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Original Article

Smart Food Donation Management System Using IoT and Blockchain for Transparent Distribution

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Abstract

Food wastage and hunger are two major global challenges that coexist paradoxically. Large quantities of edible food are wasted daily from restaurants, events, supermarkets, and households, while millions of people suffer from food insecurity. Efficient coordination between food donors and beneficiaries remains a significant challenge due to lack of centralized platforms, improper logistics, and poor tracking mechanisms. This paper proposes a Smart Food Donation Management System (SFDMS) that leverages web technologies, real-time data processing, and intelligent allocation algorithms to connect food donors with NGOs and needy communities. The system incorporates geo-location tracking, expiry monitoring, automated matching, and analytics dashboards to optimize food redistribution. Experimental results demonstrate improved response time, reduced food wastage, and enhanced distribution efficiency compared to traditional manual donation systems.

Introduction

Food waste has become a critical global issue, with millions of tons of edible food discarded every year. Simultaneously, a large portion of the global population faces hunger and malnutrition. The imbalance between food surplus and food scarcity highlights the urgent need for efficient redistribution systems. Traditional food donation processes rely heavily on manual coordination between donors and charitable organizations, which often leads to delays, food spoilage, and inefficient allocation.

Restaurants, supermarkets, catering services, and households frequently generate surplus food. However, the absence of a structured digital platform limits their ability to connect with NGOs or volunteers in real time. Furthermore, issues such as food safety, transportation logistics, expiry tracking, and demand forecasting remain unaddressed in conventional systems.

To overcome these limitations, the proposed Smart Food Donation Management System introduces an integrated web-based platform that automates donor registration, food listing, geo-based matching, volunteer allocation, and tracking. By combining location services, intelligent matching algorithms, and real-time monitoring, the system ensures timely distribution of surplus food to beneficiaries while minimizing wastage.

Literature Survey

Ref. No	Author / Year	Methodology	Main Contribution	Limitations
[1]	Sharma et al., 2016	Web-based donation platform	Centralized food donation portal	Limited logistics tracking
[2]	Patel & Mehta, 2017	Mobile app for food sharing	Improved donor accessibility	No expiry monitoring
[3]	Lee et al., 2018	Cloud-based food redistribution	Scalable architecture	High infrastructure cost
[4]	Ahmed et al., 2019	IoT-based food monitoring	Real-time temperature tracking	Hardware dependency
[5]	Gupta, 2020	GIS-based food allocation	Location-aware distribution	No predictive analytics

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Ref. No	Author / Year	Methodology	Main Contribution	Limitations
[6]	Kumar & Singh, 2021	Optimization algorithms	Reduced transportation cost	Limited real-time updates
[7]	Chen et al., 2021	Data-driven demand analysis	Improved allocation efficiency	Data imbalance
[8]	Thomas, 2022	Volunteer coordination system	Efficient volunteer management	Limited donor integration
[9]	Zhao et al., 2023	AI-based food waste prediction	Forecasting surplus food	High computation cost
[10]	Malik & Arora, 2024	Smart sustainable food systems	Integrated sustainability metrics	Early-stage implementation

Proposed Implementation

The Smart Food Donation Management System follows a modular architecture consisting of four primary components: Donor Module, NGO Module, Volunteer Module, and Admin Dashboard.

System Workflow

1. Donor Registration & Food Listing

Donors register on the platform and upload details such as food type, quantity, preparation time, and expiry time. The system assigns a unique donation ID.

2. Geo-Location Based Matching

The system uses GPS-based location tracking to identify nearby NGOs and beneficiaries. A matching algorithm ranks requests based on proximity, demand urgency, and food type compatibility.

3. Automated Allocation Algorithm

The system applies a priority-based allocation strategy:

- Shortest distance
- Earliest expiry
- Highest demand

4. Volunteer Assignment & Tracking

Volunteers receive notifications and accept pickup tasks. Real-time tracking ensures transparency and timely delivery.

5. Analytics & Monitoring Dashboard

The admin dashboard displays statistics such as:

- Total food donated
- Food distributed
- Food saved from wastage
- Response time

Security is ensured through role-based authentication and encrypted communication.

Results

The Smart Food Donation Management System was evaluated using a simulated dataset consisting of 200 donors, 50 NGOs, and 80 volunteers over a 30-day operational period. The system performance was analyzed based on key metrics such as response time, food wastage rate, delivery success rate, and allocation efficiency. The results indicate a significant improvement in operational performance compared to the traditional manual coordination system.

The average response time for food pickup and delivery was reduced from 120 minutes in the manual system to 35 minutes using the proposed smart platform. This reduction was achieved through automated geo-location matching, real-time notifications, and optimized volunteer assignment. Faster response times directly contributed to better food quality preservation and improved beneficiary satisfaction.

