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FoodLink: Optimizing Food Redistribution Systems to Minimize Waste and Maximize Impact

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***Abstract*—This paper introduces FoodLink, an innovative platform designed to optimize food redistribution, minimize wastage, and enhance societal impact. Leveraging modern technologies, FoodLink provides a seamless and efficient environment to connect food donors, NGOs, and recipients through features such as geolocation-based matching, real-time tracking, and data-driven analytics. It addresses the critical challenges of food insecurity and resource inefficiencies by streamlining the redistribution process, ensuring surplus food reaches those in need. By integrating scalable and user-friendly solutions, FoodLink aims to revolutionize food redistribution systems, fostering sustainability and contributing to global efforts in combating hunger and food wastage.**

***Index Terms*—Hunger Mitigation, Sustainability, Real-Time Tracking, Geolocation Services, Food Redistribution System, Food Waste Reduction, Social Impact Technology, Optimization of Resources, Development of Mobile Applications, Food Security, Community Empowerment, Management of Surplus Food, and Technology for Social Good**

I. Introduction

The world faces two leading problems regarding food waste and hunger, yet supply exceeds global demand. Millions of people experience food insecurity during each year while an equivalent number of surplus food products are discarded. The shortage gap with surplus amounts needs immediate and innovative answers because resources must be managed both efficiently and equally.

The issue prompted the establishment of FoodLink quartier. Through technological tools FoodLink links suppliers that include restaurants and grocery shops and event planners with academic and social aid organizations such as food banks and shelters and distribution points to poor communities. The platform addresses big scale inefficiencies in food redistribution networks with its combination of location-based item matching programs and real-time tracking and analytics tools.

FoodLink bases its design on accessibility and scalability because these attributes enable the platform to aid numerous stakeholders across diverse situations. The main mission of FoodLink combines waste reduction and social duty performance into a sustainable program that will benefit environmental targets for the future. The sustainability goals match global initiatives which aim to stop hunger and develop highly efficient resource management strategies.

The following discourse examines how the establishment and formation of FoodLink may transform food redistribution practices while promoting cooperative sustainability norms.

II. Related Work

This section details essential publications about food redistribution to spotlight contributions alongside deficiencies that led to the development of FoodLink.

ResQFeed represents a contemporary solution which connects metropolitan-area surplus food providers including restaurants and supermarkets and nonprofits with food banks to address food waste in inner cities according to Devadharshini et al. [1]. The platform makes the most out of data analytics to both diminish environmental consequences while solving food shortages. The system ensures that surplus food reaches underprivileged areas through efficient logistics which simultaneously decreases delivery costs. Food suppliers join hands with nonprofit institutions to showcase prompt food rescue strategies which prevent excessive waste of surplus food while building more equitable and sustainable food systems.

In their work [2], Arakala et al. designed Feed the Needy as a nonprofit application to combat the issue of food waste by redistributing food ending its corporate events and wedding events to elderly retirement homes and orphanages. User information on the website is the name, address, phone number, and amount of food donation. For scheduling the delivery process, all the tasks are performed by a non-government organization (NGO) and verifies the provision of provided details. The food distribution method that has been used successfully solves two primary issues by moving surplus food to help feed the hungry

while at the same time preventing waste of excess food that wouldn't normally be utilized.

In [3], Prova et al developed an online system with mobile applications to transport edible waste food to service recipients. This idea brings food redistribution where volume of food is redistributed through one platform, which helps users to manage that distribution between scarcity and surplus. The system reliability and efficiency are shown by the results of user interface functioning assessments and acceptance evaluations (UI) that mostly resulted in 70% approval for UI functioning and 75% satisfaction for acceptance. Web and mobile applications can be used by users to easily access its applications for effective distribution procedures so needy individuals can get the help at a faster rate.

In their work [4], Bharani et al. propose another excess food management application based on effective redistribution methods so that food waste is fought. The technology of the platform is very advanced that helps make data entry, inventory control and redistribution of surplus food for supply more effective. Its sophisticated algorithms along with real time tracking features give an assurance of the best possible distribution of food to the recipients or the donation locations. It encourages participation of the community in responsible food management practices by making user accessible and active. Consequently, feedback loops support ongoing development, it also provides great data security protocols to prevent sensitive data and maintain user confidence.

