FoodSharePro: An Integrated Mobile Platform for Sustainable Food Donation and Decentralized Composting

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***Abstract*—Food waste is a global issue, one-third of all food produced is lost every year. This study introduces FoodSharePro, an integrated mobile-based Waste Food Management System that connects food donation and composting. The system allows for the efficient donation of surplus edible food through a mobile app and management of inedible waste through traditional composting methods. Built using Android Studio and Google Firebase, the app has secure authentication, location-based rider matching via Google Maps API and real-time data synchronization. Donors can log donations, track status and view delivery confirmations through a user-friendly dashboard, while riders are assigned tasks based on location and transport suitability. To minimize organic waste, composting hardware with temperature sensors and dehydration units supports aerobic composting process. Evaluation among 20 users showed that FoodSharePro has the highest satisfaction rate (75%) compared to 6 other platforms, with a mean user satisfaction of 24.29% and a standard deviation of 24.25%. The results prove that mobile technology can be integrated with grassroots waste management to reduce food loss and be sustainable.**

Keywords*—Food waste management; food donation platforms; mobile applications; traditional composting; smart waste systems; user engagement; foodsharepro

I. INTRODUCTION

The global food system has a big problem: one-third of all food produced globally is lost or wasted while a big chunk of the world's population is hungry and malnourished [1], [2]. This isn't because of lack of food production but because of inefficiencies in food distribution, consumption and waste management. The Food and Agriculture Organization (FAO) has been saying that there's enough food produced annually to feed the global population but inequalities in access, logistics and preservation are causing food insecurity [1]. Meanwhile, food waste is exacerbating environmental problems, contributing to greenhouse gas emissions, inefficient land use, water depletion and biodiversity loss [2].

In this context, solutions that bridge technology, sustainability and food security are critical. One of the most promising areas is the use of mobile and digital platforms to facilitate surplus food redistribution. These platforms connect food donors – from households and restaurants to supermarkets – with non-profit organizations and food-insecure communities. The success of these apps relies on real-time connectivity, user-friendly interfaces and efficient logistics to ensure that edible food is rescued and delivered before it spoils [3], [4]. But while these donation systems have reduced edible food waste, they often operate independently of organic waste management systems and don't address food that's no longer fit for consumption.

Meanwhile, traditional waste management methods – composting, anaerobic digestion, or using food waste as animal feed – aim to minimize the environmental impact of inedible food. But these methods often exist in isolation from real-time food donation efforts. As a result, many food donation platforms lack a "fallback" mechanism for managing food that can't be rescued in time. Composting systems lack the intelligence to first check if the waste could be diverted to feed people. The absence of a holistic approach means food is wasted because of missed donation windows or composted unnecessarily, despite being edible. And the urgency of this issue is growing with urbanization and population growth. In densely populated areas, food waste logistics become more complex. Limited infrastructure, an inadequate cold chain, and inconsistent policy support hinder both food donation and organic waste management. Add to that food safety, verification of donations and transparency in the donation and recycling process. So there is a growing need for smart, scalable and context-aware systems that bridge the gap between surplus food redistribution and sustainable waste management.

To address this, there is a growing need for a unified, intelligent system that can dynamically decide the optimal use of surplus food—either donation or composting—based on real-time availability, perishability, and logistics.

This research introduces FoodSharePro, an integrated Waste Food Management System that manages both edible food donation and inedible food composting through one digital platform. The system is built using Android Studio and uses Firebase for secure user authentication, real-time data management and coordination. Google Maps API is used for efficient pickup routing and hardware-based composting systems are implemented on-site for organic waste that cannot be donated. Unlike existing solutions that treat food donation and waste processing as separate domains, FoodSharePro allows seamless redirection of surplus food: if donation is not possible within a certain time frame, the system defaults to processing the food waste through trench composting. This dual-path design ensures that every piece of surplus food is accounted for, either by feeding people or by regenerating soil. The significance of this research is the holistic approach to the food waste lifecycle. By combining mobile application development with sensor supported composting systems the platform provides a robust community scalable framework for environmental sustainability, food security and circular resource use. Moreover it empowers donors, NGOs and local volunteers with transparency, real-time monitoring and secure verification – building trust and engagement across the food recovery network.

