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Reducing Food Waste Through Digital Innovation: A Flutter-Based Food Donation System

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Abstract

Food wastage is a worldwide problem, causing environmental deterioration and loss of resources. At the same time, food insecurity affects a large number of people and communities. The goal of the proposed food donation app is to bridge the gap with a suitable and convenient platform to bring food donors and vulnerable organizations and people together. The app facilitates convenient food donation in a manner that excess food actually reaches the most vulnerable people. The website is intended to make it easy for donors, restaurants, and supermarkets to register as donors and donate surplus food items. Recipients like nongovernmental organizations (NGOs), shelters, and needy individuals can search and order food products depending on availability and location. The website also has real-time alerts that enable the donors to track requests for donation and maximize their donations for effectiveness. Location-based services are also offered on the app to enable an optimal distribution of food to minimize wastage and maximize accessibility. The app also contains a formal database to record donations to provide accountability and transparency. The app provides users with donation status, future food drives in the near future, and critical needs in the community. Simple navigation and a straightforward interface provide ease of use, hence increasing participation between donors and recipients. The solution is sustainable and socially responsible as it reduces hunger and food wastage simultaneously. Technology provides the application with a people-oriented process of food donation to ensure the process is efficient and reliable. Having such a system has a great impact on society because it ensures excess food is utilized and not wasted. The food donation app is headed towards a sustainable future, ensuring proper utilization and equitable distribution of food.

Keywords: Food donation, surplus management, online platform, food security, sustainability, waste reduction, real-time tracking, transparency, accessibility, digital solution

INTRODUCTION

Food wastage is a global phenomenon that occurs parallel to mass hunger and food insecurity. Millions of tons of food are wasted every year, while the majority of the population cannot afford adequate nutrition. This paradox indicates the need for efficient food redistribution systems to connect the food donors and recipients. The proposed food donation app is an internet-based platform to counter the problem by facilitating the collection and distribution of excess food, conserving waste, and increasing social awareness. This application is an easy and clear food donation system that allows individuals, organizations, and businesses to donate surplus food effectively. The website leverages technology to allow real-time tracking, location-based food matching, and automated reminders to make donating hassle-free. Donors are able to post surplus food, and recipients, including

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nongovernmental organizations (NGOs), shelters, and food banks, can ask for what is available and in the location. The overall goal of this website is to minimize wastage of food while making surplus food accessible to the most deserving people. The website incorporates convenience in the shape of easy navigation, secure data management, and cloud storage to monitor donations. The app also promotes accountability and transparency in redistributing food by way of monitoring systems for both donors and receivers. With its structured mode of donating food, the program promotes global sustainability objectives and a culture of consumption responsibility. The site is a solution to hunger as well as to the protection of the environment by recycling food waste and conserving resources. With digitalization, the Food Donation Application increases community participation, and food redistribution becomes more efficient, effective, and accessible.

LITERATURE REVIEW

Some research has also investigated the role of digital platforms in food donation and reduction of food waste, targeting food waste reduction and food insecurity. In January 2023, Dr. Anjali Verma authored a paper titled "Smart Food Redistribution System," which described an automated platform bridging the gap between donors, NGOs, and recipients in real time. The research highlighted the utilization of location-based tracking, cloud storage, and auto-notifications to attain effective food distribution and minimal waste [1]. A "Tech-Enabled Food Donation Network" by using artificial intelligence to predict the patterns of food surplus and streamline the redistribution. The study proved that AI-driven analytics could assist organizations in anticipating the need for donations, lowering logistical issues, and enhancing the efficiency of food collection and distribution [2]. "Digital Solutions for Food Waste Management" studied the use of mobile apps to encourage community participation in food donation. The article recognized user-friendly interfaces, donor-recipient matching, and transparency features as the most important features of optimizing participation and building social responsibility [3].

Digitization of food donation procedures has been recognized as a revolutionary method, as seen through numerous research contributions. Dr. Anjali Verma's "Smart Food Redistribution System" and Rajesh Kumar's "Tech-Enabled Food Donation Network" are both focused on the application of technology in facilitating food donation procedures. Meera Sharma's research on digital solutions also highlights the importance of user participation and usability. All these studies together indicate that the application of technology in food redistribution is not only minimizing wastage but also increasing efficiency, transparency, and accessibility and making food donation more efficient and sustainable.

