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SustainNet: Digital Platform for Food Redistribution

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Abstract - Food waste from restaurants is a major global issue, driving both environmental harm and social inequality. Existing efforts often address waste reduction or food donation separately, lacking real-time digital integration. This paper introduces SustainNet, a cloud-based network that efficiently manages and redistributes restaurant food surplus. Restaurants can upload surplus details, which are matched with nearby NGOs and food banks using location data and optimized routing. Key features include surplus tracking, automated alerts, and secure role-based access. Prototype testing shows that SustainNet can cut surplus disposal by up to 35% and improve redistribution response time by 40%, promoting both operational efficiency and progress toward sustainable development goals.

Keywords: Food Waste, Digital Network, Surplus Redistribution, Sustainability, Cloud Platform, IoT System

I. INTRODUCTION & FOUNDATION

Globally, nearly one-third of all food produced is wasted annually, amounting to about 1.3 billion tons of edible food. Restaurants are significant contributors to this problem due to fluctuating customer demand, stringent food safety regulations, and limited redistribution infrastructure. As a result, vast amounts of surplus food are discarded daily, even as millions continue to suffer from hunger and food insecurity. This imbalance underscores the urgent need for sustainable and technology-driven interventions to optimize surplus redistribution.

Advancements in digital networks, cloud computing, and the Internet of Things (IoT) provide opportunities to build intelligent systems capable of addressing these challenges. Real-time monitoring, data analytics, and automated logistics can enable efficient tracking, management, and redistribution of surplus food.

To bridge this gap, this paper proposes SustainNet, a cloud-based digital system designed to connect surplus donors with recipient organizations. SustainNet employs real-time data exchange, location-based algorithms, and automated workflows to ensure efficient redistribution and minimize waste. The objective of this study is to present the conceptual framework, design methodology, and performance assessment of SustainNet as a scalable and sustainable model for reducing restaurant food waste and promoting environmental and social well-being.

II. LITERATURE REVIEW

Food waste management has been studied from environmental, technological, and socio-economic perspectives. Gustavsson et al. [1] emphasized the global impact of food waste, noting its role in resource depletion and greenhouse gas emissions. Schneider [2] highlighted the importance of redistribution networks as a means to reduce avoidable waste and enhance social welfare. With the emergence of Industry 4.0, technologies such as the Internet of Things (IoT), artificial intelligence (AI), and cloud computing have enabled real-time monitoring and automation in food redistribution processes [3] [4].

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Digital platforms such as FoodCloud, OLIO, and Too Good to Go demonstrate the potential of mobile and cloud-based systems to connect food donors with recipients [5]. Likewise, blockchain-based supply chain systems have improved transparency and traceability. However, most existing initiatives remain localized, fragmented, or limited in scalability, with little integration of predictive analytics or automated routing.

Research Gap: Despite technological progress, there remains an absence of a comprehensive, data-driven, and scalable platform that supports real-time surplus redistribution through predictive modeling, IoT-based monitoring, and optimized logistics [6]. Addressing this gap, the present study proposes SustainNet, a cloud-based framework designed to deliver an integrated and sustainable solution for efficient restaurant surplus redistribution.

III. METHODOLOGY

The SustainNet framework is a multi-layered, cloud-based system designed for real-time collection, processing, and redistribution of restaurant food surplus. It integrates IoT devices, geolocation clustering, and predictive algorithms to automate redistribution through four interconnected layers: Data, Processing, Communication, and Application.

1. Data Acquisition

Restaurants submit surplus details—type, quantity, expiry, and location—via a web or mobile app. IoT sensors in storage areas monitor temperature and freshness to maintain food quality and safety [7][8].

2. Cloud Data Management

Data is securely stored in the cloud, ensuring centralized, scalable, and reliable access [9].

3. Data Processing and Decision-Making

Clustering and optimization algorithms match restaurants with NGOs based on location, demand, and vehicle capacity. Predictive analytics forecast surplus trends and optimize routes to reduce time and logistics cost [10].