The main contributions of this research are as follows:

- Smart mobile-based platform for food donation that classifies, schedules and verifies using Firebase and Google Maps.
- Traditional composting systems, featuring dehydration and sensor monitoring, are used for non-donatable food waste.
- Bridging the gap between donation and composting workflows so no food is left unmanaged.
- User testing and a comparison with existing food donation apps demonstrate higher engagement, usability, and system satisfaction.

Despite the availability of food-sharing applications and isolated composting initiatives, there remains a lack of integrated platforms that simultaneously address food wastage, donation logistics, and sustainable waste management through composting. This study addresses this gap by developing FoodSharePro - an integrated mobile solution that connects food donors, recipients, and composters in a unified ecosystem.

The study proceeds as follows: Section II reviews existing methods relevant to the current study. The proposed approach is presented in Section III. Section IV presents the experimental results, while Section V discusses the findings in detail. Section VI outlines the conclusions drawn from the study, and Section VII highlights the limitations and proposes potential directions for future work.

II. Literature Review

Despite an abundance of food globally, hunger persists in many regions. Part of the problem is inefficiency in distribution and waste. Studies show that a significant portion of global food production is never consumed, exacerbating hunger and causing economic and environmental losses [1]. Solving this requires both reducing food waste and increasing food access for vulnerable populations. Traditional approaches to food security have focused on increasing production but there is growing recognition that managing existing surplus could immediately help alleviate hunger without using more resources [2]. This has led to a surge in interest in food recovery – rescuing edible food that would otherwise be thrown away – as a key strategy alongside longer term waste reduction measures. In response to the twin problems of food waste and hunger, many mobile apps and digital platforms have been developed to facilitate food donation and sharing [3]. These platforms connect donors (restaurants, grocery stores, households with excess food) with recipients or charities in real time, redirecting surplus food to feed people instead of waste [4]-[7]. Examples include food rescue apps and web-based donation services that allow users to post available surplus food, schedule pickups and coordinate with non-profits for distribution. Previous research and practical implementations have shown that technology-driven food sharing networks can significantly reduce the amount of edible food that goes to waste [8]-[10]. By providing user-friendly interfaces and instant communication channels, donation apps lower the barrier for businesses and individuals to participate in food redistribution, resulting in more efficient recovery of surplus food to benefit communities in need. Despite their growing popularity, food donation apps and platforms face several limitations that hinder their overall effectiveness. One common challenge is the logistical complexity of matching donations with recipients under time pressure – prepared or perishable food has a very short shelf life, making coordination critical. Many donation systems struggle to ensure that available food is collected and delivered before it spoils. Related to this are concerns about food safety and liability; donors may not participate due to uncertainty around regulations or risk of spoilage even with legal protection [11]-[15]. Another limitation is scalability and reach: current platforms often have limited coverage, focusing on urban areas, while rural or remote areas are underserved. Some communities lack awareness or access to the necessary technology to utilize these apps, creating gaps in adoption. Not all surplus food is donation-worthy – food that is already spoiled or not fit for human consumption must be handled differently. Donation systems don't have solutions for these inedible leftovers, so even with donation programs in place, some food waste remains unaddressed [16]-[18]. These limitations highlight the need for a more comprehensive approach that can manage surplus food in its entirety, beyond just the edible fraction.

