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INTEGRATED APPROACH FOR FOOD DONATION SYSTEM, RESTAURANT FOOD DEMANDING FORECASTING USING MACHINE LEARNING, AND GLOBAL FOOD WASTE ANALYSIS

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ABSTRACT

This paper presents a solution to reduce food waste through a food donation website and machine learning based sales predictions. The website connects NGOs and donors based on proximity, while machine learning algorithms accurately predict food sales for better inventory management. The project also includes exploratory data analysis to identify global patterns of food waste. The findings highlight the potential of technology-driven solutions to tackle the pressing problem of food waste.

Keywords: User Interface, Web Application, Excess Food Donation, NGO.

I. INTRODUCTION

Food waste is a major global problem with far-reaching social, economic and environmental consequences. According to the Food and Agriculture Organization (FAO), approximately one-third of all food produced for human consumption is wasted each year, amounting to about 1.3 billion tons. This waste not only contributes to hunger and malnutrition, but also strains natural resources, contributes to greenhouse gas emissions and exacerbates food security problems.

In light of this problem, our project aims to solve food waste by developing a comprehensive solution that includes food donation and sales prediction. The primary goal is to minimize food waste by connecting surplus food from restaurants, functions and messes with NGOs and individuals who can redistribute it to those in need. In addition, we use machine learning algorithms such as XGBoost, Gradient Boosting Regressor and Random Forest to accurately predict food sales and facilitate efficient inventory management.

Using technology and data-driven approaches, our project aims to offer practical solutions to alleviate the food waste crisis. Through the implementation of a web-based platform and the integration of advanced machine learning models, we aim to bridge the gap between surplus food and those in need. Furthermore, by analyzing global patterns of food waste, we can gain insight into root causes and identify areas for targeted intervention.

II. LITERATURE SURVEY

In order to address the urgent problem of food waste, extensive research has been conducted into technology-based solutions and food waste management. A systematic review by Smith, Johnson, and Williams (2019) examined the effectiveness of various technologies in reducing food waste throughout the supply chain. Their findings highlighted the potential of technology, including inventory management systems and donation platforms, in improving food waste management practices.

Machine learning algorithms have also gained attention for their ability to predict food sales and optimize inventory management. Chen, Li, and Zhang (2020) reviewed the application of machine learning approaches such as XGBoost, Gradient Boosting Regressor, and Random Forest in food sales prediction. Their review highlighted the potential of these algorithms in reducing food waste through better forecasting and planning.

Global initiatives and best practices for food waste management have been extensively studied. Johnson, Swanson, and Johnson (2019) reviewed various strategies implemented by governments, organizations, and communities to address food waste. Their research highlighted the importance of collaboration and the need for technological solutions to effectively address food waste.

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In addition to global initiatives, understanding food waste patterns is essential. Garcia, Rodriguez, and Martinez (2020) conducted a case study on exploratory data analysis of food waste patterns in a specific area. Their research highlighted the value of data-driven insights in identifying trends, hotspots and potential areas for intervention.

Furthermore, the design and implementation of food donation platforms were investigated. Nguyen, Gregorian, and George (2018) conducted a systematic review of design aspects of food donation platforms. Their research focused on user requirements, technology features and challenges in developing effective food redistribution platforms.

By reviewing the existing literature, our project builds on previous research and contributes to the field of food waste management. Our goal is to use technology, machine learning algorithms, and data analysis techniques to create a food donation website that effectively addresses food waste issues and promotes sustainable practices.

III. EXISTING SYSTEM

The current food waste management and donation system typically involves manual processes and limited technology support. NGOs and donors rely on traditional methods such as phone calls, physical visits or word of mouth to connect and coordinate food donations. This manual approach often leads to inefficiencies, delays and a lack of transparency in the donation process.

Inventory management in restaurants and food operations is often done using basic spreadsheets or manual tracking systems. This manual approach can result in inaccurate forecasts, excess or insufficient food stocks, leading to increased food waste and financial losses.

