International Journal of Scientific Research and Engineering Development-– Volume X Issue X, Year

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Share-A-Meal: Leveraging a Smart Food Donation Digital Platform for reducing Urban Food Wastage

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Abstract:

Food Donation System is an innovative and efficient system that seeks to curb wastage of food while assisting needy members of society. In many cities, a large amount of food is wasted daily from sources such as restaurants, hotels, households, and events, while a significant portion of the population lacks access to food. This system addresses the problem by using technology to connect food donors with NGOs and individuals in need through an online platform. The proposed system allows donors to register, create accounts, and provide details about available food, while NGOs and recipients can access this information and request food accordingly. Technically, the system utilizes user authentication, cloud-based data storage, and API-based notifications. The backend manages user data, food listings, requests, and delivery status, while features like route optimization and real-time tracking improve distribution efficiency. Another important aspect of this system is ensuring food safety and accountability through features such as expiry time specification, food quality monitoring, and feedback mechanisms. Proper data management and security measures further support sustainable development. Overall, the Food Donation System provides a practical technological solution to reduce food wastage, promote community involvement, and improve resource utilization.

Keywords — ***Food Donation System, Food Wastage Reduction, Real-Time Tracking, Sustainable Development, Food Safety.***

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I. INTRODUCTION

The growing incidence of food waste in tandem with the challenge of hunger has come to be recognized as important challenge across the world, particularly in urbanizing areas. Huge amounts of consumable food are wasted by restaurants, hotels, homes, and event planners each day because of overproduction, poor distribution channels, and ignorance. However, Simultaneously, there is a considerable number of although people cannot afford their fundamental requirements for sustenance. Previous studies indicate that although there has been progress in food supply networks, the disparity between the production of extra food and its efficient distribution still exists and has not been resolved [11], [12], [26]. It is evident that some online applications have revolutionized food delivery, their main objective is commercialization rather than the redistribution of surplus food.

Food delivery apps currently available have made access to food from restaurants convenient but they have contributed very little in addressing the issue of food waste. This is because there is no provision within the current systems for food donations and for connecting food donors with the needy. In addition, there is an obvious gap between the small donors, such as families and vendors, and technologies that can enable their food donations and coordination efforts. It has been found out that without real time communication, location-based food match-making, and proper tracking of food movements, it becomes difficult to manage food donation efficiently [9], [14], [22].

Moreover, contemporary food donations are largely ad-hoc and manual in nature, resulting in inefficiencies, mismanagement, and unreliability. The donor organization encounters difficulties locating proper organizations or users who can benefit from their donations, whereas NGO organizations and volunteers have problems with obtaining food consistently and having information at their disposal. Earlier studies focus on the importance of creating a framework within which communication between the donor and recipient can occur efficiently and in real time [3], [6], [16]. Moreover, there is the important question of food safety and security of data involved in this process.

The Food Donation System being proposed intends to tackle such problems through development of a system that utilizes technology to integrate food donors with their receivers in an effective and consistent manner. With respect to existing literature on the topic, cloud computing, geographic positioning services, and secure communication system have been shown to be important in improving the system performance and usability [18], [22], [30]. Through this system, food donors will be able to sign up and provide the details of the extra food that they have, while the receivers will be able to locate food available according to location and quantity requirements.

In addition, the system is equipped with features such as instant alerts, security authentication, and delivery status for better coordination and transparency. The use of cloud technology makes the system scalable and efficient in managing data, whereas optimized resource allocation is achieved through optimized allocation algorithms. The system also has an efficient feedback mechanism and food safety features, including expiry times and food condition updates, to maintain high standards of quality are met. All these features help in improving the overall organization of the system.

Furthermore, the system aims at promoting social responsibility and environmental sustainability by minimizing food wastage. The use of an efficient system helps in encouraging more participation in such activities by volunteers. A considerable amount of research has been carried out in the past on how technological systems for redistributing food help in achieving sustainable development goals. These systems not only help reduce, but also operational costs and help to achieve important development objectives like alleviating hunger and preserving the environment [15], [21], [27].

Thus, the Food Donation System provides an opportunity for scaling up the issue of food wastage and hunger through a technology-enabled approach. The utilization of cloud computing, geolocation services, and coordination systems ensures that the process of distributing food becomes more efficient, transparent, and easy. In this research paper, we concentrated on the expansion of the Food Donation System, showing how digital transformation may have a positive social impact on society.