PROBLEM STATEMENT

Hunger and food wastage are two gigantic global problems of great concern to social welfare and sustainability. A vast amount of food is wasted every day by consumers, restaurants, and supermarkets, while millions are hungry. The absence of a coordinated and streamlined food donation system worsens the problem, resulting in wastage and inefficient redistribution of food. Traditional food donation systems are disorganized, based on hand-to-hand coordination between donors and recipients, leading to logistical inefficiencies, communication breakdowns, and food wastage. Lack of real-time monitoring and transparency in donations also discourages donations from potential donors and reduces the efficiency of food delivery operations. NGOs and community groups struggle to identify and recover excess food in a timely manner, thus reducing their capacity to feed the poor. The Food Donation Application is designed to address these pressing problems by providing a centralized online platform that connects food donors and recipients in an efficient and transparent manner. The system is designed to make donation easier by enabling real-time tracking, automated notifications, and location-based matching. By digitalizing food donation processes, the platform minimizes food wastage, optimizes logistics in distribution, and promotes greater community participation.

Besides, the system enhances accountability through a systematic database of donations to ensure that food reaches targeted beneficiaries in a timely fashion. Dependability and user-friendliness for receivers and donors are assured by cloud storage and secure management of data. Closing the loop

between surplus food and hunger, the initiative provides sustainable food management as well as social responsibility culture. This change will likely lead to an open, efficient, and scalable food donation system that will finally end hunger, save the planet, and improve food security for vulnerable communities.

METHODOLOGY

Requirement Gathering

Interact with food donors, NGOs, shelters, and community members to understand the problems in the current food donation process. Collect information on problems such as food wastage, ineffective distribution, and absence of real-time tracking. Choose major features such as donor-recipient matching, real-time tracking, location-based tracking, automated alerts, and secure data storage. Rank features according to their effect on food donation efficiency and user interaction.

System Design

Design a system architecture that outlines interaction between various elements, including user interface, database, and processing at the backend. Implement an intuitive and easy-to-use interface for users as well as technical users. Include scalability for more users and donations. Employ secure features in the form of encrypted data storage, user login, and access control to prevent unauthorized access and data theft.

Platform Development

Set up the development environment with Flutter as the front-end and Firebase as the backend services. Add basic features such as user registration, listing of foods, donation requests, and status updates. Add real-time notifications and location-based matching to increase efficiency. Add a responsive design that is mobile and tablet compatible.

Database Integration

Enact a well-structured database to track donor and recipient data, donation history, and food supply in real time. Use Firebase Firestore to synchronize data in real time and provide secure cloud storage. Encrypt all sensitive information and enact backup procedures to prevent loss of information.

Testing

Do unit testing to ensure each feature works as expected. Do integration testing to ensure frontend, backend, and database work harmoniously. Do cross-platform testing to ensure it works on Android and iOS platforms. Do security testing to prevent unauthorized access and data exposure.

Deployment and Maintenance

Host the application on cloud-hosting platforms like Firebase Hosting or Google Cloud for maximum availability and least downtime. Install performance monitoring software to track real-time usage and identify any issues. Regularly update for security patches, new features, and system enhancements. Have a backup and disaster recovery system in place to ensure continuity of service.

Training and Support

Create user manuals, video tutorials, and FAQs to tell users how the platform operates. Provide donor and NGO training to get the most out of it. Create a support system in the form of a helpdesk or a chatbot to handle technical queries and functionality issues. Collect users' feedback after launching the platform to improve and integrate future developments.

SYSTEM FEATURES

Launched to change the concept of food donation and redistribution for good, the Food Donation Application provides an intuitive means for donors and recipients to come together digitally and exchange food in an efficient manner. It allows for fast coordination, real-time tracking, and secure management of food donations, which drastically reduces food wastage while improving accessibility

for those in need. The application comprises a centralized Admin Dashboard at its core, which acts as the control panel for overseeing users, monitoring donations, and managing platform operations. Administrators monitor real-time activities of donations, users verification and maintainability of the system. Furthermore, analytics and reporting tools on the dashboard assist in evaluating donation patterns, measuring impact, and making data-informed enhancements to the platform (Figure 1) [4, 5].