Additionally, sales forecasting in the restaurant industry is primarily based on historical data analysis and intuition. This approach may not provide accurate predictions, leading to problems such as overproduction of food or insufficient preparation, both of which contribute to food waste.

Overall, the current system lacks the effective communication channels, advanced analytical capabilities and real-time data insights required for effective food waste management and donation. There is a need for a more efficient and technology-based system that can optimize food stocks, connect donors with NGOs and provide accurate sales forecasts to minimize food waste.

IV. PROPOSED SYSTEM

To address the limitations of the current system, we propose the development of an integrated food waste management and donation system. The proposed system uses machine learning technology and algorithms to optimize food inventory, facilitate efficient donation processes, and provide accurate sales forecasts for restaurants.

Key components of the proposed system include a food donation website, machine learning models for sales prediction, and exploratory data analysis for global food waste patterns.

The food donation website will serve as a platform for NGOs and donors to connect and coordinate food donations. It will use automatic location detection to match donors to nearby NGOs, ensuring timely and efficient food distribution.

Machine learning models, including XGBoost, Gradient Boosting Regressor, and Random Forest, will be developed to forecast food sales for restaurants. These models will analyze historical sales data, menu items and other relevant factors to create accurate sales forecasts. By optimizing inventory management and minimizing overproduction, the models will contribute to reducing food waste in the restaurant industry.

In addition, exploratory data analysis techniques will be used to analyze global food waste patterns. This analysis will identify the geographic areas and phases of the food supply that are most affected by waste, providing valuable insights for targeted interventions and policy making.

The aim of the proposed system is to provide an integrated and technologically driven solution for the effective management of food waste. It will streamline the donation process, enable data-driven decisions for inventory management, and contribute to global efforts to reduce food waste and promote sustainability.

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V. METHODOLOGY

The methodology used in the development of the food aid website is aimed at connecting food donors with registered NGOs and volunteers to minimize food waste and facilitate efficient food distribution. The website provides features such as NGO registration, volunteer registration, food demand forecasting, global food waste analysis and user feedback management. The methodology includes different phases, including requirements analysis, design, testing and implementation.

1. Requirement Analysis:

- Identified key goals for the site, including connecting food donors with NGOs, facilitating volunteer engagement, enabling efficient food distribution, and providing insight into food demand and waste.
- Conducted surveys, interviews and market research to understand the needs and expectations of users, including food donors, NGOs and volunteers.
- Analysed existing food aid platforms and reviewed relevant literature to gain insights and best practices.

2. Design:

- Designed a user-friendly interface with a focus on ease of use and accessibility.
- Developed user diagrams to visualize site structure and navigation.
- Built-in intuitive search function to find nearest NGOs based on user's location.