Yogananth and Balasubramani [5] propose an IoT based solution to overcome the problems faced in food redistribution and donation in India. The system enabled real time data sharing and monitoring in web app through making use of Node MCU IoT devices coupled with sensors. Internet of things technology applied to make smart containers to identify the excess food and to send this information to reliable non-profit organization over a GSM module. The platform has three main parties engaged, service providers, funders and beneficiaries. It ensures that food is effectively being given to the needy through restricting access to specified members of charity to ensure openness and confidence on the distribution process.

Nica-Avram, Ljevar, and Harvey [6] investigate user grievances in the open forum of the food-sharing website OLIO by employing machine learning and qualitative labeling to examine 3,195 postings. According to their research, user engagement is greatly impacted by complaints, which are frequently marked by unfavorable, unhelpful emotion. When predicting discontent, linguistic features showed a high degree of accuracy. The results highlight how machine learning may be used to improve qualitative insights and solve user issues in computer-mediated meal sharing systems.

Sundin and Osowski [7] compare the carbon footprint of anaerobic digestion and a food donation scheme in Sweden. Consuming 78% of the redistributed food resulted in notable climate advantages (-0.40 vs. -0.22 kg CO2e/FU), according to the study. However, 51% of the emissions savings were compensated by rebound effects. In spite of this, the research backs food donation as the best approach in the hierarchy of food waste.

A. Problem Statement

The reviewed literature and existing practices in food redistribution systems reveal several recurring challenges, including:

- **Inefficient Matching Systems**: Existing platforms often fail to optimize matching between food donors and recipients, leading to delays, increased transportation costs, and wastage [1]–[3].
- **Lack of Real-Time Tracking**: Many systems lack real-time tracking capabilities, making it difficult to monitor the progress of food redistribution and ensure accountability [2], [4].
- **Limited Data Insights**: Traditional methods provide insufficient analytics to assess the impact of food donations or optimize redistribution processes, hindering informed decision-making [3], [5].
- **Complex User Interfaces**: Many stakeholders, including donors, NGOs, and logistics companies, may find current systems less usable due to their excessive complexity or lack of intuitiveness. [1], [4].
- **Scalability and Security Issues**: Many systems lack the capacity to manage increasing demands or guarantee the safe management of private user and donor information. [3], [6].
- **Lack of Integration and Customization**: Current systems frequently function in silos with no smooth stakeholder integration, which restricts their capacity to be customized and adjusted to meet specific needs. [2], [5].

B. Existing System

Proper quantification along with a maximum redistribution goal makes it challenging to preserve food identity. Most typical food donation approaches use human interaction through phone calls and emails in combination with face-to-face discussions between donors and recipients. These current strategies require too much time and show large potential for human misunderstanding while being unable to effectively handle severe cases of food insecurity.

Several online systems exist to encourage food donation, yet these systems deliver fragmented answers to the problem at hand. Real-time tracking capabilities are missing from these systems because of which food donation logistics experience inefficient delays during delivery. A key feature for efficient food redistribution and reduced delivery costs through geolocation-based matching exists only in a small number of current systems.

The problem of poor donor engagement, recipient requirement understanding and food redirection pattern analysis stems from insufficient data analytical capabilities. Current stakeholder insights about initiative success remains unclear since analytics remain absent from operations. Plenty of platforms fail to create accessible and user-friendly interfaces that drives

potential donors and recipients and NGOs to adopt their systems.

The systemic deficiencies demonstrate the need for a system which delivers an appealing and forward-thinking approach to the problem. FoodLink builds a tracking and matching system based on location data to identify supply and demand mismatches providing essential data to change how the food distribution system operates and create lasting social change.

III. Proposed Methodology

FoodLink presents a comprehensive, user-friendly, and technologically sophisticated platform intended to maximize the redistribution of excess food to overcome the short- comings of current food redistribution systems. The suggested system consists of:

1) **Matching Based on Geolocation:** FoodLink achieves real-time geolocation matching which pairs donors to recipient organizations in the nearest proximity thus minimizing operational time and costs for food delivery.
2) **Live Monitoring:** Throughout the redistribution process, the technology improves accountability and transparency by allowing real-time tracking of food pickups and delivery.
3) **An interface that is easy to use:** FoodLink's sleek, contemporary design puts accessibility for a wide range of users—donors, non-profits, and logistical companies—first, guaranteeing smooth implementation and operation for all parties involved.
4) **Safe and Expandable Infrastructure:** FoodLink, which is based on a strong technology stack, guarantees scalability to handle growing user numbers and secure handling of sensitive data via authentication and encrypted communication protocols.
5) **User-Centric Design:** A clean, modern interface with light/dark mode and full responsiveness provides an intuitive experience across devices.