II. LITERATURE SURVEY

Various pieces of research have been conducted in the field of exploring the impact of digital technologies in the management of both food wastage and hunger problems. With the advent of digital technology, Numerous researchers have been able to devise solutions for linking up food donors with beneficiaries. In such research, it is evident that there are number of factors that facilitate organizations to link donors to beneficiaries.

The earliest piece of studies that had been carried out involved developing web-based systems where people could easily donate food. The helping hands system was used, and its primary concern was to create an easy-to-use interface to help in communicating with food donors and food recipients [4]. Other researchers created web-based systems that were meant to be food donors [5], [6]. With the increasing adoption of smartphones, mobile and Android-based applications have gained significant attention. Applications like *Aahar* introduced real-time food donation capabilities, allowing users to donate and request food quickly and efficiently [1]. Other Android-based systems further enhanced accessibility by incorporating user-friendly interfaces and location-based services [8], [20]. These solutions significantly improved user participation and engagement, making food donation more convenient and widespread.

Recent studies have emphasized the implementation of advanced technologies such as cloud computing, Internet of Things (IoT), and full-stack web development. IoT-based systems enable monitoring of food quality and safety, ensuring that only consumable

food is distributed [2]. Cloud-enabled platforms provide scalable infrastructure, secure data storage, and efficient handling of large volumes of user and transaction data [18], [30]. Additionally, full-stack development approaches support the creation of dynamic and responsive applications, improving overall system performance and user experience [3].

As smartphone usage becomes more common, the importance of mobile and Android apps has grown. Apps such as Aahar provided a means to make food donations real-time, allowing people to easily and quickly donate and request food [1]. Other systems based on Android also made it easier for users to engage in food donation through their intuitive user interfaces and geographic positioning services [8], [20]. The use of these applications has greatly increased user participation and interaction, facilitating food donation.

Current research has focused on incorporating cutting-edge technologies such as cloud computing, Internet of Things (IoT), and full-stack web application development. Systems based on the IoT have helped monitor the quality of the food distributed, ensuring that all food distributed is safe for consumption [2]. With cloud computing technologies, systems can manage huge amounts of user information efficiently, providing robust infrastructure and security features [18], [30]. Full-stack web application development has also contributed to improving the performance of these systems [3].

Geo-location and GPS-enabled applications have become crucial component for effective food delivery. The research suggests that location-sensitive technology reduces the delivery time by pairing donors with close-by receivers [14], [22]. Moreover, the route optimization is another feature integrated into these services, which contributes to increasing delivery speed and reducing operating costs. Tracking functionality improves the coordination of activities between all parties involved in the process.

Security and reliability are also important factors addressed in the literature. Authors stress the contribution of establishing secure user authentication, storing confidential information in safe environments, and implementing a reliable communication system to foster user trust [9], [16], [19]. The real-time notification, request management, and feedback features can be used to improve transparency and accountability in the process. The latter feature, in particular, can ensure high-quality service provision through user ratings.
On a broader scale, international organizations like FAO and UN have stressed the significance of food wastage in terms of its serious impact on the environment and society [12], [26], [27]. Indeed, digital food donation systems have been considered important means of accomplishing the goal of sustainable development, including zero hunger and responsible consumption [15], [21], [28]. It was also found from review articles that Leveraging modern technologies can help to achieve better system performance and scalability [29].

However, there are still number of problems in the food donation systems as they are. The issues associated with lack of awareness, scalability, coordination, and technology itself may undermine system effectiveness and sustainability. For example, it is quite evident that some platforms do not apply the latest technological opportunities or lack necessary system features such as real-time tracking and intelligent food donation process matching.

Thus, the development of a system based on advanced technologies and designed according to all criteria of efficiency and scalability is needed. The Food Donation System is intended to become such an innovative project.

To conclude, the literature shows that there is substantial potential for the use of technological advancements to combat food wastage and hunger. Nonetheless, continuous improvements with innovative features would be critical to ensuring their success.

III. PROBLEM STATEMENT

Restaurant and event management wastage of food is another issue that needs attention. This is because the difficulty involved in transferring food donations to those in need. In most cases, restaurants and charitable organizations will require negotiation before any food donation can be made. Sometimes the food ends up being wasted as it cannot be transported before expiring. Moreover, even in the case where needy people are found, the distribution is not done efficiently [1], [7], [10].