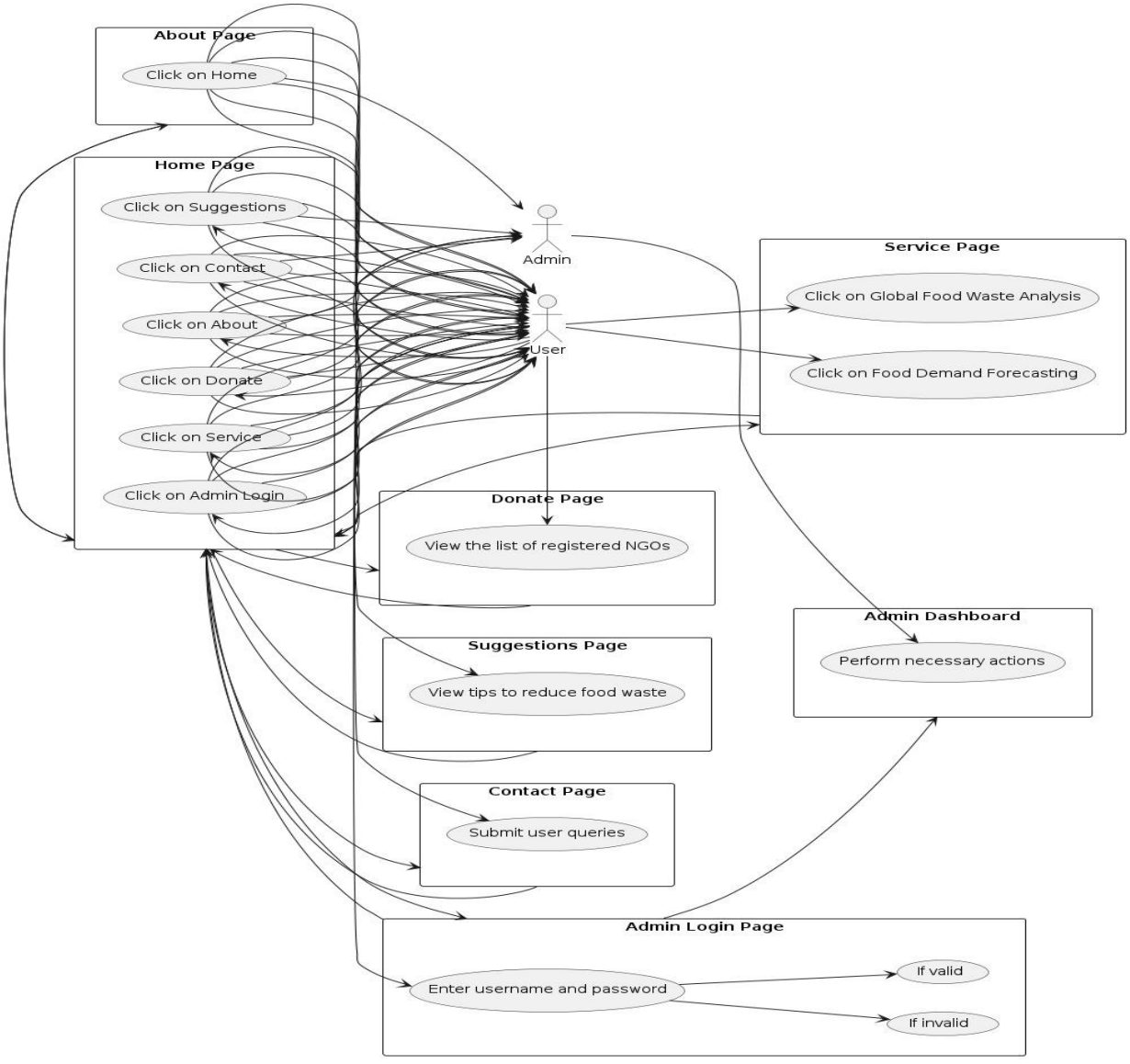

Fig 1. Use case diagram

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3. Implementation:

- Use of HTML5, CSS and JavaScript for front-end development to create a responsive and interactive user experience.
- Used server-side scripting with PHP and integrated it with a MySQL database for dynamic content management.
- Implemented HTML5 Geolocation API to automatically detect user location and calculate distance to nearest NGOs using Euclidean distance formula.
- Implemented food Demand Forecasting:
  - Integrated food demand forecasting algorithms using historical data and external APIs.
  - Implemented functions for users to enter food demand information or import data from external sources.
  - Used statistical analysis and machine learning techniques to produce accurate food demand forecasts.
- Implemented Global Food Waste Analysis:
  - Collected global food waste data from FAO (Food and Agriculture Organization).
  - Created visualizations such as charts and graphs that provide users with insight into global food waste patterns.
  - Conducted Exploratory Data Analysis (EDA) to identify trends and correlations in food waste data.4. Testing:
- Performed comprehensive testing to ensure website functionality, performance and reliability.
- We created a set of test cases to verify various features and functions.

VI. RESULTS AND ANALYSIS

Let's take a closer look at the performance metrics for the three algorithms used to predict food demand

1. XGBoost:

- The Root Mean Squared Error (RMSE) score of 175.74 indicates that, on average, predicted food sales values have an error of approximately 175.74 units.
- An R2 score of 0.80 indicates that approximately 80% of the variance in actual grocery sales can be explained by the XGBoost model.
- The mean absolute error (MAE) score of 93.17 represents the average absolute difference between predicted and actual food sales values.