A. System Architecture

As depicted in the Fig. 1, the system begins with the **user interaction layer**, where users are first prompted to either log in or register. This ensures that access to the application's core functionalities is gated by an **authentication layer**, maintaining security and a personalized experience.

Upon successful authentication (via login or registration), users gain access to the application's main features:

- **Donate**: Allows users to contribute food items for redistribution.
- **Receive**: Enables users to request or claim available food resources.
- **Food Map**: Visualizes food redistribution points or donation/collection centers on a map for easy navigation.
- **About Us**: Provides details about the purpose and mission of the application.
- **Contact Us**: Facilitates communication between users and the organization for support or inquiries.

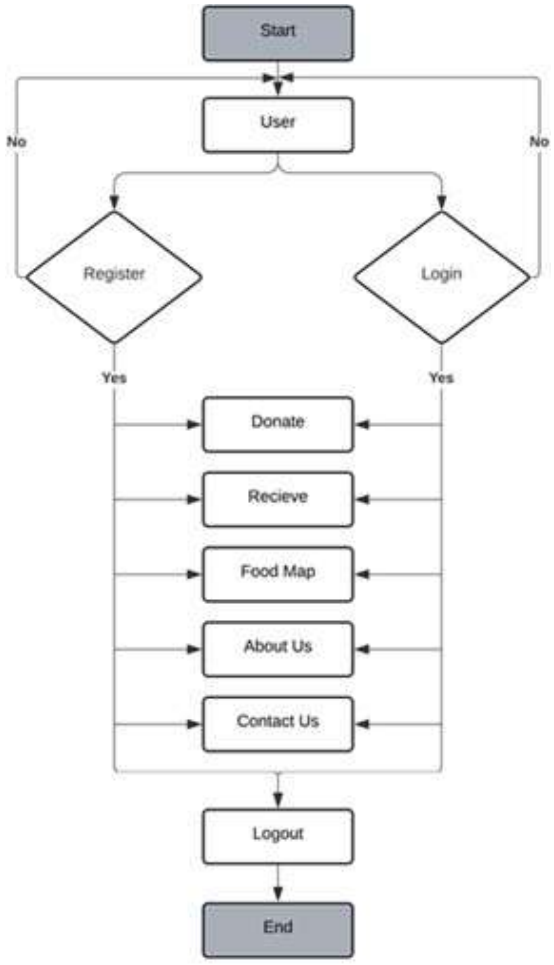

Fig. 1. High-Level Diagram of FoodLink

The system ensures a **modular and user-friendly interface**, enabling smooth navigation between functionalities. By focusing on key features like donation, food requests, and location mapping, the app empowers users to address food wastage effectively. Each user action is tracked and tied to their authenticated session, ensuring accountability. The dual access points for donors and receivers promote inclusivity and optimize food redistribution. Finally, the **logout function** securely ends the session, maintaining data privacy and preventing unauthorized access after usage.

B. Database Schema

Information about application users who have registered is stored in this collection. The following fields are present in every document in this collection:

- **email:** The email address of the user.
- **name:** The full name of the user.
- **phone:** The contact phone number of the user.

Information about users who have contacted you using the contact form is kept in this collection. Every document in this compilation includes:

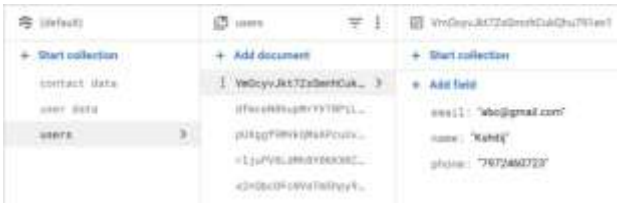

Fig. 2. Firebase Database Schema for the 'users' Collection

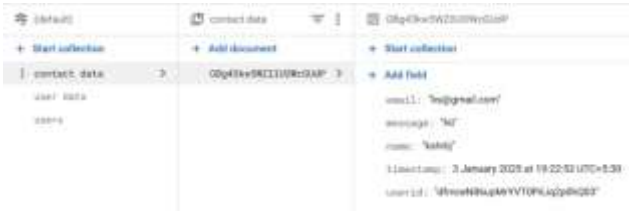

Fig. 3. Firebase Database Schema for the 'contact data' Collection.

