

Food Waste Management System in Restaurants Using Smart Monitoring and Donation Platform

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ABSTRACT

Food waste is a major global issue that affects the environment, economy, and society. Restaurants and food service industries generate a significant amount of food waste due to overproduction, improper storage, and inaccurate demand pre-diction. This research paper proposes a food waste management system for restaurants that helps monitor food production, track waste patterns, and distribute surplus food to nearby NGO's or food banks. The system provides a digital platform where restaurants can record food data, analyze wastage trends, and receive recommendations for reducing waste. Additionally, the system supports real-time communication with food donation organizations to ensure that surplus food is distributed efficiently. The proposed solution helps reduce environmental impact, minimize operational costs, and promote sustainable food practices.

Keywords—Food waste management, restaurants, sustainability, food donation, food waste monitoring system.

1. INTRODUCTION

Food waste has become a serious global concern in recent years. According to reports from the Food and Agriculture Organization (FAO), nearly one-third of the food produced worldwide is wasted every year. Restaurants, hotels, and catering services contribute significantly to this waste due to inefficient planning and overproduction. [6].

Food waste leads to several problems including environmental pollution, unnecessary consumption of resources, and financial losses. When food waste decomposes in landfills, it releases methane gas which contributes to climate change. Additionally, large amounts of water, energy, and labor are wasted when unused food is discarded. [7].

At the same time, millions of people around the world suffer from hunger and food insecurity. This situation highlights the need for effective systems that can reduce food waste and redistribute surplus food to those in need. [1].

The proposed Food Waste Management System aims to solve this problem by providing a digital platform that allows restaurants to track food preparation, monitor waste levels, analyze data patterns, and donate surplus food to nearby NGOs. [4].

2. PROBLEM STATEMENT

Restaurants often prepare more food than required in order to meet uncertain customer demand [1]. As a result, a large quantity of food remains unused at the end of the day and is discarded [2] [3].

The major problems associated with food waste in restaurants include:

- Lack of proper monitoring systems for food waste
- Poor demand forecasting
- Limited communication between restaurants and NGOs
- Environmental pollution due to discarded food
- Financial loss for restaurants

Therefore, a smart food waste management system is required to track, analyze, and reduce food waste effectively.

3. LITERATURE REVIEW

Food waste management has become an important research area due to its environmental, economic, and social impacts. Many researchers have proposed different approaches to reduce food waste in restaurants and the food service industry. Gustavsson et al. studied global food losses and found that nearly one-third of the food produced worldwide is wasted every year. The study highlights that restaurants and catering services

contribute significantly to food waste due to improper planning, large portion sizes, and inefficient storage methods. The research emphasizes the importance of implementing proper monitoring systems to track food waste in the hospitality sector [1].

Kummu et al. analyzed the environmental impact of food waste and concluded that wasted food results in unnecessary consumption of natural resources such as water, land, and energy. The study also explains that food waste increases greenhouse gas emissions when it decomposes in landfills. Therefore, reducing food waste can significantly contribute to environmental sustainability. [2].

Several technology-based solutions have been developed to address food waste problems. Some restaurant management systems focus on inventory tracking and demand forecasting to minimize excess food preparation. These systems help restaurant managers monitor food stock levels and prevent food spoilage. [3].

Food rescue platforms are another popular solution proposed by researchers. These platforms allow restaurants to donate surplus food to nearby NGOs, shelters, and charitable organizations. Applications such as food donation networks connect restaurants with volunteers who collect and distribute excess food to people in need. Although these platforms help redistribute surplus food, they often lack proper monitoring and analytical capabilities. [4].

Sharma and Patel proposed a smart food waste monitoring system that collects data related to food preparation and left-over food in restaurants. Their system uses digital dashboards to analyze food waste patterns and provide recommendations for reducing waste. The research demonstrates that data-driven analysis can significantly help restaurants improve food planning and reduce unnecessary waste. [5].

Other studies have explored the use of Internet of Things (IoT) technologies for food waste management. IoT-based systems use sensors and smart devices to monitor food storage conditions, temperature, and waste levels in real time. These systems provide accurate data that helps restaurant managers take corrective actions before food gets spoiled. [16].