Hence the platform; a donation platform where food donors (restaurants, grocery stores, and even individuals alike) can enter and manage listings of available food. Donors can enter information including food type, quantity, expiration and location, ensuring only fresh and usable food is available. The other end consists of your recipients – which can be NGOs, shelters, food banks, etc. who can see what is available and request food donations according to their needs. In addition, role-based access control generates that users interact with the platform under their given roles in a security level and usability. It includes real-time tracking of donations and automated notifications of updates on a donation status, ensuring that both sides, donors and recipients can track the availability of food, donations, and delivery times. Push notifications give users instant updates to make sure the food is delivered on time and quickly after preparation [6].

Central to the system is its location-based matching system which utilizes geolocation services to match donors and recipients based on their local proximity. This reduces food transportation costs, and others to ensure homeless and other needy people get the food, as quickly as possible to minimize spoilage and maximize re-distribution efforts. An interactive map support is provided to locate donation pick up and areas nearby. Because user data is highly sensitive, the platform uses encrypted cloud-based storage for secure data storage and privacy protection; this ensures that personal and transactional information is secure. For instance, email or mobile verification as authentication mechanisms add an extra layer of protection, protecting unauthorized access, while also creating trust from users [7].

Through community engagement and transparency features, the platform promotes active participation and transparency in the way that users can see donation histories, success stories, and impact metrics. It also paves the way for a more transparent system by using the public donation board to show recent contributions to encourage more people to donate as well.

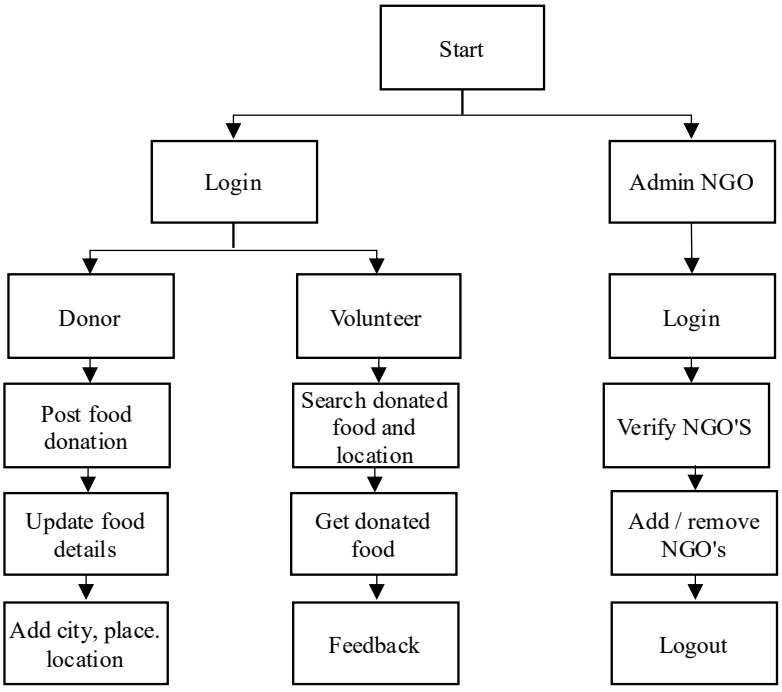

Figure 1. Architecture system design diagram.

A feedback and rating system further enhances the community, where users can deliver feedback on their experience, ultimately preventing poor service and making donations more efficient. The app is available across platforms and has a responsive, mobile-friendly user interface that works on mobile devices, tablets, and desktops. The inclusion of multiple languages in this makes the platform easier to access for distinct communities making it even more widely adopted.

The platform encompasses security and compliance, but secure logins and session management along with secure login for regular backups ensure these aspects. The app also follows all food safety protocols, meaning that the food being given out is all up to standard before someone gets their hands on it. To maximize efficiency, it features built-in analytics and reporting tools, giving users a comprehensive snapshot of donation trends, major contributors, and the overall success of food redistribution initiatives. Using this data, donors and organizations can better understand where to concentrate their efforts to address food distribution in an efficient fashion [8].

The design of the platform is primarily focused on modular architecture and scalability, enabling the subsequent introduction of cities or countries. Further future improvements might involve artificial intelligence (AI) prediction of food surplus, food blockchain tracking and automated logistic arranging through AI for greater efficiency in food donation and redistribution. With the combination of these features, you can call Food Donation Application a sustainable, transparent and community-driven solution to the food waste and hunger gap.