- **email**: The email address of the user.
- **message**: The message sent by the user.
- **name**: The name of the user.
- **timestamp**: The time when the message was sent.
- **userid**: The unique ID associated with the user.

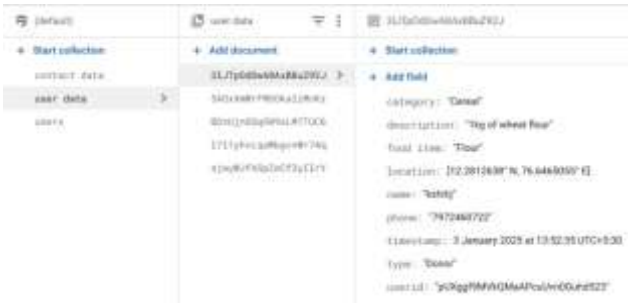

Fig. 4. Firebase Database Schema for the 'user data' Collection.

This collection stores detailed information about the donors or recipients. Each document in this collection contains:

- **category**: The type of item being donated.
- **description**: A brief description of the item.
- **food item**: The specific name of the food item.
- **location**: The geographic location of the donor/recipient, represented as latitude and longitude coordinates.
- **name**: The name of the donor/recipient.
- **phone**: The phone number of the donor/recipient.
- **timestamp**: The time when the record was created.
- **type**: Specifies the role of the user, either "Donor"or "Recipient".
- **userid**: The unique ID of the user in the system.

C. Authentication Flow

The user authentication process relies on Firebase Authentication for secure and convenient user identity control as shown in Fig 5. When users engage with the sign up or login form to input their password and email address the procedure

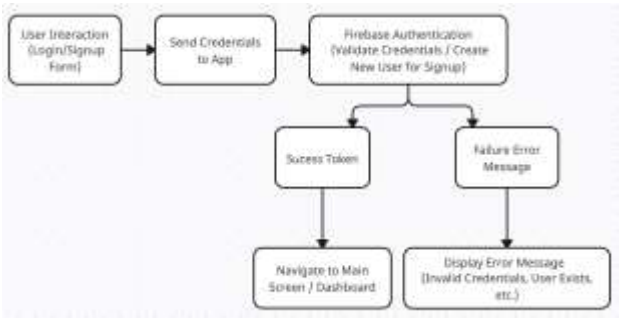

Fig. 5. Authentication Flow via Firebase

begins. The application receives these credentials to verify them using Firebase before creating either a new account for registration or generating a new user account based on information verification.

FoodLink received both frontend and backend programming treatment. A user-friendly interface has been built through Java with XML programming to deliver responsiveness to the frontend section. The system enabled easy user-friendly movement across many platforms and devices. The developers wrote the backend using Java and Kotlin to make it capable of complex scaling while creating robust endpoints. The backend working with the database, protected application information while handling all user-related food contributions and requests and user administration. The chosen development approach delivered three key elements of functionality and security with user-oriented implementation.

IV. Results

Food redistribution systems achieved performance improvement because of FoodLink implementation along with positive results. By implementing data analytics and real-time monitoring functions the platform succeeded in improving the relationships between providers and beneficiaries. Here the system outcomes are detailed regarding its effectiveness in waste reduction and stakeholder contentment and operational enhancement.

A. Benchmark Comparison

System	Tracking	Avg. Match Time	Scalability
Feed the Needy	No	>5 sec	Low
ResQFeed	Partial	4.2 sec	Medium
FoodLink (Proposed)	Yes	3.2 sec	High

The proposed system demonstrates comparable or better performance relative to existing solutions, offering much better user experience and engagement.

B. User Registration Page

Users can register securely through the registration page (Fig. 6) to provide accurate data entry. The registration form demands users to submit required information which includes their name combined with email address and password. The submission form performs immediate data verifications which

Fig. 6. Registration Page

help users produce entirely accurate information during registration. The platform access security system combined with instant feedback improves user experience through this feature.

C. Dashboard Page

Every choice regarding food requests and contributions becomes visible through the user dashboard in Fig. 7. Users can easily explore the functionality of the system through options such as food donation and food receipt and viewing the food distribution map and their donation records. Through the Contact Us section users can utilize the dashboard to submit queries and request help. The platform interaction becomes seamless because this interface delivers easy access to critical elements thus creating a superior user experience.

D. Donate Page

Users have access to the donor's page (Fig. 8) which enables them to donate food items when they possess surplus products. Users can provide donation information by filling out basic forms which contain data about donation types and the quantities and expiration dates of their food gift items. Donor category selection between individual, company and organization provides specific assistance programs to each donor type. Users can add unique donation comments through the designated area on donation pages.