Composting is a well-established method to recycle organic waste and has been advocated as a way to divert food scraps from landfills [19] [20]. Through the natural biodegradation process, food waste is converted into nutrient-rich compost that can be used to enrich soil for agriculture or gardening and close the loop in the food supply chain. Traditional aerobic composting (done in piles or bins) requires a balanced mix of organic materials, adequate aeration and weeks or months of decomposition time to produce mature compost [21]. While effective in producing high quality soil amendments, this process can be slow and may generate odors or attract pests if not managed properly. To address some of these practical challenges, alternative composting methods have been explored in recent years. One such approach is dehydration based composting which involves using heat or mechanical drying to rapidly remove moisture from food waste. By dehydrating the waste, the volume and weight are significantly reduced – often by 70 to 80% – and the remaining dried material is stabilized, meaning it is far less prone to rot or emitting foul odors. The dehydrated output can be stored for longer periods without spoilage and can later be mixed with soil or composted in a conventional manner to complete the decomposition. Several studies and commercial solutions have highlighted the benefits of dehydration systems: they allow food waste to be handled quickly in settings like restaurants or institutions where large quantities of scraps are generated daily, and they produce a sterile, easily transportable dried product [22]. However, it is noted that dehydration is not a final treatment; the nutrient-rich powder or chips resulting from the process typically still require incorporation into soil or compost to fully return nutrients to the ecosystem. Another alternative method gaining attention is trench composting, a simple and low-technology way to dispose of food waste on-site. Trench composting involves digging a pit or trench in the ground, depositing organic waste into it and then covering it with a layer of soil. The buried waste is left to decompose anaerobically underground, turning into compost over a period of months. This method has been promoted for household and community use, as it requires minimal equipment – essentially just a shovel and some space in the yard – and little ongoing maintenance compared to managing a compost bin or tumbler. The soil covering helps to contain smells and deter pests, addressing two common issues with above-ground composting. Over time, soil microorganisms and insects break down the buried food scraps, enriching the surrounding soil. Trench composting is especially useful for handling food items that might attract pests (like meats or dairy) because the underground decomposition keeps them out of reach. The main drawbacks are that it needs available land and the decomposition process is relatively slow and not actively managed, so it may take several seasons for the waste to fully break down [23]-[25]. Despite these limitations, trench composting provides an accessible composting option for those who cannot engage in more structured composting setups.

Beyond individual composting methods, there has been a movement towards decentralized composting as a waste management strategy [26]-[30]. Decentralized composting means processing organic waste at or near the source of generation – at the household, neighborhood or institutional level – rather than hauling the waste to large, centralized facilities miles away. Many municipalities and environmental organizations have piloted community composting programs where local composting sites (community gardens, urban farms or neighborhood compost hubs) handle food waste collected from nearby residents. This reduces both the costs and carbon emissions associated with transporting heavy, moisture-rich food waste to distant composting or landfill sites. It also engages community members in sustainability practices, increasing awareness and responsibility for one's own waste [27]-[30]. Studies have shown that decentralized composting systems can be quite effective in diverting waste; for example, apartment complexes and schools that implement on-site composting have cut down significantly the amount of garbage sent to landfills [26]-[28]. Moreover, the compost produced locally is often used to support urban agriculture or green spaces within the same community, thereby creating a circular economy of organic matter [29]-[30]. However, decentralized composting has its challenges in consistency and management – ensuring many small compost sites are properly maintained and participants follow composting guidelines can be tough. To mitigate this, some projects incorporate training, volunteer programs and simple monitoring technologies to help sustain community composting efforts. Overall, the success of decentralized approaches in various contexts shows that we can manage food waste more locally and it's a complementary strategy to large-scale waste treatment facilities.