Artificial Intelligence (AI) has also been explored for food demand prediction. AI algorithms analyze historical sales data and customer patterns to predict the quantity of food required for future days. This approach helps restaurants reduce over-production and improve operational efficiency. [17].

Despite these advancements, many existing systems focus on only one aspect of food waste management, such as inventory control, donation, or monitoring. There is still a need for an integrated system that combines waste tracking, data analysis, and food donation management. [8].

The proposed Food Waste Management System addresses these limitations by providing a unified platform where restaurants can record food production data, analyze waste trends, and notify nearby NGO's for surplus food donation. This integrated approach can help reduce food waste while supporting social welfare and environmental sustainability. [9].

4. PROPOSED SYSTEM

The proposed Food Waste Management System is designed to help restaurants monitor food preparation and reduce wastage. The system consists of a digital platform that records daily food production, consumption, and leftover food.

The main components of the system include:

A. Data Collection

Restaurants enter daily information about prepared food and leftover quantities. This data is stored in a centralized database.

B. Waste Analysis

The system analyzes historical data to identify patterns of food wastage and provides recommendations for reducing waste.

C. Donation Management

If surplus food is available, the system sends notifications to registered NGOs or food banks.

D. Dashboard Interface

Restaurant managers can view waste statistics, reports, and suggestions through an easy-to-use dashboard.

5. SYSTEM ARCHITECTURE

The System Architecture of the proposed Food Waste Management System is designed to efficiently monitor food waste in restaurants and facilitate the redistribution of surplus food. The architecture consists of several interconnected modules that work together to collect data, analyze food waste patterns, and communicate with NGOs for food donation.

The main components of the system architecture are described below.

A. Restaurant dashboard

The Restaurant Interface is the primary module through which restaurant staff interact with the system. This interface allows restaurant employees or managers to enter information about food preparation, the quantity of food served, and the amount of leftover food at the end of the day. [10].

The interface is designed to be simple and user-friendly so that restaurant staff can easily update data without requiring technical knowledge. The data entered by the staff is automatically stored in the system database for further analysis.

B. Central Database

The Central Database is responsible for storing all the information related to food preparation, food consumption, and food waste. It maintains historical records of daily food data which helps in identifying patterns of food wastage over time.

The database stores information such as:

- Type of food prepared
- Quantity of food prepared
- Quantity of food served
- Quantity of leftover food
- Date and time of entry

This stored data is later used by the waste analysis module to generate reports and insights.

C. Waste Analysis

The Waste Analysis processes the collected data and identifies patterns in food wastage. It analyzes historical records to determine which food items are frequently wasted and on which days waste is highest.

Using this analysis, the system provides useful recommendations to restaurant managers such as reducing preparation quantities or improving menu planning. This helps restaurants make better decisions and minimize food waste.

D. Notification System

The Notification System plays an important role in the redistribution of surplus food. When the system detects that a large amount of food is left unused, it automatically sends notifications to registered NGOs or food banks.

These notifications may be sent through mobile applications, SMS, or email. The message contains details such as the type of food available, quantity, restaurant location, and pickup time.

This ensures that surplus food is collected quickly before it becomes unsuitable for consumption.

E. NGO dashboard

The NGO Interface allows charitable organizations or food banks to receive notifications from restaurants. Through this interface, NGOs can view available food donations and confirm whether they can collect the food.

Once an NGO accepts the request, they coordinate with the restaurant for pickup and distribute the food to people in need. This helps reduce hunger and ensures that edible food is not wasted. [12].

F. Admin Dashboard

The Admin Dashboard provides an overview of the entire system. It displays reports, charts, and statistics related to food waste. Restaurant managers can monitor daily waste levels, identify trends, and evaluate the effectiveness of waste reduction strategies.

The dashboard may include features such as:

- Daily and monthly waste reports
- Graphs showing waste trends
- Food donation records
- Performance analysis

These insights help restaurant management improve operational efficiency and reduce unnecessary food production.

G. Working Flow of the System

The overall working process of the system is shown in Figure 1.