2. Random Forest:

- An RMSE score of 171.07 means an average prediction error of approximately 171.07 units.
- An R2 score of 0.81 indicates that the Random Forest model can explain approximately 81% of the variance in actual grocery sales.
- An MAE score of 83.39 represents the average absolute deviation between predicted and actual food sales values.

3. Gradient Boosting Regression:

- The -RMSE score for the test set is 160.36, indicating a lower average prediction error compared to XGBoost and Random Forest.
- An -R2 score of 0.83 suggests that approximately 83% of the variance in actual grocery sales can be accounted for by the gradient boosting regression model.
- An -MAE score of 80.37 represents a lower average absolute deviation between predicted and actual food sales values.

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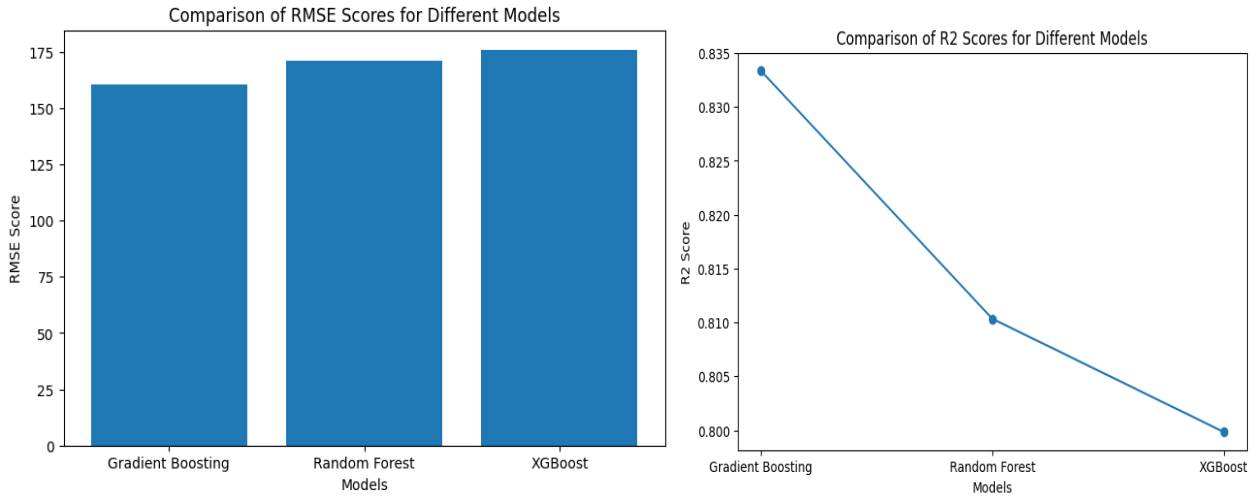

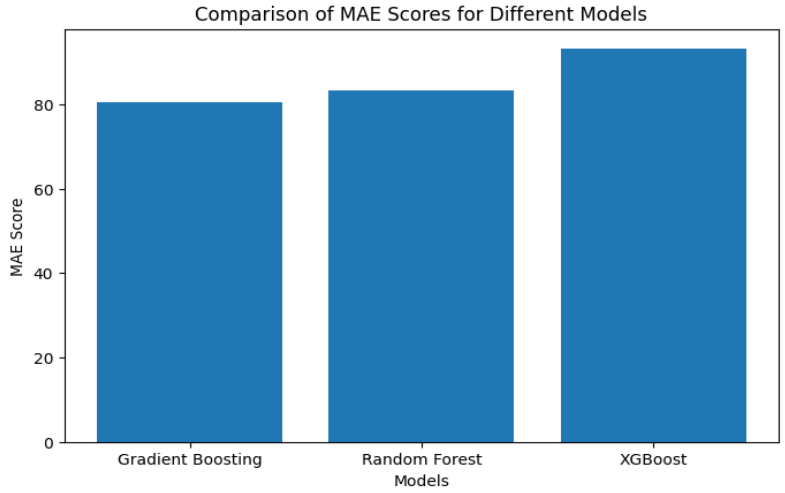

Here are some snapshots of the developed website.