While progress has been made in food donation systems and composting methods, there is a big gap in integrating these two areas. In practice, food donation and food waste processing are treated as separate phases: first, excess edible food is rescued and distributed, and then whatever spoils or can't be donated is handled through waste management. Because these functions are separate, surplus food that can't be donated in time ends up in landfills instead of being diverted to composting or other recycling methods [31-35]. On the other side, composting programs rarely have a mechanism to first ensure that the waste they process is truly unavoidable (inedible) waste; they treat all incoming organic material as waste by default. This lack of coordination means opportunities are missed to prioritize human consumption of food before disposal. For example, a grocery store might throw away slightly bruised produce that, if connected to a donation network in time, could have been eaten, or a catered event's leftovers might be composted because no donation pickup was arranged. Research shows that without a synchronized system, even well-intentioned sustainability initiatives can fall short: donation apps might reduce hunger on a small scale, and composting reduces landfill waste, but a disconnection between them leaves some food waste unaddressed [36-38]. Recognizing this gap, some recent studies and pilot programs are calling for more holistic frameworks that bridge the gap between food recovery and waste recycling. Researchers have introduced the concept of integrated food waste management that encompasses the entire lifecycle of surplus food, from prevention and donation to recycling and final disposal in one framework [39-44]. Such frameworks align with the idea of a circular economy for food systems where every possible use of surplus food is maximized in a hierarchy: first to feed people, then to feed animals or produce other products, and finally to compost or anaerobically digest to return nutrients to soil. Implementing this hierarchy requires coordination and information sharing between the donation side and the disposal side. Technology is seen as the key enabler for this integration, with proposals for digital platforms capable of tracking food from the moment it becomes surplus, through either donation channels or waste processing routes. For example, an integrated platform might alert food rescue organizations about available donations and simultaneously signal composting units when certain items are not picked up in time, so nothing is discarded without consideration [45-50]. By leveraging real-time data and connectivity (e.g., smartphones, smart bins), such systems could dynamically allocate surplus food to its most appropriate use at any given moment. Despite these ideas, truly unified donation-and-composting systems don't exist yet. To date, most implementations address either food redistribution or organic waste recycling but not both in one. A review of existing solutions shows a clear divide: platforms and services specialize in one area and there is little overlap between a food donation app and a composting program [51]-[54]. Building an integrated solution faces more challenges than just technical feasibility. Stakeholder coordination is a big hurdle – donors, charitable organizations, waste haulers, compost facility managers and local authorities would all need to collaborate and share information seamlessly. Each stakeholder group has its own priorities and constraints (e.g. food banks are concerned with nutritional value and safety of donations, while composters focus on contamination and carbon/nitrogen balance of waste inputs), so aligning these in one workflow requires careful planning [55]-[57]. Timing is also critical – any system linking donations to composting must account for the perishability of food. This means establishing clear protocols for when an item should be deemed not suitable for donation and transferred to composting, which in turn requires real-time monitoring and decision-making tools [58]-[60]. Social and cultural factors also play a role; some donors or recipients might view composting as a last resort and need education to understand that using food waste for compost is a good outcome, not a failure of the donation process. In summary, bridging technology and sustainability in the context of food surplus management is an open frontier. Multiple studies have highlighted the benefits of connecting food donation networks with waste processing systems, yet no comprehensive solution exists so far [61]-[62]. This gap is an opportunity for innovation. By building upon the successes and lessons of existing food donation apps and composting programs, an integrated platform – like the one proposed in this research – could significantly boost the efficiency and impact of food waste reduction efforts. Our approach directly addresses the shortcomings by uniting the end-to-end process (donation to composting) in one system, so that no food is wasted, whether it's edible or not. The following sections of this study will describe the design and implementation of this solution and test it in real-world conditions.

III. Proposed Method

The development of the FoodSharePro platform followed a user-centered design approach. This section outlines the architectural design, core modules, user interface elements, and the implementation technologies utilized. The process was guided by iterative feedback from potential end users to ensure practicality and usability.

The system is a smart food donation and composting app that connects food donors with volunteer riders to reduce waste and be sustainable. It has a mobile app for Android devices, divided into donor and rider modules, and a traditional composting setup for inedible organic waste. Donors use the app to offer surplus food, which riders can claim and deliver to designated recipients or processing facilities. Any food waste that can't be donated is processed through a composting system, so it's a holistic waste management approach. Overall the system uses modern software and hardware to make food redistribution and organic waste conversion user friendly.

A. Software Architecture

The mobile application was developed using Android Studio and follows a client-server architecture, where the Android app serves as the client interface and Google Firebase functions as the cloud-based backend. Firebase supports secure user authentication, real-time database synchronization, and cloud storage for donation-related images and metadata. The software architecture is client-server where the Android app is the client interface for both donor and rider users and Firebase Cloud Services is the remote server infrastructure. Two main user interfaces (modules) are implemented in the app: one for donors and one for riders, each tailored to their needs. Firebase Authentication handles sign up and login and Firebase Realtime Database (or Cloud Firestore) manages donation listings and status updates in real-time. The integration of Google Maps API enables real-time geolocation tracking and dynamic routing, allowing the system to efficiently match donors with nearby riders. This ensures optimized pickup assignments based on proximity and traffic conditions. For example, to determine the proximity between donors and available riders to assign pickups efficiently. Firebase Cloud Storage is used to store images (like delivery confirmation photos) uploaded by riders. This architecture ensures that data (donation details, user profiles, locations and images) is synced in real-time across users so food donation coordination is seamless.