The working flow of the Food Waste Management System begins when restaurant staff enter the details of surplus food into the system, including food type, quantity, location, and time of availability. This information is then stored in a central database, where it can be accessed and managed efficiently. The system includes a waste analysis that analyzes the collected data to identify patterns of food surplus and potential waste. When surplus food is detected, the system automatically sends notifications to nearby NGOs or food banks. These organizations can review the available food details and confirm the collection request through the platform. After confirmation, the NGO representatives collect the food from the restaurant location and distribute it to needy people or communities. This process ensures that excess food is properly utilized instead of being wasted,

thereby contributing to sustainable food management and social welfare.



Fig. 1. Working Flow of Food Waste Management System

6. METHODOLOGY

The proposed food waste management system is implemented as a web-based application that helps restaurants track food waste and connect with NGOs for surplus food distribution. The system is developed using modern web technologies including HTML, CSS, JavaScript, and React.

The frontend of the application is designed using HTML and CSS to create a responsive and user-friendly interface for restaurant staff and NGO users. JavaScript and React are used to build dynamic components that allow users to enter food preparation data, monitor waste statistics, and receive notifications in real time. [13].

The Food Waste Management System uses Node.js to develop the backend of the application, which handles server-side operations and communication between users and the database. In this system, Node.js processes requests such as user registration, login, adding food donation details, and sending food collection requests. When a donor uploads information about surplus food, the Node.js server stores the data in the database and makes it available for receivers like NGO's or volunteers. Receivers can view the available food and send requests to collect it, which are processed by the Node.js backend. Node.js also helps in managing multiple user requests efficiently and ensures smooth communication between the frontend and database, making the system fast, reliable, and suitable for real-time food donation management. The main function of the system is the food donation and request process. First, a donor logs into the system and adds information about the surplus food. The donor enters details such as food type, quantity, and location where the food can be collected. Once the information is submitted, it becomes visible to receivers who are registered in the system. [14]. Receivers can then check the list of available food donations. If they find suitable food that can be distributed, they can send a request to collect it. The system updates the request status and informs the donor about the receiver who will collect the food. This process ensures proper communication between donors and receivers.

The system follows the steps below:

- 1) Restaurant staff enter food preparation and leftover food data through the web interface.
- 2) The data is stored in a centralized database for further processing and monitoring.
- 3) The waste analysis processes the stored data to identify patterns of food waste.
- 4) If surplus food is detected, the system automatically triggers a notification module.
- 5) Notifications are sent to nearby NGOs or food banks registered in the system.
- 6) NGOs confirm the collection request and distribute the food to people in need.

The waste tracking process is performed by analyzing the difference between prepared food quantity and consumed food quantity. This simple analytical method helps identify excess food and supports better food planning in restaurants. By using this approach, the system ensures that surplus food is efficiently redistributed instead of being wasted.

7. ADVANTAGES OF THE PROPOSED SYSTEM

The proposed system provides several benefits:

- Reduces food waste in restaurants
- Helps distribute food to needy people
- Reduces environmental pollution
- Improves restaurant management efficiency
- Provides useful waste analysis reports

8. RESULTS AND DISCUSSION

In this section, we present the functionality and outcomes of the developed food waste management system named Pure Plate. The system is designed to reduce food wastage by connecting food donors such as restaurants and households with organizations or individuals who need food. The developed web application provides a simple and user-friendly interface for donating food, registering users, managing donations, and contacting administrators. The appearance of the system's landing page and main pages is illustrated below in the corresponding figures.

When users open the application, they are greeted with the homepage interface, which presents the main objective of the platform. As shown in Figure 2, the homepage displays a banner image along with the project title "Pure Plate." The page highlights the importance of reducing food waste and encourages users to donate excess food. The homepage also provides quick navigation options such as Home, About, Contact, and Profile. A section explaining the working process of the system is included, which describes how donors can donate food and how it will be collected and delivered to people in need.

Upon selecting the donate food option, users are redirected to the authentication page illustrated in Figure 3. This page allows existing users to log in using their registered email and password, while new users can create an account through the registration form. The registration form collects basic details such as username, email address, district, contact number, and password. After successful registration or login, users gain access to the main features of the system.

After authentication, users can access their profile page, as shown in Figure 4. The profile page displays the personal details of the logged-in user, including their name, email address, and other account information. It also shows a list of food donations made by the user, including the food name, type, quantity, date, and delivery status. This feature helps users track their contributions and ensures transparency in the donation process.