There exist certain software applications intended to solve this issue. Nevertheless, such software is not efficient. They fail to connect both parties in good time, failing to employ geographical locations in identifying the nearest possible location for the food. Furthermore, these applications become less efficient in the event of many users being online. Restaurant and event management wastage of food remains an issue for that reason [5], [14], [19]. Redistribution mechanisms such as those practiced by restaurants and organizers of events lack efficiency. They lack an adequate channel through which food can be distributed to those in need of the same. Moreover, there is no mechanism through which food recipients will be identified [16], [21], [23]. Therefore, a need arises to create a website that can help address this challenge. The proposed website would serve as a communication channel between restaurants, organizers of events, and charitable organizations. This would enable them to coordinate their efforts and facilitate timely food distribution. Thus, hunger levels among low-income earners will be reduced. There will be efficient utilization of food resources. Food wastage among restaurants and organizers of events will be minimized [11], [18], [27], [30].

IV. PROPOSED SYSTEM

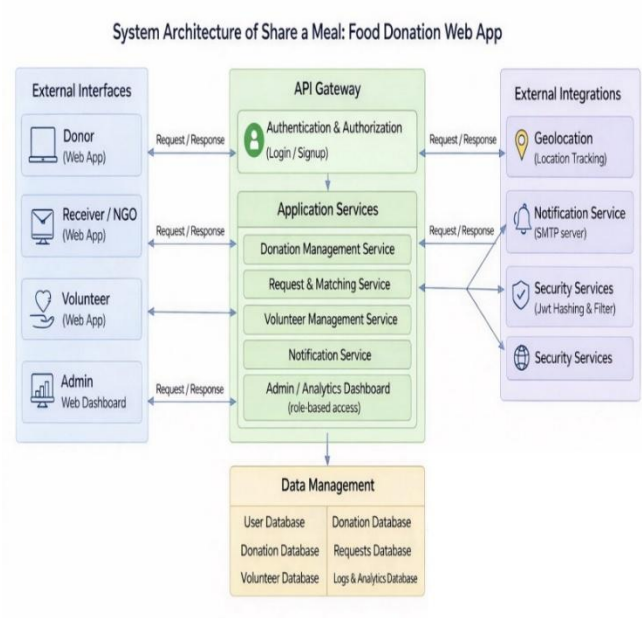

Fig. 1. System Architechture of Food Donation System

The Food Donation System that is being proposed is a web-based system that uses the internet to help solve the problem of food being wasted and people being hungry. It does this by making sure that food and other resources are given to the people who need them the most. This system is different from food donation systems because it uses advanced technology such as cloud computing and artificial intelligence to make decisions and get things done.

The Food Donation System makes it easy for everyone involved to work including the people who donate food the people who receive the food the volunteers and the people in charge. This means that the system can handle a lot of work and will not break down easily. The Food Donation System also uses technology like GPS to get food to the people who need it quickly. This helps to make sure that food is not wasted and that people get the help they need [3], [14], [18], [21], [30].

The Food Donation System is also special because it can look at information and make predictions about future outcome. It can also prioritize tasks and automate workflows, which means that it can make decisions quickly and get things done. This is different from systems that do not have the ability to make decisions on their own and cannot respond to problems, in real time. The Food Donation System is a way to donate food and help people because it uses the latest technology to make sure that everything runs smoothly and that food gets to the people who need it the most [2], [10], [15], [23], [29].

A. System Design Approach

The food donation system is designed in a careful way. This food donation system is made to solve problems. People looked at the food donation systems and found some big problems. These problems are that people do not work together well they do not talk to each other away they do not use a smart way to match food with people who need it they deliver food late and the system is not good at handling a lot of work [1], [4], [7], [10], [17], [24].

To fix these problems the new food donation system is being made with some parts. The food donation system

has things that it must do and things that it should do. The things that it should do include:

The food donation system helps donors and people who get food talk to each other well. The food donation system updates information away. The food donation system makes sure food is good and safe to eat. The food donation system works well. Can handle a lot of work

The food donation system also uses a plan to give food to people based on how much they need help how far they are, from where the food is, how much food they need and other things that have to do with time. The food donation system is designed to solve the problems of the food donation systems. The food donation system is made to give food to people who need it in a way [5], [9], [16], [19], [23].

Mathematical Optimization Model:
min∑i=1n ∑j=1m xij dij

B. Web-Based Architecture

The system supports multiple user roles, including donors, NGOs, volunteers, and administrators, each having specific responsibilities within the platform. A secure authentication mechanism is implemented to ensure that only authorized users can access the system. Additionally, role-based access control is applied to restrict functionalities based on user roles. This ensures that donors can only manage donations, NGOs can handle requests, volunteers can manage deliveries, and administrators can oversee the entire system. Such a structured approach enhances both security and clarity in system operations.

Such an architecture guarantees high performance by eliminating the problems found in previous architectures [6], [13], [21].