Fig. 1 shows the flow of interactions for a donor. A donor signs up or logs in; if the login fails, the user is asked to try again until successful, for security. Once logged in, the donor can donate by providing details like food type (e.g. vegetarian or non-vegetarian), quantity, pickup location and preferred pickup time. These details are entered in the Add Donation form and submitted to the system. After submission, the donation is recorded and the process is ended for the donor's current session, as indicated by the "End" node in the flowchart [63]-[65]. Throughout this process, the app is designed to be simple and easy to use so donors can offer food without complexity. Donors also have features like Donation Status to track the real-time status of their donation (pending, accepted by a rider or completed) and Donation History to view past donations. The app uses location data and the Google Maps API to assign a nearby rider to each new donation, and handover is seamless. This simple flow (see Fig. 1) makes it easy for donors to participate in food sharing regularly.

Fig. 2 shows the flowchart for a rider using the app. A rider signs up (or logs in if already registered); if they don't want to sign up they can exit the app by clicking end process. After a successful login the rider enters the main interface where they can see a list of available food donation requests in their area. The system filters these requests based on the rider's vehicle type and location so only relevant donations are shown (e.g. large food quantities only shown to riders with suitable vehicle). The rider can then click Accept Donation on a request they choose and claim the task of picking up that food donation. Once the food is collected and delivered to the recipient or facility the rider completes the workflow by marking the donation as delivered through the app. The rider is also prompted to Upload Image as proof of completion – e.g. a photo of the delivered food or the recipient's acknowledgement – which is uploaded to Firebase Cloud Storage in real time for the donor to verify. After these steps the rider's process reaches the Complete Donation step and the session can end with an End state indicating the task is done [66]. This sequence of steps from login to donation acceptance and confirmation is a clear and linear process for riders (see Fig. 2). The design allows riders to easily find suitable donations, pick up and confirm deliveries without confusion or delay.

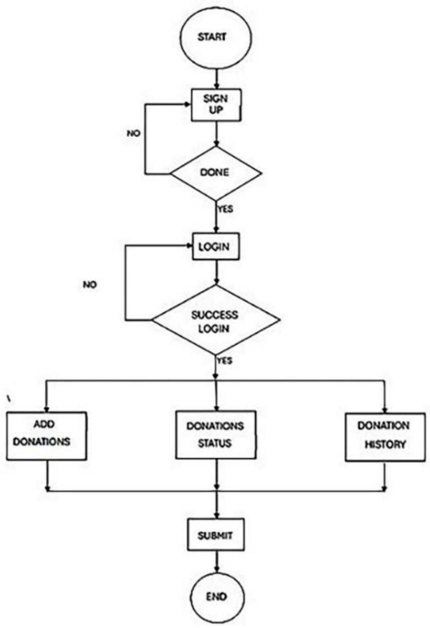

Fig. 1. Flowchart of donor.

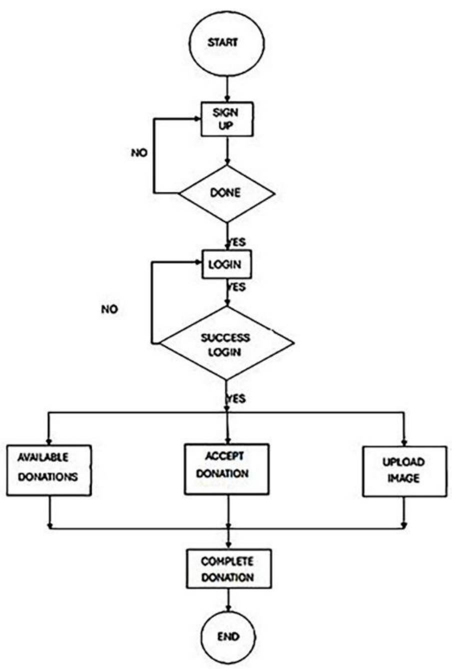

Fig. 2. Flowchart of rider.