RESULTS

App Navigation Flow

From Login and Sign-Up to Home Screens for NGO and Donor Users (Figures 2–9).

Figure 2. Login screen.

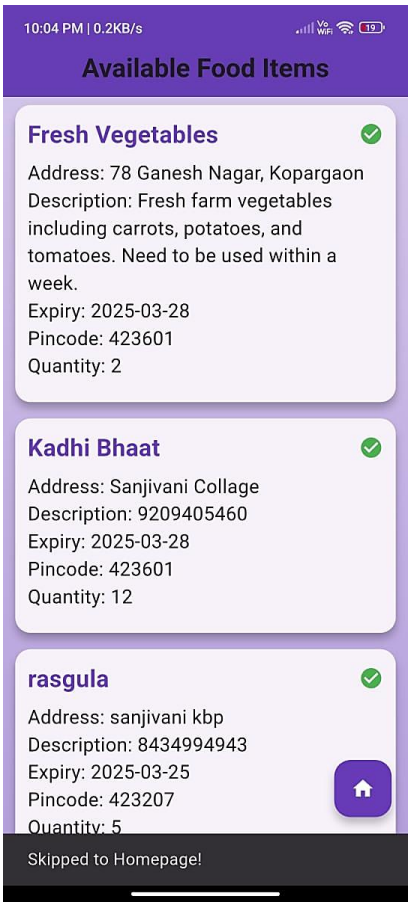

Figure 3. NGO home screen.

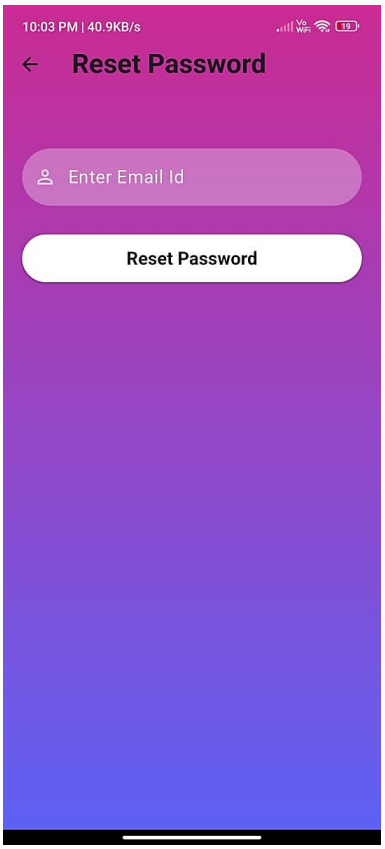

Figure 4. Reset_Password screen.

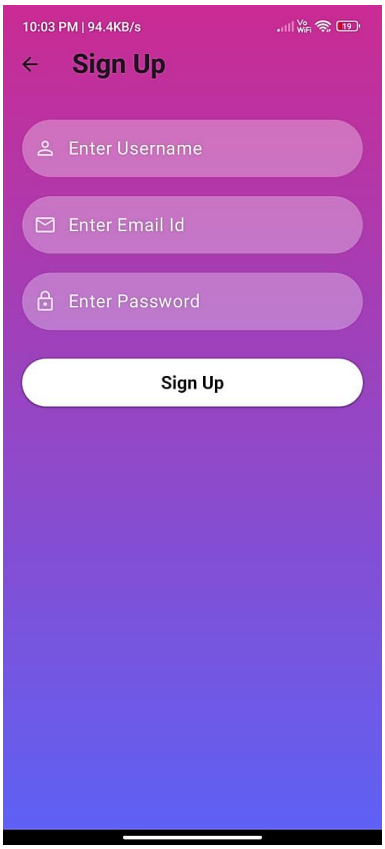

Figure 5. Sign_Up screen.

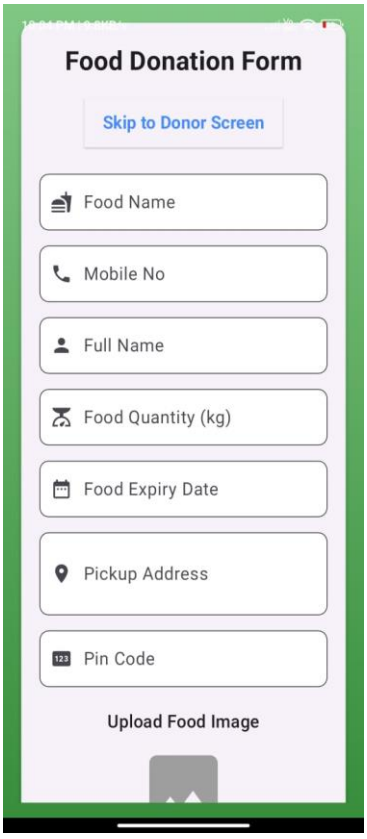

Figure 6. Donor_Screen.