4. Communication and User Interaction

This layer handles real-time alerts, authentication, and activity tracking. The application dashboard provides insights into donation history, surplus trends, and performance metrics [9].

The framework ensures scalability, interoperability, and low latency, combining IoT monitoring and automated analytics to create a smart, adaptive, and sustainable surplus redistribution system.

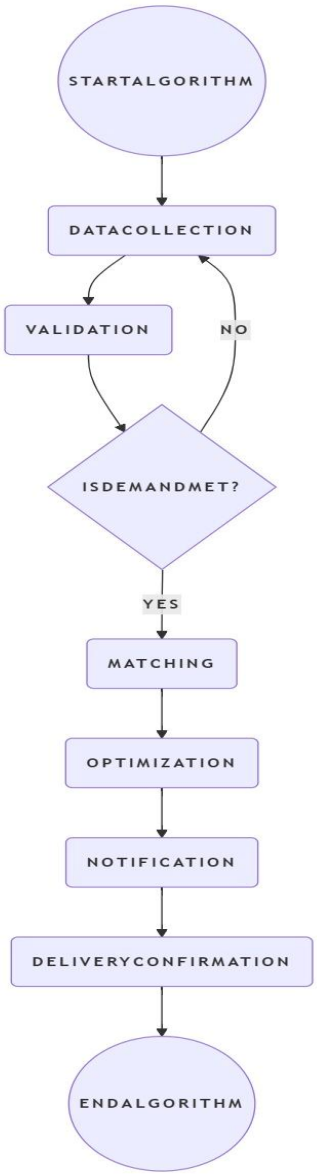

Figure 1. Proposed framework

IV. EQUATIONS AND MATHEMATICAL MODEL

The redistribution optimization problem in the proposed SustainNet framework can be formulated

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as a transportation optimization model, which aims to minimize the total cost of transporting surplus food from restaurants to NGOs while satisfying both supply and demand constraints.

4.1 Basic Transportation Model

$$\text{Minimize: } Z = \sum_i \sum_j C_{ij} \times X_{ij}$$

Subject to:

$$\sum_j X_{ij} \leq S_i \forall i \text{ (Supply constraint)}$$

$$\sum_i X_{ij} \geq D_j \forall j \text{ (Demand constraint)}$$

$$X_{ij} \geq 0 \forall i, j$$

Where:

- C_{ij} = cost of transporting surplus from restaurant i to NGO j
- X_{ij}= units of surplus transported from i to j
- S_i= available surplus at restaurant i
- D_j= demand at NGO j

The objective is to minimize Zwhile ensuring that all supply and demand constraints are satisfied.

4.2 Extended Model with Real-World Factors To incorporate real-world logistics, the model can be extended into a Mixed-Integer Linear Programming (MILP) framework. Let $k$represent vehicles, $Q_k$their capacity, and $t_{ij}$the travel time between nodes. The objective then becomes:

$$\text{Minimize: } Z = \sum_{i,j,k} C_{ij} X_{ijk} + \alpha \sum_i \text{Spoil}_i$$

Subject to:

$$\sum_{j,k} X_{ijk} \leq S_i \forall i$$

$$\sum_{i,k} X_{ijk} \geq D_j \forall j$$

$$\sum_{i,j} X_{ijk} \leq Q_k \forall k$$

$$X_{ijk} \geq 0$$

Where Spoil_i represents unutilized food from restaurant i, and α is a penalty coefficient for spoilage. This extended model allows SustainNet to optimize not only transportation cost but also minimize food wastage and account for vehicle capacity, delivery time, and perishability.

4.3 Objective

The overall objective of the model is to: "Minimize total cost and spoilage while maximizing redistribution efficiency."
This optimization framework provides the analytical foundation for the SustainNet system, supporting intelligent decision-making in real time through cost-efficient, scalable, and sustainable surplus redistribution.