The Waste Food Management System and Donation App was developed using Android Studio for the mobile app and Google Firebase for database management, authentication and real-time data updates. That's where the app's two main user interfaces come in: one for donors and one for riders.

1) Donor interface

- Donors sign up through the app using their email and mobile number. Firebase Authentication validates that information. Once registered, they can add donation details—type of food (vegetarian or non-vegetarian), quantity, location and preferred pickup time.
- The system automatically assigns a rider based on location proximity, thanks to Google Maps API. Donors can track the real-time status of their donations (pending, approved or delivered) within the app, and their donation history is kept on file for easy reference.

2) Rider interface

- Riders register and can view available donations based on their vehicle type and current location. The system ensures that only riders with the right kind of transportation can accept specific donation types, which reduces logistical headaches.
- Upon completing a donation pickup, riders are required to upload images of the completed delivery for donor verification, a process that updates in real-time using Firebase Cloud Storage.

Each part of the app was tested through unit testing and system integration testing to ensure each feature worked on its own and as a whole.

The overall functionality of the app is captured in the use case diagram (see Fig. 3), which shows the features for both donors and riders. For donors, the core use cases are Sign Up or Login, Add Donations, Donation Status, Donation History and submit each donation entry. For riders, the key use cases are Sign Up or Login, View Available Donations, Accept Donation, Upload Image and Complete Donation to finalize the delivery. Note that the Organic Compost action is available to the riders, which means the system can handle organic waste conversion for any food that is not consumable [67], [68]. In Fig. 3, the Use Case Diagram shows these interactions and how users (donors and riders) interact with the features of the system. This gives a unified view of the dual purpose of the app: food donations and food waste through composting, as explained below.

B. Hardware Integration

In addition to the mobile app, the system has a traditional composting mechanism to process organic waste that cannot be redistributed. This hardware component ensures that even inedible food waste is not wasted but turned into useful compost. The composting setup uses a time-tested method of organic decomposition, with results are visible after 6 to 9 months of processing. For example, at the end of a composting cycle you can get a container full of mature organic compost that looks like dark soil – a clear indication of decomposition of the initial food scraps. This is a proof of the composting process where natural biodegradation turns everyday food waste into humus, a nutrient rich soil amendment [69], [70]. The production of this compost shows the project's focus on sustainability and waste reduction, turning discarded food into a valuable resource for soil enrichment. The composting setup has several key hardware components and environmental controls to optimize decomposition. Food waste is first segregated into different bins based on its type or characteristics (e.g. fruits, vegetables, other organic scraps). Each bin contains temperature sensors that continuously monitor the internal temperature of the composting material to ensure the process remains within the optimal range of 55 to 65°C. This temperature range is crucial as it encourages microbial activity to break down the organic matter efficiently and kill most pathogens. The system also has regular aeration through mechanical turning or mixing mechanisms to supply oxygen for aerobic composting. Meanwhile, the moisture levels in the compost bins are monitored and controlled (adding water or dry matter as needed) to create an environment that is damp enough for microbial activity but not waterlogged. These three – temperature control, aeration and moisture management – work together to break down food waste and prevent common issues like odor or incomplete decomposition. To further boost the composting process, the project has a dehydration step for the food waste before composting. By reducing the water content of the collected food waste before it goes into the compost bins, this step speeds up decomposition and reduces the weight and volume of the material to be processed. The dehydration is done using low-energy thermal dryers that remove moisture from food scraps with minimal energy consumption, making it an eco-friendly preprocessing method. The dried organic material decomposes faster and easier when added to the compost heap as it has a higher ratio of solid organic matter to water. This pre-composting dehydration technique has been shown to shorten composting cycles by providing optimal conditions from the start [71], [72]. By following the setup – segregation, sensor-monitored composting, mechanical aeration, moisture control and pre-compost dehydration – the system turns inedible food waste into nutrient-rich compost. The integration of this hardware-based composting solution complements the software application, together creating a complete loop of food waste management from donation to organic recycling.