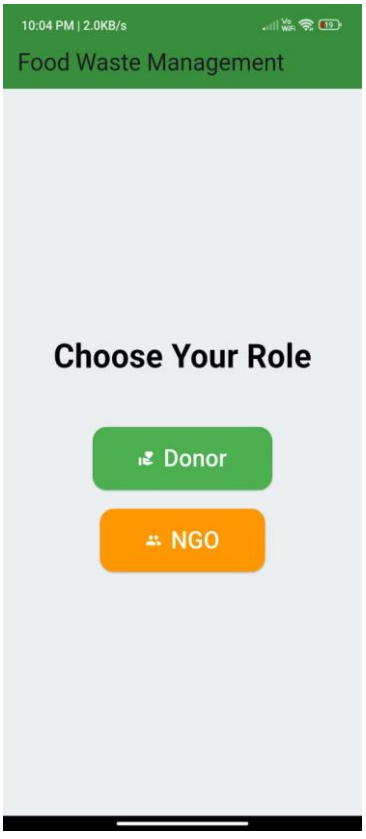

Figure 7. Choose user screen.

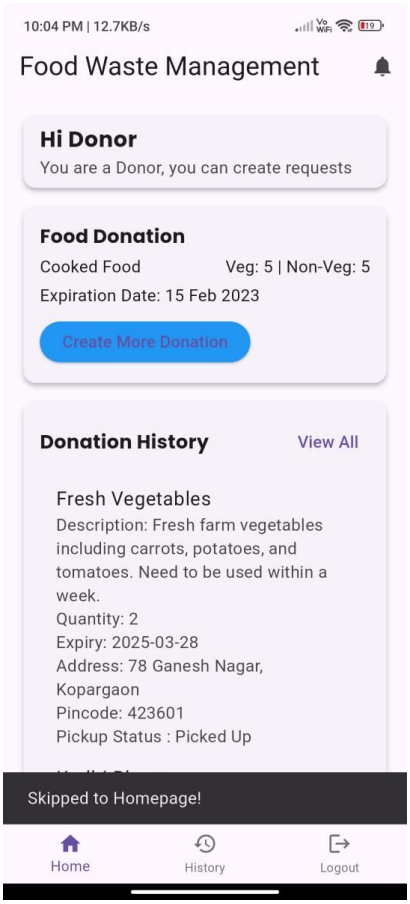

Figure 8. Donor_Home_Screen.

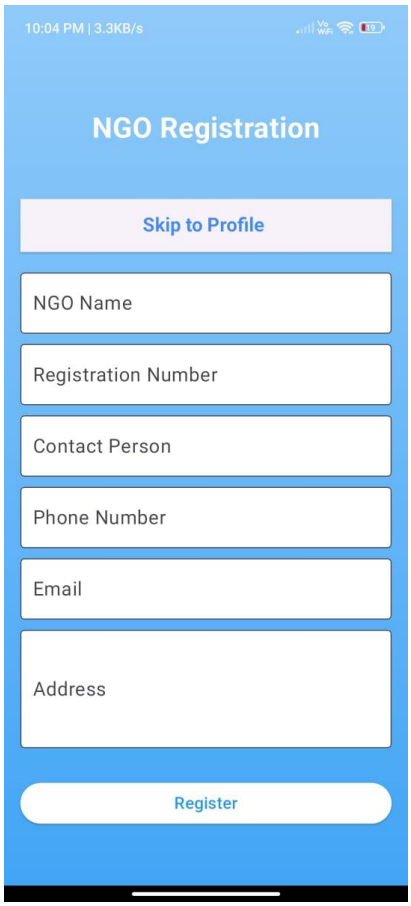

Figure 9. NGO_Screen.

DISCUSSION

When it comes to creating an efficient, user-friendly platform for food donation and distribution with an emphasis on minimum food wastage and maximum social benefit, the Food Waste Management Application hits the ball out of the park. Some important results that can be noted from the system are as follows [9, 10].