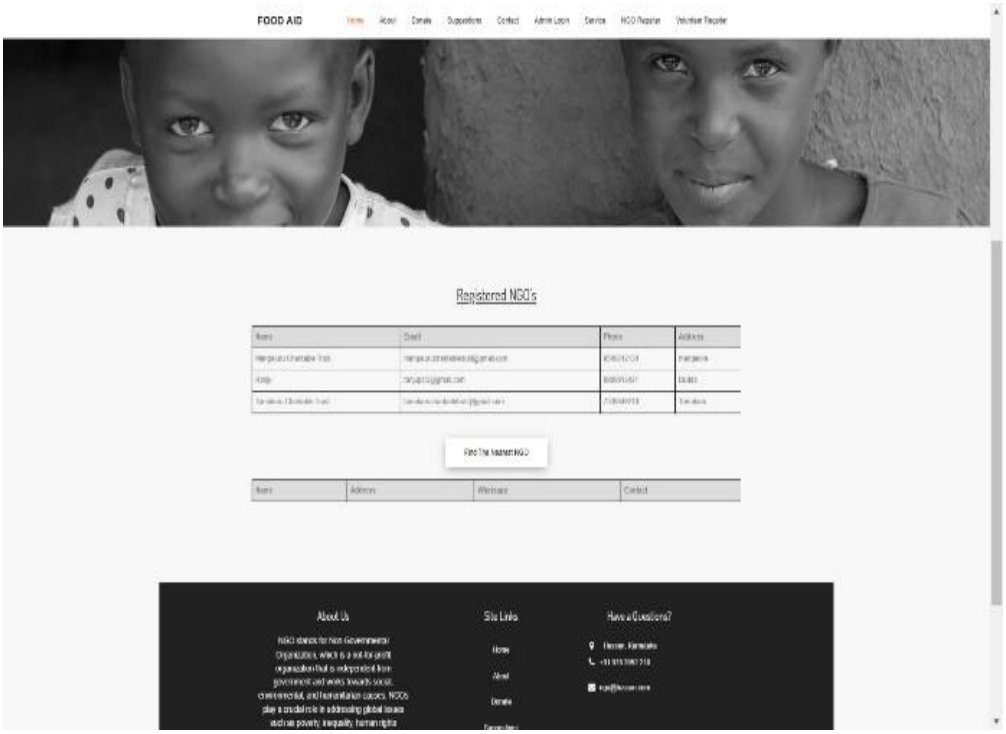

Fig 2. Nearest Ngo Page

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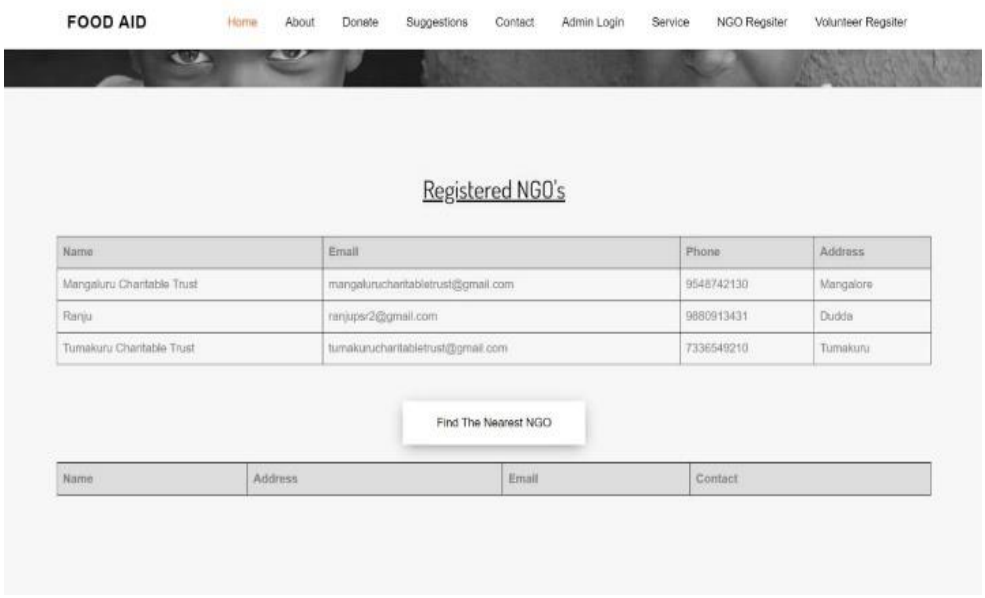