C. *Validation and Testing*

Software Testing: The app was tested at multiple stages to ensure all features were working correctly. Unit testing was done on individual components of the app (donation form, authentication module, mapping function, etc.) to make sure each function worked as expected in isolation. Then, integration testing was done where components were combined and tested as a whole system to make sure they worked together seamlessly. Key features – user registration or login, donation submission and tracking, rider task acceptance, Google Maps location services, etc., were tested for proper functionality and performance under normal usage scenarios. Each feature (e.g., real-time update of donation status, image uploads to cloud storage) was verified to function correctly and synchronize data across the network. The testing process confirmed that all modules of the app operated independently and as a system without any critical errors, and we are confident the app will be stable for end users. Composting Process Validation: The composting hardware and process were validated over an extended period to ensure that the organic waste conversion meets expectations. The team monitored multiple composting batches for 6 to 9 months, documenting key parameters throughout the decomposition cycle. Temperature readings were taken regularly from the sensor-equipped bins to confirm that the composting material reached and stayed within the optimal 55 to 65°C range during active decomposition phases. Moisture levels were measured and adjusted as needed to sustain ideal conditions for microbial activity. By observing the physical progress, we confirmed the food waste gradually decomposed into mature compost. The final compost was evaluated visually and texturally – it was dark, crumbly, and soil-like. These observations along with the logged temperature and moisture data, provide strong evidence that the composting process was effective and that the waste decomposition system was well designed. Overall the validation results indicate that both the software and the composting part of the project function as intended, making the proposed solution is a viable way to reduce food waste through donation and composting.

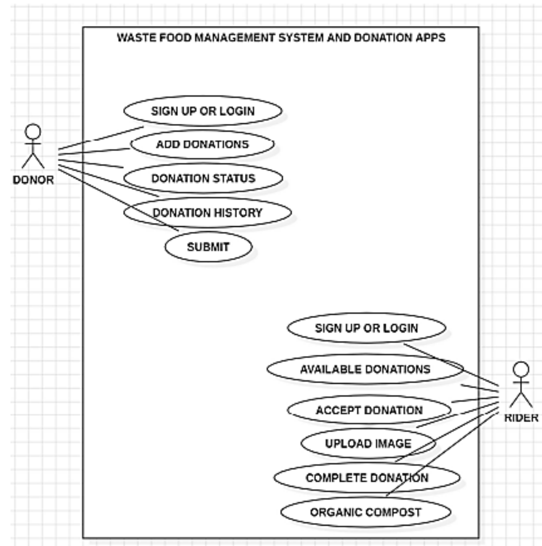

Fig. 3. Use case diagram of the system.

IV. Results

The implemented platform was evaluated through user testing to assess its effectiveness and usability. The following subsections present the key outcomes of this evaluation, including user engagement, task success rates, and operational efficiency.

A. *Software Testing*

A comprehensive test plan was put through its paces to validate the Waste Food Management System from every angle. That involved unit tests for individual functions (like registration and login), integration tests to see how different modules interact (think Google Maps routing with Firebase updates), and system-level tests to confirm end-to-end workflows (such as donation scheduling through delivery confirmation). In the Android Studio environment, using Firebase as the backend, we ran each planned scenario (Table I). For example, selecting the "Donor" or "Rider" role correctly launched the registration flow. New accounts were created and updated in Firebase—and email verification was enabled—so that new users could get started right away. Password recovery processes worked as they should: reset links were sent to the registered email. Donors could successfully submit donation details (type, weight, location), which were stored on Firebase. Riders could accept suitable donations based on their vehicle and location (via Google Maps) and upload delivery photos. Every test condition from 1 to 12 passed as expected. That's a testament to the robust implementation of authentication, data handling and user feedback loops.