The admin dashboard, illustrated in Figure 5, enables administrators to monitor and manage the overall system activities. The dashboard displays the list of registered users and food donations. Administrators can view details such as donor name, food category, quantity, address, and contact number. This interface helps the admin manage donations efficiently and ensures that food is distributed to the right beneficiaries. The system also includes a Contact Us page, shown in Figure 6, where users can submit queries or feedback regarding the system. This page provides a form where users can enter their name, email address, and message. The submitted feedback is stored in the database and can be reviewed by the administrator. This feature improves communication between users and system administrators.

Figure 7 shows the Restaurant Dashboard of the Pure Plate Food Waste Management System. It allows restaurant users to manage their food donations. The dashboard displays the total number of donations and users, along with a table showing details of donated food such as name, category, date, address, and quantity. A View option is provided to check donation details.

Overall, the developed Food Waste Management System successfully demonstrates how digital platforms can be used to minimize food waste and support social welfare. The user interface is simple, responsive, and easy to navigate, enabling users to quickly donate surplus food and connect with organizations that distribute food to people in need. The system ensures efficient food management, reduces wastage, and contributes to community support and sustainability.

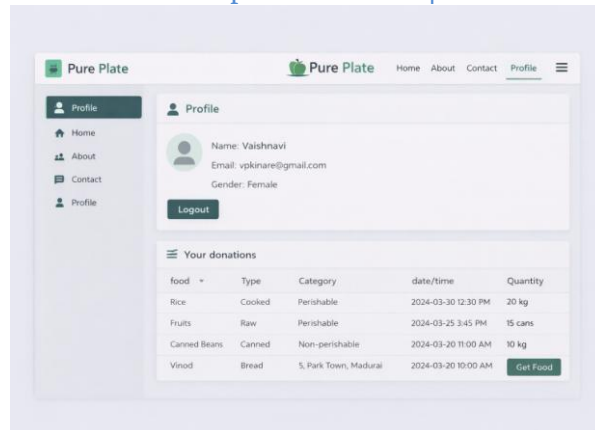


Fig. 2. Homepage interface displaying the main sections of the food donation platform.

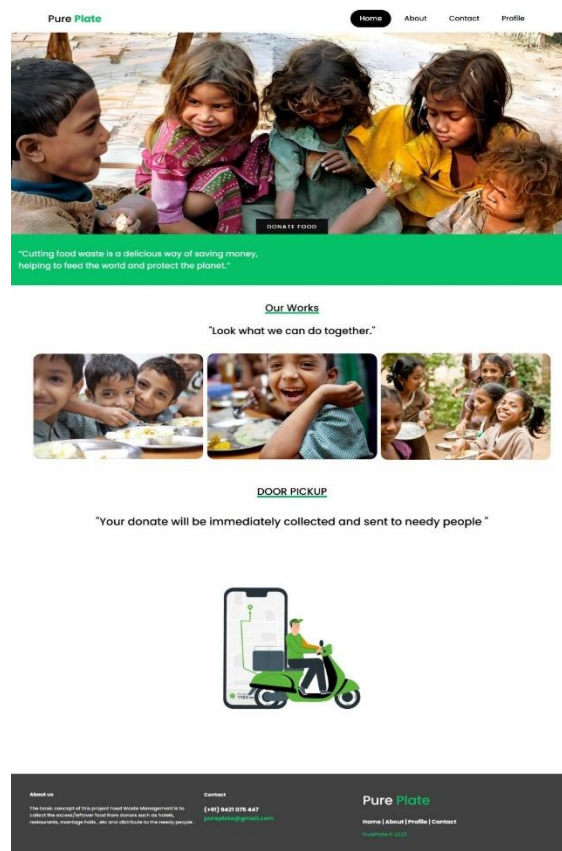


Fig. 3. User authentication interface for login and new user registration.