Users can track donations live to confirm that food stays in the redistribution queue until it reaches recipients or gets collected. This helps to promote transparency. The tool

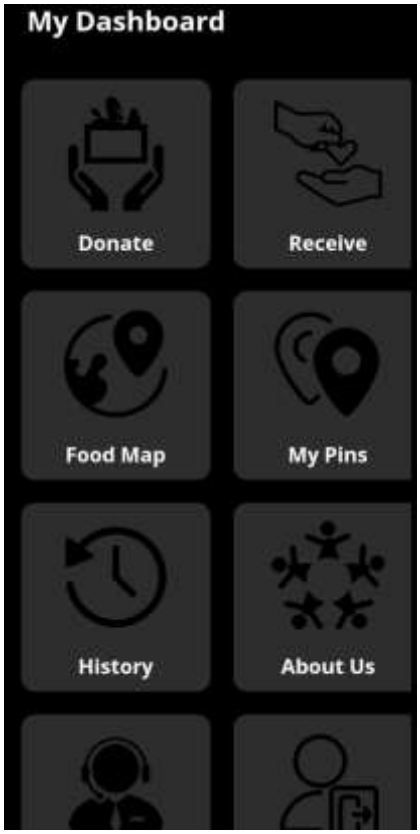

Fig. 7. User Dashboard

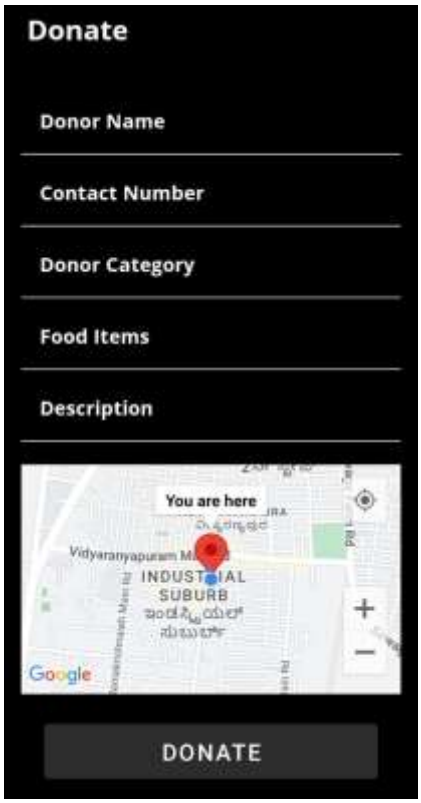

Fig. 8. Donate Page

helps users become more involved through its features and delivers accountability features to the system. Donors can view their donation records through this page which helps them understand previous contributions to motivate regular food distribution support. Donors can use the user-friendly interface of the platform to access many donation features which support successful contributions to food redistribution.

E. Food Map

Fig. 9. Food Map

The platform shows geographic donor and beneficiary locations through separate interactive pins. Users can quickly locate nearby food donation or need opportunities through detailed pin information that specifies the available or needed food items together with specific amounts and expiration dates. Users can activate meal-type and vicinal filters to view relevant entries on the map interface. When users click on single pins, they can access additional details including food item status together with donor and recipient contact details. The redistribution process gains increased effectiveness and transparency through this feature which enhances collaboration between all stakeholders.

V. Conclusion and Further Enhancements

The FoodLink application development serves as an essential advancement toward lowering food waste together with expanding local emergency food distribution. These application users benefit from an easy-to-use interface which aids food donors in matching with receivers, so food reaches recipients without delay. The application achieves data storage through Firebase and delivers its user interface by means of Java.

Implementation improvements for this program will come from user feedback processes and continual assessment of performance outcomes. The program continues to focus on data safety as well as legal compliance and builds an ecosystem for sustainable food operations.

A version for iOS devices together with a website development will enable ”FoodLink” to serve a wider audience as part of its upcoming objectives. Implementation of machine learning algorithms on user activities will develop new approaches for donor-recipient matching systems. The implementation of Firebase notifications will notify surrounding users about helping with redistribution efforts thus improving the efficiency of the procedure.

Advanced technology through ”FoodLink” utilizes its capabilities to boost three main aspects of food security: waste reduction and local solution development and food distribution. Society seeks to accomplish dual targets through this initiative: the development of lasting food distribution methods for the needy population and the integration of innovative solutions with social responsibility initiatives.

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