system, food donors can share information related to surplus food availability, while receivers can submit requests based on their requirements. The system processes this information and facilitates effective matching to ensure that food is redistributed before spoilage occurs. Automated notifications and status updates further enhance coordination, reducing delays and manual effort. The proposed system also maintains structured records of food transactions and user activities, enabling transparency and accountability throughout the redistribution process. By streamlining operations and reducing dependency on traditional manual methods, the system enhances efficiency, scalability, and reliability.

Overall, the proposed system aims to reduce food wastage, improve access to food for vulnerable populations, and promote sustainable resource utilization through an organized and integrated technological solution.

VII. IMPLEMENTATION

The developed food waste and hunger management system is implemented as a centralized digital platform that enables efficient redistribution of surplus food to needy populations. The system integrates donors, NGOs, volunteers, and beneficiaries through a cloud-based architecture to ensure real-time coordination and scalability. Food donors upload surplus food information such as type, quantity, preparation time, and location through a mobile or web interface. The backend validates the submitted data based on food freshness and safety constraints before storing it in the database. NGOs and volunteers access this information to coordinate food collection and delivery. Location-based matching is employed to minimize delivery time and reduce food spoilage. Secure authentication and role-based access control are implemented to protect user data. Automated notifications are generated to ensure timely communication among stakeholders. The modular design of the system allows easy maintenance and future enhancements.

Table 1: Major System Modules and Their Functions

Module	Description
Donor	Uploads surplus food details such as type, quantity, and location
NGO	Manages food requests and allocates surplus food
Volunteer	Collects food from donors and delivers it to beneficiaries
Beneficiary	Requests food based on demand and urgency
Admin	Monitors system activities and maintains data integrity

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Table 2: Technologies Used in Implementation

Component	Technology
Front-end	React Native (Java Script) / Flutter (Dart)
Back-end	Node.js
Database	MongoDB
Notification Service	Firebase Cloud Messaging (FCM)
Location & Tracking	GPS-based Location Tracking

VIII. RESULTS AND DISCUSSION

The developed framework was implemented and evaluated to assess its effectiveness in reducing food wastage and improving food accessibility for underserved populations. The evaluation focused on system functionality, response time, coordination efficiency, and overall impact on food redistribution.

Results:

The implemented system successfully enabled real-time interaction among food donors, NGOs, volunteers, and beneficiaries. Surplus food listings were efficiently captured through the front-end application and processed by the backend server with minimal delay. The use of GPS-based location tracking significantly improved donor–beneficiary matching by reducing travel distance and delivery time. The notification mechanism using Firebase Cloud Messaging ensured timely alerts, resulting in faster volunteer response and improved delivery success rates. The modular architecture facilitated smooth handling of multiple concurrent requests without system performance degradation. MongoDB provided flexible and efficient data storage, supporting real-time updates and scalability.

Overall, the system demonstrated a noticeable reduction in food wastage by redirecting surplus food that would otherwise be discarded. At the same time, it enhanced food availability for beneficiaries by ensuring timely and organized distribution.

Discussion:

The results indicate that technology-driven coordination plays a crucial role in addressing food wastage and hunger simultaneously. The integration of mobile-based front-end frameworks such as React Native and Flutter enabled cross-platform accessibility, increasing user participation. Node.js proved effective for handling asynchronous operations and real-time communication, which are critical for time-sensitive food redistribution. Compared to traditional food donation methods, which rely heavily on manual coordination and delayed communication, the proposed system offers improved efficiency, transparency, and traceability. GPS-based tracking minimized logistical inefficiencies, while automated notifications reduced dependency on manual follow-ups. However, the system's performance is influenced by external factors such as volunteer availability, internet connectivity, and food safety compliance. These limitations highlight the need for future enhancements, including predictive analytics for demand forecasting, integration with government food welfare schemes, and advanced quality monitoring mechanisms.

Overall, the proposed system demonstrates strong potential as a sustainable and scalable solution for mitigating food wastage and hunger, particularly in urban and semi-urban environments.