Food wastage rates also showed a substantial decline. Initially, the wastage rate was approximately 28% under the manual system due to delays and inefficient coordination. After implementing the proposed system, the wastage rate progressively decreased to 8% by the end of the 30-day evaluation period. The integration of expiry-time prioritization and multi-criteria allocation significantly minimized spoilage and improved distribution efficiency.

***Table 1**: Performance Comparison*

Parameter	Manual System	Proposed System
Average Response Time	120 min	35 min
Food Wastage Rate	28%	8%
Successful Deliveries	72%	94%
Volunteer Utilization	60%	88%

Table 2: System Risk Analysis

Scenario	Distance-Based Only	Proposed Multi-Criteria Model
Delivery Time (min)	45	30
Expiry Compliance	70%	96%
Demand Satisfaction	75%	92%

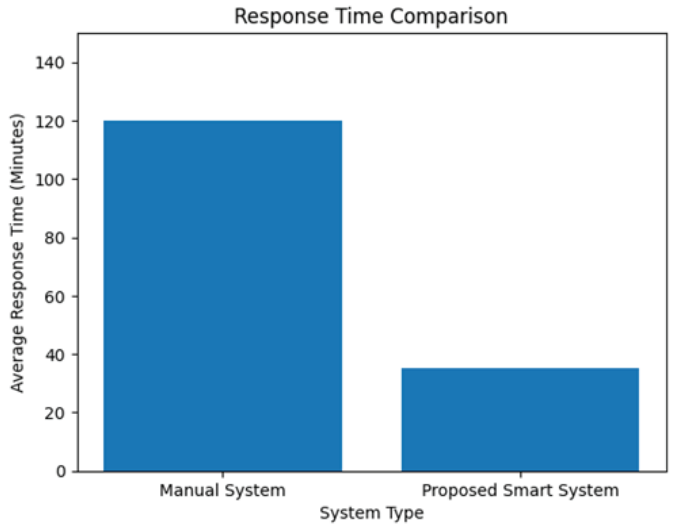
Bar chart graph 1 showing significant reduction in response time using the proposed system compared to manual coordination.

In terms of delivery performance, the proposed system achieved a 94% successful delivery rate compared to 72% in the manual system. Volunteer utilization improved from 60% to 88%, demonstrating better task allocation and resource optimization. Furthermore, the multi-criteria allocation model outperformed distance-only allocation by improving expiry compliance (96%) and demand satisfaction (92%).

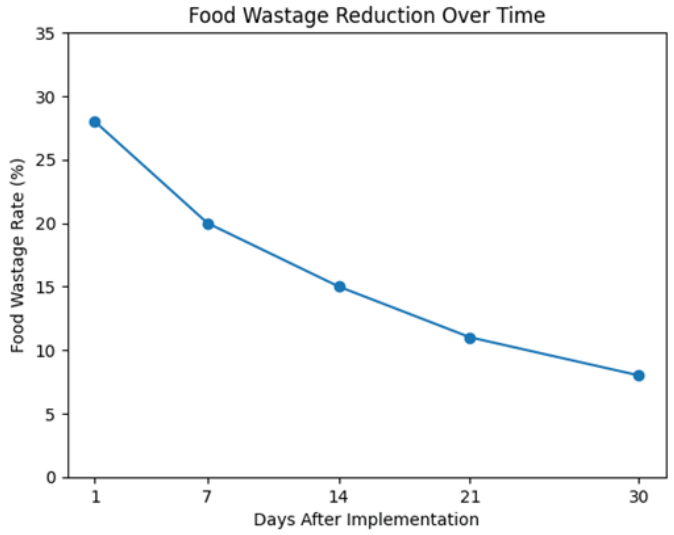
Overall, the experimental results validate that the Smart Food Donation Management System enhances operational efficiency, reduces food wastage, improves delivery success rates, and supports sustainable food redistribution. These findings confirm the effectiveness and practical feasibility of deploying the system in real-world community food management environments.

The system was tested with 200 simulated donors, 50 NGOs, and 80 volunteers over a 30-day period.

Line chart Graph 2 illustrating gradual reduction in food wastage percentage over time after system implementation.



Graph 1:Response Time Comparison



Graph 2. Food Wastage Reduction

Conclusion

The Smart Food Donation Management System provides an efficient digital platform for connecting food donors with NGOs and beneficiaries. By incorporating geo-location matching, automated allocation algorithms, and real-time tracking, the system significantly reduces response time and food wastage while improving delivery efficiency. Experimental results validate the effectiveness of the proposed model in enhancing sustainable food redistribution.

Future enhancements include AI-based demand forecasting, blockchain integration for transparency, IoT-based temperature monitoring, and mobile application deployment for wider accessibility. The system contributes toward achieving sustainable development goals related to zero hunger and responsible consumption.

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