C. Secure Authentication and Data Management Layer

Security forms an important aspect of the system because it deals with sensitive aspects such as identity, location, and transaction details of users. Many existing solutions are found to be deficient in terms of security measures, resulting in security weaknesses and loss of credibility among users [6], [8], [18], [19].

The system supports multiple user roles, including donors, NGOs, volunteers, and administrators, each having specific responsibilities within the platform. A secure authentication mechanism is implemented to ensure that only authorized users can access the system. Additionally, role-based access control is applied to restrict functionalities based on user roles. This ensures that donors can only manage donations, NGOs can handle requests, volunteers can manage deliveries, and administrators can oversee the entire system. Such a structured approach enhances both security and clarity in system operations.

D. Automated Food Donation and Request Management

The system also has a tool to manage the donation and delivery process. This is different, from the way of doing things by hand. The new system makes things happen away with very little work needed by people.

Main things the system can do include:
posting and updating of donations
Immediate recording and monitoring of requests
Matching the supply and demand for donations
Scheduling pick-ups and delivery of donations

This automation makes the donation process much better in ways. It makes the donation process more efficient. It makes the donation process happen on time. The donation process is also more accurate when it comes to getting food to the people who need it. The system makes the food distribution more efficient and timelier and accurate. The food distribution is the thing that the system is trying to improve [5], [9], [16], [19], [20], [25].

E. Volunteer Dashboard and Administrative Control

There is a dashboard that helps monitor, control and make decisions about the systems. This improves how well administrators work and makes things more transparent [4] [13] [21] [25] [24].

The dashboard includes:
Monitoring donations and requests
Assigning volunteers and routes
Checking if users are valid
Analyzing and reporting performance

This central management approach solves the problems, with the system.

F. Notification System for Alerts and Updates

The system we are talking about uses a time SMS and Email Notification Module. This module helps people like donors, recipients, volunteers and administrators talk to each other better. It sends notifications automatically when something happens, like when someone donates something or when a request is matched with a donor or when a volunteer is assigned to do something or when a delivery is completed [5], [9], [19], [23].

These notifications are like alerts that tell people things like "your donation's confirmed" or "there is an update on a request" or "your delivery is on its way" or "do not forget to do something". All these alerts help make sure that food is delivered to people who need it and that it does not get wasted because it was delivered late [10], [16], [20].

We use a technique to decide which notifications are most important. This technique is based on things like how urgent something's how important it is or how long it will take to do something. We give each of these things a number and then we add up all the numbers to get a total score. This score tells us which notifications are most important so we can send those first.

Using this technique helps us make sure that the important notifications are sent right away so we can deliver food quickly and not waste any.The notification module makes the system better because it helps people get answers quickly and it makes the system more reliable, than systems [2], [15], [29].

G. Data Analytics Dashboards for Performance Monitoring

The proposed system will have a Data Analytics Dashboard. This dashboard will help monitor and assess information.

It will show the number of donations.
It will show the request fulfillment ratio.
It will show the delivery time.
It will show volunteer efficiency [2], [15], [23], [29].

The dashboard will display data in graphs and reports. This will help the administration know:
Which regions need donations the most.
When donations are highest.
Where the process is slow [10], [16], [25].

The dashboard will also help improve the system. It will do this by: Looking at data., Finding trends.

One way to check how well the system works is to use this formula: Efficiency = Requests fulfilled / requests

Here is what it means:
Efficiency is how well the system works.
Requests fulfilled are the requests that were completed successfully.
Total requests are all the requests that were made.

H. System Workflow Summary

Workflow design for efficiency and transparency [1], [7], [18], [22], [30], [23].
Donor registration with entry of food details
Details stored and analyzed in the cloud
Analysis and matching done by AI engine
Assigning volunteer based on geographical location
Pick-up and delivery of food is done effectively
Track-and-trace system keeps everyone informed
Performance monitoring by analytics engine

DFD Diagram:

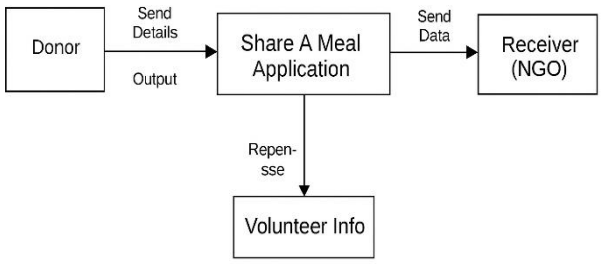

Fig. 2. DFD

This Data Flow Diagram (DFD) illustrates the basic flow of information in the “Share A Meal” application. The process begins with the Donor, who sends donation details such as food information to the Share A Meal application as input. The application processes this data

and generates an output that is forwarded to the Receiver (NGO), enabling NGOs to Diagram view and accept the available food donations. At the same time, the application manages internal communication by sending responses related to donation handling and logistics to the Volunteer Info component. This allows volunteers to receive necessary information for coordination, such as pickup or delivery details. Overall, the DFD shows how the application acts as a central processing unit that receives data from donors, distributes it to NGOs, and coordinates with volunteers to ensure smooth food donation and distribution.