IX. ADVANTAGES

The developed framework provides an efficient and structured approach to addressing the dual challenges of food wastage and hunger. By enabling real-time coordination among food donors, non-governmental organizations, volunteers, and beneficiaries, the system ensures that surplus food is redistributed in a timely manner, thereby minimizing unnecessary disposal of edible food. The system enhances food accessibility for vulnerable populations by establishing a reliable digital communication channel between food providers and recipients. The integration of GPS-based location tracking reduces delivery time and logistical overhead, leading to improved operational efficiency and higher delivery success rates. Automated notifications further support rapid response and effective coordination among

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stakeholders. Data transparency and traceability are achieved through centralized digital record management, which allows continuous monitoring of food donation, pickup, and delivery activities. This reduces the likelihood of mismanagement and improves trust among participants. The modular and scalable system architecture enables seamless handling of increased user activity and supports future expansion across wider geographic regions.

In addition to social benefits, the system contributes to environmental sustainability by reducing food waste-related emissions and resource loss. Overall, the proposed solution demonstrates significant potential as a sustainable, scalable, and technology-driven framework for mitigating food waste and hunger.

X. LIMITATIONS

While the developed system shows promising results in reducing food wastage and improving accessibility, certain limitations need to be acknowledged. The system relies heavily on continuous internet connectivity for real-time data exchange, notifications, and location tracking. In regions with poor network infrastructure, delays in communication may affect timely food collection and distribution.

The performance of the system is also dependent on the availability and responsiveness of volunteers. During peak demand periods or emergencies, limited volunteer participation may lead to delays in food delivery, potentially affecting food quality and safety. Additionally, the system does not currently incorporate automated mechanisms for verifying food quality beyond basic freshness constraints provided by donors. Scalability, while supported by the cloud-based architecture, may require additional optimization when deployed at a large scale across multiple regions. Increased user traffic and data volume could introduce performance challenges if backend resources are not adequately managed.

Additionally, the system primarily addresses short-term food redistribution and does not directly tackle the underlying causes of food insecurity, such as economic constraints and supply chain inefficiencies. These limitations highlight the need for complementary policy-level and community-driven interventions.

XI. CONCLUSION

This paper presented a technology-driven food waste and hunger management system designed to facilitate efficient redistribution of surplus food to underserved communities. By integrating mobile-based front-end frameworks, a cloud-supported backend, real-time notifications, and GPS-based location tracking, the proposed system effectively addresses the challenges of food wastage and delayed food distribution.

The implementation and evaluation results demonstrate that the system enhances coordination among donors, NGOs, volunteers, and beneficiaries while minimizing response time and food spoilage. Centralized data management and secure communication mechanisms improve transparency, traceability, and operational reliability. The modular architecture ensures scalability and supports future enhancements without major structural changes.

Although certain limitations exist, the proposed solution provides a practical and sustainable framework for mitigating food waste and hunger. With further technological advancements and wider adoption, the system has the potential to contribute significantly to social welfare and environmental sustainability.

XII. FUTURE SCOPE

The proposed food waste and hunger management system can be further enhanced through the integration of advanced technologies and expanded operational features. Future developments may include the incorporation of predictive analytics and machine learning techniques to forecast food demand and surplus generation patterns. Such capabilities would enable proactive planning and more efficient resource allocation. Integration with government welfare programs and public distribution systems can improve large-scale adoption and policy-level impact. The system can also be extended to include real-time food quality assessment using IoT-based sensors for temperature and hygiene monitoring, thereby improving food safety assurance. Enhancing volunteer coordination through route optimization algorithms and incentive-based participation models could further reduce delivery time and improve engagement. Additionally, multilingual support and offline functionality may increase accessibility in rural and low-connectivity regions.

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Future versions of the system may also incorporate blockchain-based traceability to ensure transparency and trust across the food redistribution process. These enhancements would strengthen the scalability, reliability, and societal impact of the system, making it a comprehensive solution for sustainable food management.

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