User Authentication

The login/signup functionality successfully restricts access to verified users, comprising of donors, NGOs, and administrators. This protects security and ensures the integrity of the donation process and distribution.

Seamless Donation Process

The platform offers a streamlined interface to enable donors to put available surplus food up for donation. The simple form submission updates the Recent Donations section instantly making communication between Havers and the Donors smooth.

Admin Efficiency

The Admin Panel is used for monitoring donations, verifying requests, and managing food distribution. This minimizes manual efforts and makes sure food reaches those who need it.

Real-Time Updates

This system also makes sure that when a food donation entry is made, they are refreshed in real time so that these NGOs or recipients can list all the available donations with just a glimpse. This accelerates the distribution process and prevents food from going to waste due to delays.

Tracking and Transparency

It also contains features that allow donations to be tracked by donors and recipients to ensure transparency in the donation process. This instills trust in the community and so promotes more participation.

Data Security and Integrity

Storing data on Firebase helps in securing transactions and controlling access to sensitive data like donor information and food stock. This improves fault tolerance and user trust.

Food Waste Management Application has helped the processes of food donation be performed in a more time-efficient and effective manner. By combining real-time updates, intuitive tools, and a secure data environment, a smooth experience for all parties is cultivated. It also promotes community involvement to minimize food waste and ensures that any surplus food is delivered to those in need. But ongoing refinements, such as improved AI matching between donors and recipients and wider accessibility, can optimize the impact of the system.

CONCLUSION

The Food Waste Management Application is a practical initiative that demonstrates the potential of mobilizing surplus food to those in need and minimizing food wastage. This digital platform, which has been built with the aim of increasing transparency and improving efficiency in food resource management by solving inefficiencies in the ways that food is typically donated and distributed. By automating it multidisciplinary food donation system helps provide real tracking, automatic status update, improve coordination between donors, NGOs, and the recipient by sharing the data through firebase and save the manual effort used to track food donation in its physical form.

The interface of the system is one of its key features, which makes it easy for donors to quickly list surplus food, for NGOs to manage requests effectively, and for administrators to oversee the whole process easily. This is a user-centric design that is intuitive and adapts to the technical abilities of the users – thus making it practical and versatile for use by individuals and organizations. The platform is further decorated in real-time donation updates and an interactive tracking system for boosts that contribute in sustaining anxiety and pave the way for trust in and as a means of stimulating more contributions.

The application built with a strong security framework protects the sensitive data of the users like donor information as well as food inventory information. The system is protected by secure login protocols, encrypted transactions, and Firebase authentication mechanisms to prevent unauthorized access to the system and guarantee integrity and confidentiality of data. By maintaining up-to-date databases and access permissions, this platform maintains an environment that supports food donations, system transparency, and customer/waste management reliability. In addition, the Food Waste Management Application is scalable, making it adaptable to the changing need. Modular design will allow for further development such as pair matching volunteers (using AI) to donors, automation of notifications, and extensive integration with other food security movements. This adaptability allows the platform to stay up to date and adapt to new technological developments and food redistribution in the future.

While operational efficiency may capture the essential innovation of the system, it has had an equally significant impact on social engagement, making food donation far more accessible – and systematic. This is evidenced by its diverse user base – drawing rental apartments and residential buildings – interested in sharing food that can potentially reach those who may have gone without. Real-time tracking and a visible history of donations are part of that transparency, leading to trust among donors, NGOs, and beneficiaries, and encouraging more people to chip in to reduce food waste. But, despite the system already showing significant strides in controlling food waste, its future as a long-lasting solution relies heavily on regular upgrades and on timely interventions. Keeping it effective will require regular

updates, better user feedback integration and enhanced security protocols. Moreover, outreach and engagement indeed can further increase awareness and onboard donors and NGOs into the system.

In short, the Food Waste Management Application is an essential step in the battle against food waste and starvation. This plan seeks to confront the current predicament, and build a better future, by harnessing digital technology to facilitate food donation and distribution. In addition to reducing food that would have been wasted, as more people use the platform it could become a model for effective food waste disposal, facilitating positive change that can serve as a model for communities and a more equitable distribution of food resources. This achievement showcases the impactful role of digital solutions in tackling global challenges and emphasizes the importance of technological advancements in creating a more sustainable and food-secure planet.

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