Fig 3. Donate Page

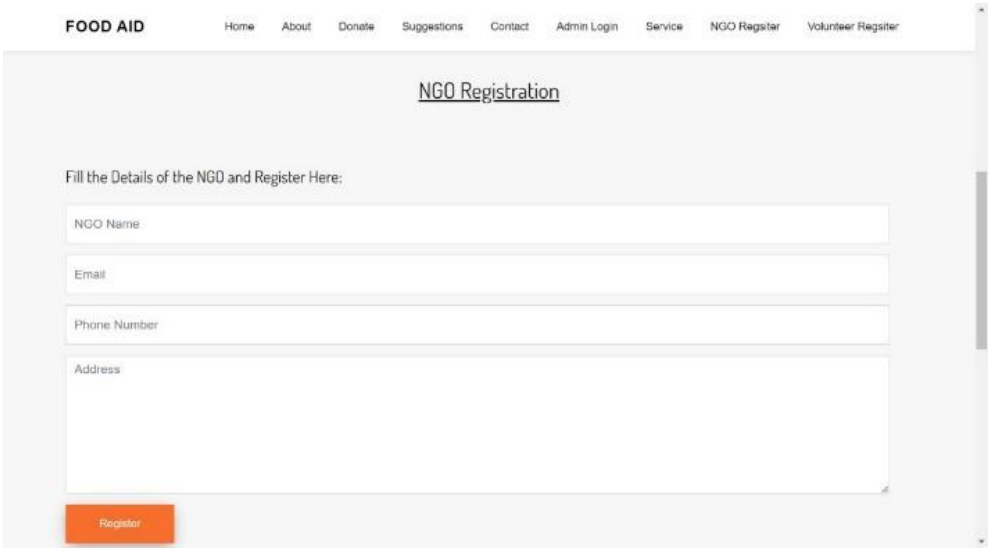

Fig 4. Ngo Registration

Fig 5. Volunteer Registration

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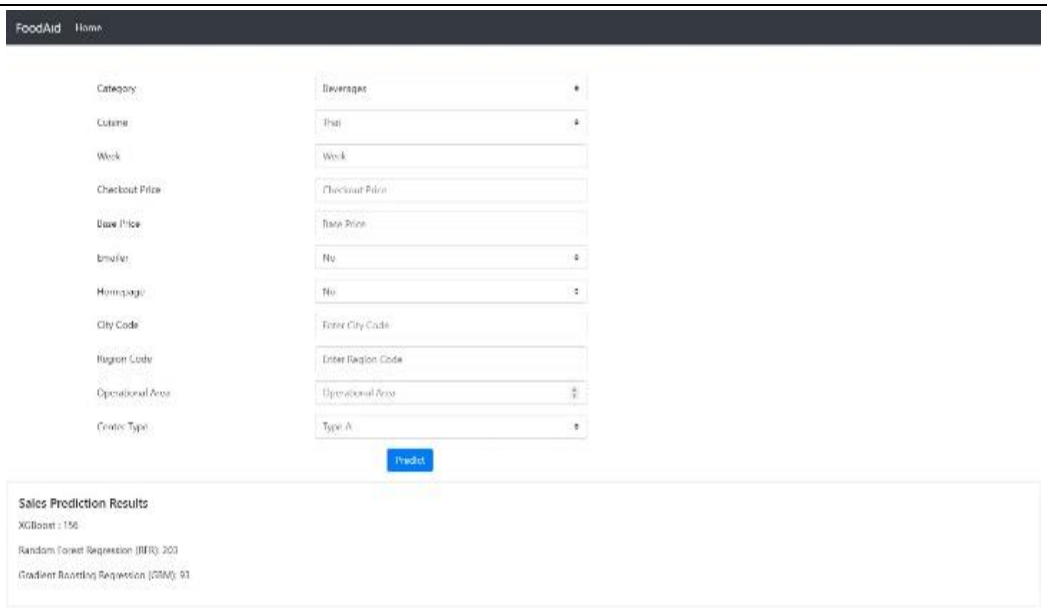