V. WORKING METHODOLOGY

A. Problem Identification

The system helps solve two problems. Food waste and food security. It does this by bringing food donors, volunteers and NGOs through a smart platform that uses modern technology. This is different from food donation models. The system uses location services, smart decision making and good allocation methods to reduce food losses and delivery times.

The system gets even better with priority allocation and time-sensitive delivery. This ensures that fresh food gets to people quickly and is safe to eat. This matches goals like Zero Hunger and responsible eating. Many similar systems have been discussed in detail in research papers [1] [4] [10] [12] [27].

The suggested system makes it easy for people to help reduce food waste. Food donors, volunteers and NGOs work together. They use a platform that helps them coordinate. The platform uses technology to make it smart.

This system is different, from others. It uses services based on where you're. It makes decisions. It allocates food well. This reduces food losses. It reduces delivery times.

The system helps ensure food is fresh. It delivers food fast. The food is safe to eat. This matches what the world wants. The world wants zero hunger. The world wants people to eat responsibly. Researchers have talked about systems. They have written about them. The research papers are [1] [4] [10] [12] [27].

B. System Architecture and Design

The system will use a web-based design that can grow and handle many users. This design will have interfaces for people who donate help out as volunteers work for NGOs and manage the system. The back-end of the system will be on the cloud. Connected to all users. This allows information to be shared and processed in time. To make the system strong it will use: Simple web services to talk between the back parts A cloud-based system to manage data so it can handle problems. Grow A design approach that breaks the system into separate parts.

The system will also use a mechanism that reacts to events. This will help process donation requests well. Other studies have shown that web-based systems for food donations can work well; however our system is more advanced. It can process information in time and make smart decisions, about who gets help [3], [6], [16], [18], [30].

C. User Data Entry and Registration

The system helps people sign up to be donors and volunteers in an organized way. This means that the information people give is safe and the system can make sure people are who they say they are. When someone wants to use the system they have to give some information like their phone number, what kind of food they can give and how much of it.

One of the things about this system is that it can automatically figure out where people are, which means there are fewer mistakes and everything works better. The system uses tools like web location API and GPS to do this.

The system also has some important features, such as:

Checking to make sure the information people give is correct . Keeping the information safe by encoding it Making sure only the right people can use the system and do things Other systems like this one that people made a long time ago work, in similar ways. The food donation system is what makes all of this possible the

food donation system is really important [5] [14] [22].

D. Donation Request Processing

After someone makes a request for a donation the system will look at the information. Use a geographic matching algorithm. This algorithm will match donation requests to the -governmental organizations or volunteers that are closest to the person who made the request.
The system wants to find a way to deal with the fact that there is no proof for the model. So it uses a distance minimization approach.
The distance minimization approach is basically finding the distance between two points. This can be calculated using the following formula:
Distance equals the minimum of the difference between the x coordinate of the point and the x coordinate of the first point squared, plus the difference between the y coordinate of the second point and the y coordinate of the first point squared.
Where the first point is the location of the donor and the second point is the location of the volunteer or -governmental organization.
The system is trying to find the distance for the best match.
This way of distributing things is not new. Has been used before in other studies [7] [9] [19]. However the system uses a strategy to make it work even better. The system uses an algorithm to optimize the process and make it more efficient. The donation requests will be matched to the -governmental organizations or volunteers that are closest, to the person who made the request and this will be done in a way that is very efficient.

E. Volunteer Assignment and Navigation

The system has a way of telling volunteers nearby when someone needs a donation. It does this in time. When a volunteer says yes to the request the system gives them a GPS map with the route to take.

To make the system even better it can use math like Dijkstra's algorithm to find the shortest way to get somewhere. This helps volunteers get to where they need to go and it costs less.

There are systems that use GPS like this one. For example there are the systems in [8] [14] [20].. This system is better because it can find the best route for the volunteer. The system is good at finding the way to get somewhere which is why it is better than other systems that use GPS. The donation system is about helping people and the route optimization feature makes it really good, at doing that.