9. FUTURE WORK

In the future, the proposed system can be enhanced by integrating Artificial Intelligence to analyze historical food preparation data and predict food demand more accurately. This would help restaurants reduce excess food production and minimize waste. The system can also incorporate IoT-based sensors to automatically measure food waste levels in kitchens and storage areas, enabling real-time monitoring. Additionally,

The image displays two side-by-side web forms. The left form is titled 'Login' and has a red header 'Account already exists'. It contains fields for 'Enter your email' and 'Enter your password', a 'Login' button, and a link 'Not a member? Signup Now'. The right form is titled 'Registration' and has a green header 'Account created successfully'. It contains fields for 'Enter your name', 'Enter your email', 'Select District' (a dropdown menu with options: Chennai, Kancheepuram, Coimbatore, Madurai, Salem; Madurai is selected with a green checkmark), and 'Confirm password'. It also has a 'Signup' button and a link 'Already a member? Login Now'.

Fig. 4. User profile interface showing personal details and account information.

The image shows an admin dashboard for 'Pure Plate'. On the left is a dark green sidebar with an 'ADMIN' header and menu items: Dashboard, Analytics, Donates, Feedbacks, Profile, Logout, Dark Mode, and Logout. The main content area has a 'Select Location:' dropdown set to 'coimbatore' and a 'Get Details' button. Below this is a table with columns: Name, food, Category, phono, date/time, address, and Quantity. The table contains three rows of data: Ravi Kumar (Rice, Perishable, 9876543210, 2024-04-04 10:30 AM, 123, Gounder Street, Coimbatore, 20 kg), Meera (Canned Beans, Non-perishable, 9123456789, 2024-04-03 2:00 PM, 56, Lotus Colony, Coimbatore, 15 cans), and Suresh (Fruits, Perishable, 9012345678, 2024-04-02 11:00 AM, 789, Nanjappa Road, Coimbatore, 10 kg). Below the table, it says 'No results found.'.

Fig. 5. Admin dashboard used to manage food donations and system records.

The image shows a contact interface for 'Pure Plate'. At the top, there's a navigation bar with 'Home', 'About', 'Contact' (highlighted), and 'Profile'. Below is a hero section with a photo of a woman talking on a phone and a 'CONTACT US' button. Underneath is a 'contact us' form with fields for 'Name', 'Email', and 'Message', and a 'Send' button. Below the form, contact information is listed: 'Email: pureplate2@gmail.com' and 'Address: SSPM College of engineering'. At the bottom, there's a 'chat bot support' section with a text input field and a 'Say something...' button. Below that is a 'Help & FAQs?' section with three expandable questions: 'How to donate food?', 'How will my donation be used?', and 'What should I do if my food donation is near or past its expiration date?'.

Fig. 6. Contact interface allowing users to send inquiries or feedback.

developing a mobile application would make it easier for restaurant staff and NGO representatives to access the system and manage food donation requests more efficiently. Another possible improvement is the implementation of real-time track-ing of food donation deliveries, which would help ensure that

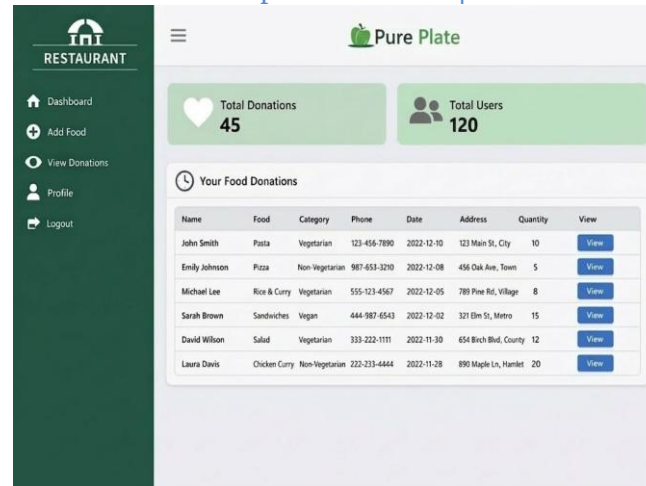


Fig. 7. Restaurant Dashboard User Interface displaying order statistics and recent order details. surplus food reaches the intended beneficiaries quickly and safely.

10. CONCLUSION

Food waste management is an important issue that requires innovative technological solutions. The proposed Food Waste Management System provides an efficient platform for monitoring food waste in restaurants and redistributing surplus food to NGOs.

By using data analysis and digital communication, the system helps reduce environmental impact, minimize operational costs, and promote sustainable food practices. The system also contributes to social welfare by ensuring that excess food reaches people in need instead of being wasted.

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