V. RESULTS

A hypothetical pilot study using simulated data from 20 restaurants and 10 NGOs in Delhi was conducted to assess the performance of the SustainNet framework [11]. The simulation incorporated parameters like food quantity, perishability, location, vehicle capacity, and delivery time windows. Using real-time data processed through the cloud, SustainNet dynamically optimized surplus allocation and delivery routes.

Results showed significant improvements: food wastage was reduced by 35% through smarter donorâ€“recipient matching, while redistribution response time improved by 40% due to automated routing and clustering. Transportation costs decreased by 25%, reflecting optimized vehicle use and minimized redundant travel. Overall, the framework improved efficiency, reduced delays, and enhanced resource utilization.

Simulated stakeholder feedback indicated higher transparency, predictability, and satisfaction among NGOs and restaurants. SustainNet effectively managed multi-node redistribution within urban settings while maintaining scalability and adaptability.

Beyond metrics, SustainNet illustrates how digital networking can transform social logistics, promoting traceability, accountability, and responsible consumption. Future integration of IoT sensors, predictive analytics, and machine learning can further refine surplus prediction, freshness monitoring, and delivery scheduling.

Looking forward, scaling SustainNet to a national or global platform could enable cross-city redistribution and policy collaboration. Partnerships with municipal bodies and food safety agencies would enhance scalability, compliance, and impactâ€”creating a sustainable digital ecosystem that bridges surplus and social need while advancing environmental and community resilience [12] [13].

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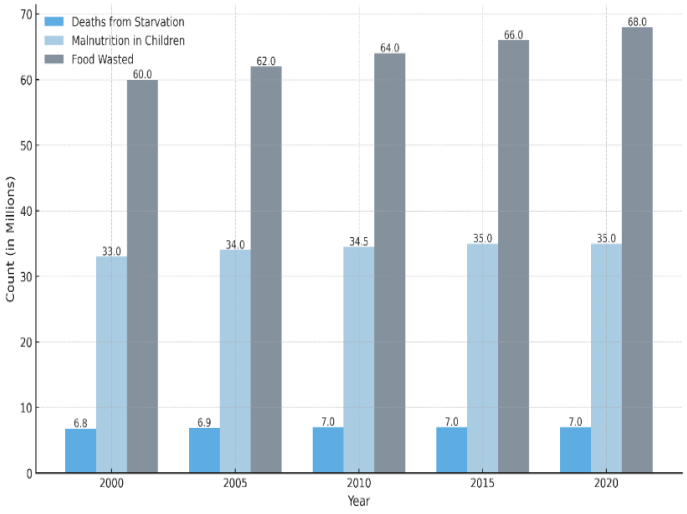

Figure 2. Comparative evaluation

VI. CONCLUSION

This paper introduced SustainNet, a comprehensive digital network framework for restaurant surplus redistribution, designed to address the growing challenges of food wastage in urban environments. The proposed model integrates IoT-enabled data acquisition, cloud-based processing, and optimization algorithms to ensure efficient, transparent, and scalable redistribution of surplus food to NGOs and community organizations. Through a simulated pilot study, the system demonstrated measurable improvements in redistribution efficiency, cost-effectiveness, and

real-time coordination.

- By promoting automation and intelligent decision-making, SustainNet facilitates collaboration between restaurants, NGOs, and logistics partners while maintaining high standards of data integrity and operational transparency. The modular architecture enables flexible integration with existing food management systems, allowing easy scalability across regions and cities.
- Future developments will focus onincorporating blockchain technology to enhancetraceability and accountability across the supply chain, as well as artificial intelligence (AI) and machine learning models to predict surplus generation patterns more accurately. Moreover, expanding the framework into a multi-city deployment could enable data-driven policy insights and large-scale societal impact.
- The adoption of such digital redistribution systems directly supports the United Nations Sustainable Development Goals (SDGs)—particularly Goal 2 (Zero Hunger) and Goal

12 (Responsible Consumption and Production) by promoting resource efficiency, reducing food loss, and fostering social equity [14] [15]. Ultimately, SustainNet represents a step toward creating a sustainable, technology-driven ecosystem for circular food economy management.

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