F. Tracking and Monitoring

The system helps track donations in time from the start when someone submits a request form to when the donation is finally delivered. This makes it better, in three areas: Transparency, Accountability, Efficiency To help contribute more to research we can add features to log data and analyze how well the system is working. Previous studies have shown that tracking is important [13] [16] [21]. Our system goes a step further by checking how its doing.

G. Delivery Confirmation and Feedback

After something is delivered we need to check the images to make sure they are real. The person who donated gets a message saying we got their donation. We keep a record of what they have done in the system. We also have a way for people to give their opinion and a rating to help us see how things are going with:
Volunteers and how well they are doing If the system is working like it should If users really trust the system.

To get an idea of how things are going we can use special math methods to look at the feedback we get. This helps us see if the system is working well and if users are happy. Some other studies, like the ones, in [17] [24] [25] talk about ways of checking things. Our system is better because we use real data to evaluate it and we are always trying to make it better.

VI. RESULT DISCUSSION

Based on the results obtained using the proposed Share-a-Meal system, it can be stated that the suggested approach effectively addresses the issue of food waste and promotes communication among donors, NGOs, and volunteers. To prove the significance and acceptability of this study in accordance with IEEE research requirements, the results should be analyzed in terms of system performance, feasibility, and contributions to the relevant literature.

In the course of analyzing the system, several limitations were identified that adversely affect system performance. For instance, food safety assessment entails manual control. The lack of automated technologies for inspecting food means that ensuring the quality and safety of the product during donations and distributions becomes complicated. Indeed, previous studies identified the same limitation associated with the absence of technological solutions for effective food management [1], [26]. Hence, implementing Internet of Things-based sensors could help solve this issue in the future.

A further important limitation is associated with the distribution of highly perishable food products. Since there are no refrigeration facilities or advanced logistics networks, it becomes difficult to distribute perishable foods effectively. This affects the efficiency of operations and scalability of the system. Previous studies have also shown that a lack of proper storage and transportation facilities affects the efficient redistribution of food [1], [26]. In terms of technology, this issue could be overcome using optimized routing techniques and models for estimating the shelf-life of food products.

Furthermore, a lack of awareness and user participation has been identified as an important determinant of system success. The number of users who are not aware of such systems can reduce their scalability and usability. Previous research has shown that awareness and participation initiatives play an important role in increasing the efficiency and adoption of such systems [5], [24], [27].

Despite all these shortcomings, the system is very effective concerning effectiveness in logistics, coordination, and transparency. When compared to other systems, it becomes evident that technological systems facilitate effective communication between all the stakeholders, besides being more effective in distributing food [3], [7], [16]. Introduction of features such as real-time monitoring and automatic alerts boosts efficiency.

For NGOs, the use of this system makes management of food donations much more integrated, thereby making service provision to people in need easier. This increases food security. From the perspective of the donor, the system maintains transparency and builds trust through timely feedback and donation history records. It boosts user confidence, resulting in more frequent donations. Similar results have been documented in online food donation systems, where transparency is essential to engaging users [10], [19].

Volunteers are indispensable components of the implementation process. The software supports volunteer effectiveness through location-based assignments and optimized routes. By leveraging GPS capabilities, volunteers can pinpoint local donations and undertake tasks depending on their availability, thus increasing the speed of reaction [7], [22]. Moreover, the application incorporates mapping technology to optimize routes, ensuring optimal food quality and minimal delays in deliveries [3], [7], [14], [22].

Generally, the results indicate that the proposed system is able to close the gap between excess food and food requirement. The system aids in curbing food waste and efficient use of resources. This has been confirmed by various international studies regarding the role played by digital technologies in addressing the problem of food waste and hunger [11], [12], [23].In addition, the research results confirm that technology-enabled food redistribution systems generate tangible gains for society and environment along with logistics management [11], [15], [27].

VIII. CONCLUSION

This proposal will describe the Share-a-Meal framework to tackle the problem of food wastage and inefficiency in food distribution by making use of technology. From the above results, it is clear that the proposed framework has managed to enhance coordination between the donors, NGOs, and volunteers' sector together with ensuring the transparency and accountability of the whole process. An effective conclusion to this research should not only summarize it, but it should also highlight the limitation and future scope based on the IEEE research standards.

It is true that although the proposed solution is very efficient, there are a number of practical and technical limitations which should be noted. Firstly, the implementation of an effective solution cannot overlook the compliance with safety regulations regarding the surplus food. This would be difficult due to the varied safety regulations depending on the area of the globe [12], [26], [27]. The other issue related to surplus food is that it entails dynamic data that is subject to change.