Fig 6. Food Sales Predictions

Fig 7. Web Scraping

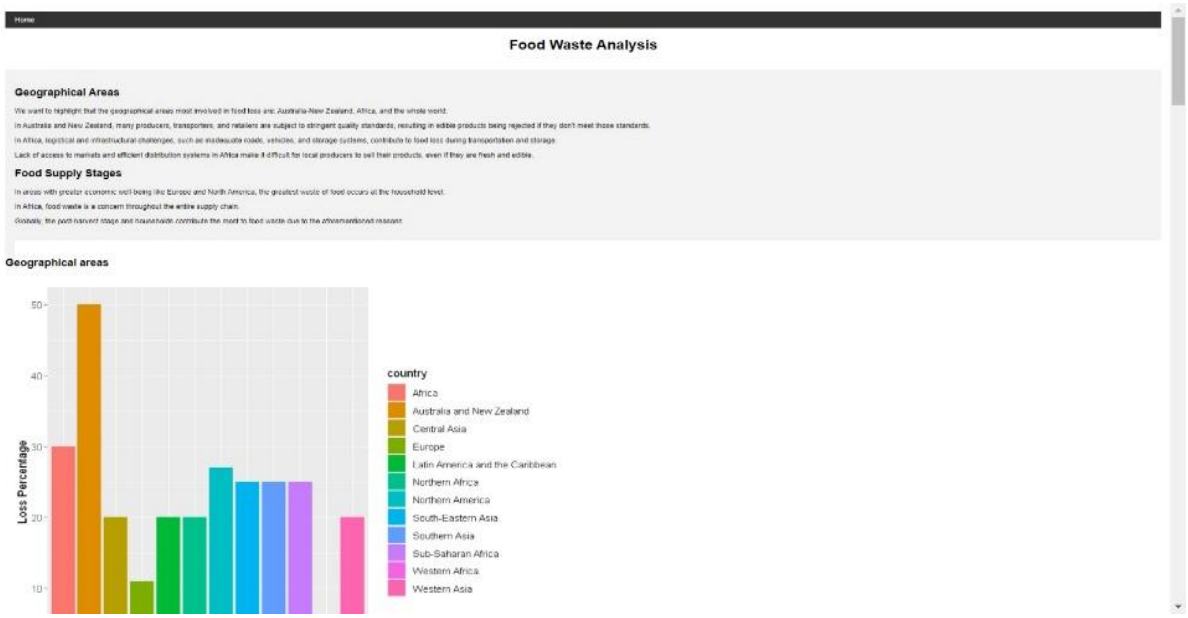

Fig 8. Global data Analysis

VII. CONCLUSION

In conclusion, our project focused on addressing the issue of food waste management through the development of a food donation website, food sales prediction using machine learning algorithms, and global food waste analysis. We have successfully implemented a user-friendly website where NGOs can register and donors can easily find and donate surplus food. Food sales prediction models using XGBoost, Gradient Boosting Regressor and Random Forest algorithms provided accurate predictions for restaurants, enabling them to optimize food production and reduce waste. In addition, our exploratory analysis of global food waste data shed light on the geographic areas most affected by food loss and highlighted potential areas for improvement.

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