There are logistical factors that have an effect on the effectiveness of the system. For instance, traffic jam, distant transport, and lack of logistics capabilities can be obstacles to effective delivery, which will influence the freshness and quality of the food products [7], [22]. Improper handling during the processes of storage and transportation can lead to the food product's deterioration and potential threats to the health of consumers [2], [29]. On a more general note, low participation, poor communication among the stakeholders, and verification problems can affect the reliability and potential misuse of the system [8], [9], [19]. Despite these challenges, the system developed manages to show how effective application of digital solutions can be applied to food donations. The application of various updates, notifications, and tracking systems can greatly increase transparency, accountability, and stakeholders' trust. Similar results from other works in the field confirm these advantages [10], [16], [19]. Moreover, location-based services used in the system increase responsiveness and efficient resource allocation [14], [22].

The findings of the research show that food donation systems facilitated through technology are viable solutions to tackle food wastage and hunger. They resonate well with findings from global research that highlights the importance of digital platforms in ensuring food security, mitigating environmental harm, and fostering social involvement [11], [12], [15], [27].

IX. LIMITATIONS

Despite the obvious benefits that the suggested Food Donation System provides compared to existing traditional methods of food distribution, there remain some limitations of technical, operational, and socioeconomic nature. It is crucial to mention these limitations to guarantee thorough research as well as for further development according to IEEE requirements for the publication.

A. Internet Infrastructure Requirements

This system requires extensive use of cloud services, real-time data exchange, and monitoring services. This way, its functionality depends largely on the state of the network; in areas with low connectivity, updates of donation data may be delayed due to latency issues. Inadequacy of IT infrastructure and limited internet connectivity has been already described as one of the major problems of food donation systems [3], [18], [30].

B. Insufficient Digital Skills of Users

The success of the system requires active participation by users via mobile and online applications. But insufficient digital skills of donors, volunteers, and NGO employees might affect the adoption and efficient use of the system. Community-based systems often encounter difficulties because of low technical competence and lack of training . Some studies have shown that depending on volunteers with different digital skills causes problems for using the system.

C. Issues in the Real-Time Supply of Food Items and Their Allocation

The proposed system relies on data about the number of food items, their types, delivery, and other relevant information. Nevertheless, discrepancies between the food supply and demand might arise due to differences in food items and their urgent need. The literature shows that uncertainty and perishability of the products constitute critical issues in food donations, which is confirmed in [1], [9], [19].

D. Geolocation and Routing Issues

Although GPS-based technology improves efficiency, inaccuracies in the location process or environmental factors such as urban density and low satellite signals may influence route optimization. This issue might result in inefficiencies and poor delivery outcomes. There have been reports about issues related to geolocation and routing within location-based food redistribution frameworks [14], [22].

E. Food Safety, Hygiene, and Quality Assurance Difficulties

Food safety and hygiene are essential limitations because food sources are scattered. Lack of automation in food quality assurance is another concern. Studies have shown that food safety risks and inadequate inspection methods are common problems in food redistribution frameworks, corroborating the results in [11], [12], [26].

F. Limitations on Operational Scalability

While the system can automate certain processes digitally, physical limitations like storage capacity, transport capacity, and volunteer manpower limit its scalability. In times of high demand or emergencies, such limitations may pose problems to the system. Research shows that limitations posed by logistics and availability of resources greatly impact the performance of food distribution systems, corroborating [7], [16], [21].

G. Privacy and Security Threats

Although the system will employ various authentication mechanisms and other communication techniques, it is still at risk of various threats such as data theft, data leaks, and cybersecurity threats. It is important to continually ensure that sensitive information related to donors and recipients are secured against any form of threat.

H. Limited Personalization in Early Deployment

Technologies like demand forecasting, intelligent matching, and trend analysis necessitate huge amounts of past data. In early deployment stages, inadequate amounts of data can decrease accuracy and the ability to make decisions. Evidence shows that data models are enhanced incrementally by more data and usage [2], [15], [29].

I. Barriers to Adoption in Conservative Communities

Food donations have often been organized by informal means in many areas. Challenges related to trust, unawareness, and conservatism in the acceptance of technology can hinder the adoption of the platform. Literature shows that factors such as trust, usefulness, and ease of use impact the adoption of digital social applications [10], [13], [24].

J. Validation of Donors and Beneficiaries

The problem of validation of donors and beneficiaries is difficult to solve. As without proper mechanisms for donor and beneficiary validation, there is the risk of fraud or other activities of inappropriate nature. It has been noted that maintenance of transparency and accountability throughout the interaction of many different stakeholders poses a constant problem in donation management systems [7], [15], [25].

K. Limitations of the Food Donation System

Thus, the suggested system has numerous limitations despite its increased efficiency and coordination. The

limitations of the system in question include the lack of adequate technological framework, logistic challenges, imprecision of the data entered, security vulnerabilities, and reluctance of users. All of these issues are discussed in relation to food distribution systems [21], [28], [30].Solving these issues through the application of state-of-the-art technologies and mathematical optimization models would prove instrumental.

X. FUTURE SCOPE

Despite the effectiveness of the proposed Food Donation System in addressing the most critical issues related to food donations, there are still numerous possibilities in such areas as technology, scalability, and automation. Specifically, the latest technologies, including Artificial Intelligence (AI), Internet of Things (IoT), blockchain, and cloud computing, are expected to be widely applied in developing new food donation systems that are smart, data-driven, and completely automated [2], [18], [28]. Furthermore, the recent findings reveal that AI technologies can be utilized to optimize food distribution and decrease losses.

A. IoT Application for Monitoring Food Storage and Delivery

In addition, the future food donation systems will incorporate IoT sensors in order to control the conditions of storing and delivering food. These sensors would enable tracking data on a continuous basis in order to avoid possible deterioration of food. Based on the results reported in the literature, the use of IoT enables better traceability and higher quality of food in the supply chain [2], [11], [26].

B. Blockchain Transparency and Donor-Recipient Transaction Traceability

Blockchain technology could help ensure the safety and transparency of transactions related to donations by keeping immutable records. Blockchain systems allow creating a tamper-resistant log of transactions and developing trustless mechanisms, contributing to increased accountability among parties involved. Indeed, research studies support the use of blockchain in promoting auditability and trust within food supply chains despite potential limitations concerning scalability issues, in line with [15], [21], [28].

C. Predictive and Proactive Approaches Using Artificial Intelligence Models

Future developments in such solutions should incorporate machine learning algorithms and even deep learning networks to better predict the level of demand and create proactive approaches towards food redistribution. AI technologies may be used to shift from a reactive approach to proactive food sharing initiatives. Existing literature is supportive of AI optimization of logistics and demand forecast processes , in accordance with [2], [16], [29].

D. Automatic Volunteering and Delivery Planning

There could be developed optimization algorithms aimed at automating volunteer assignment along with aid delivery process. Such AI-driven tool could assist in optimizing travel distance and reducing expenses while enhancing deliverability. It would be especially efficient in case of extensive operations and emergency cases [14], [22], [30].

E. Nationwide Food Redistribution Network

Cloud-based service could be implemented in order to extend the network coverage beyond cities towards nation-wide scope. Cloud computing allows for effective management within the network which increases its efficiency. The experience of digitalization shows that applying cloud technology to food redistribution is very effective in terms of minimizing losses [3], [18], [30].

F. Enhanced Verification and Rating Mechanism

AI can be used in verifying and rating donors, volunteers, and recipients based on their reliability and credibility history. Integration of blockchain and artificial intelligence will enhance the existing identification and anti-fraud methods as well [15], [21], [25].

G. Integration With Government and Welfare Systems

Government agencies, NGOs, food banks, and social services can benefit from using the system to coordinate

food distribution efforts. This can help achieve better coordination between policies and food-related initiatives implemented at national level [11], [12], [27].

H. Mobile-First Development and Offline Functionality

Further development will require mobile-first design improvements aimed at addressing accessibility problems associated with technology illiteracy. Implementation of offline features and streamlined interfaces will allow for wider adoption of the system in poorly connected areas [4], [13], [20].

I. Integration of Food Quality Assessment Technologies

Modern technologies like computer vision and sensor-based inspection techniques may be applied for automatic assessment of food quality. AI-powered image analysis allows detecting food spoilage, contamination or other quality issues, which will lead to improved safety. The integration of advanced technologies for food inspection purposes is already becoming more common; see [2], [15], [29].

J. Future Research Areas

The suggested system provides an avenue for further scientific exploration in the domains of:
Models for predicting redistribution of food
Systems of decentralized donations
Use of AI in humanitarian logistics
Cloud technologies for social benefit automation

ACKNOWLEDGMENT

I would like to express my sincere gratitude to all those who have supported and guided me in the successful completion of my project titled "Food Donation System."
I am thankful to our respected Principal, Head of Department, and project guide for their valuable guidance, encouragement, and continuous support throughout this project work. Their suggestions and motivation helped me complete the project successfully.
I also extend my gratitude to all faculty members for providing the necessary knowledge and resources during the development of this project.

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