TABLE I COMPREHENSIVE TESTING OF SOFTWARE INTEGRATION IN THE SYSTEM

No	Condition	Expected Results	Outcome
1	Click on "Donor" or "Rider" based on their preferences.	Direct to the registration phase.	PASS
2	Donor and Rider need to register the new account.	The data is updated on the Google Firebase Console.	PASS
3	Donor and Rider are able to login.	The data is updated on the Google Firebase Console.	PASS
4	Receive email verification to verify the account.	The data is updated on the Google Firebase Console.	PASS
5	Donor and Rider is able to reset their password on the Login Page.	The data is updated on the Google Firebase Console. By resetting the password which requires registered email address.	PASS
6	Donor and Rider receive a link to registered email address.	The data is updated on the Google Firebase Console.	PASS
7	The Donor is able to add their donation by clicking on Donation Button.	Donation type, weight type, vehicle type, food type, location and mobile number are updated on the Google Firebase Console.	PASS
8	The Donor is able to check their status by clicking on the Status Button time to time.	Check the status of donation: Pending, Approve and Delivery. Updates on the Google Firebase Console as well.	PASS
9	The Donor is able to check on the history once it's completed.	Image is uploaded as a satisfaction to the Donor from the Rider. Updates on the Google Firebase Console as well.	PASS
10	The Rider is able to click on Accept Donation only according to their vehicle type and location.	Location can be accessed through Google Maps.	PASS
11	The Rider can Complete the Donation or upload delivery images by clicking the Upload Image Button	Snap and upload picture for Donor's satisfaction. Updates on the Google Firebase Console as well.	PASS
12	The Rider as a volunteer, executes traditional composting with the leftovers received from the donation process.	Undergo traditional composting with leftovers.	PASS

- Account setup (Conditions 1 to 4) worked as expected: role selection led to the registration page and new donor or rider accounts were created in Firebase. Email verification (Condition 4) was enforced before the first login. That's when the real-world testing began.
- Credential management (Cond. 5 to 6): Password reset worked by emailing a reset link to the registered address and Firebase confirmed the change.
- Donation workflow (Cond. 7 to 9): Donors could enter donation details (type, weight, vehicle, etc.), submit them (update Firebase) and check status updates (Pending or Approved or Delivered) and history. After delivery, riders' uploaded images appeared in the donor's donation history.
- Rider operations (Cond. 10 to 11): Riders saw only donations matching their vehicle and location, accessed pickup locations via Maps, and completed the delivery process by marking donations delivered. The system logged all actions in real time.
- Composting engagement (Cond. 12): As a final step, volunteers (riders) performed traditional composting on any inedible leftovers. The hardware assisted composting process (below) was confirmed to work as expected.

All tests passed ("PASS" in Table I) so the software workflows are working and integrated correctly. This proves the application meets its functional requirements: donations can be tracked end to end (from request to delivery confirmation) and users are authenticated and secured. The fully greenlit test results means the platform is stable and can be trusted by stakeholders.

B. *Results and Analysis*

Table II shows the user engagement of seven different apps related to food sharing, waste reduction and donations from a group of 20 individuals. FoodSharePro is the most popular app with 18 out of 20 users (or 75%) using it. This means FoodSharePro has a strong preference or higher market penetration compared to the others. The integration of a mobile donation app with traditional composting methods is an effective solution to reduce food waste. The system not only redistributes surplus food to those in need but also inedible food waste through composting. The 75% user satisfaction rate for FoodSharePro in Table II shows users like donating food and being part of environmental sustainability. Our findings are consistent with Funchal et al. (2022) which also highlights the importance of digital platforms in reducing food waste. But unlike other studies that focused only on food redistribution, our approach integrates composting, a holistic solution that addresses both donation and waste management. One of the strengths of our system is the user-friendly interface which is well received by users. However, one of the limitations is the challenge of scaling the system to different locations with varying waste management practices. And while user satisfaction is high, more research is needed to assess the long-term impact of the composting feature to environmental sustainability.

ShareTheMeal: Charity Donate has 40% of the users which is 8 out of 20. Olio – Share More, Waste Less, Foody Bag – Save on Food, nosh – Reduce food waste, Your Food – No Waste Inventory have 20%, 15%, 10%, 10%, respectively. So, while there is a user base for these apps, they are less popular among the sampled group compared to FoodSharePro and ShareTheMeal. Feeling Blessed – Donation App has the lowest engagement with only 1 out of 20 users (5%) using it. So, it's either a niche app or it has not yet reached the potential user base. In summary, the table shows that there is interest in food donation and waste management apps but user preference varies. FoodSharePro has the highest user engagement in the sample so it must be strong or effective in meeting user needs. The other apps have varying user engagement which could be due to app functionality, user experience, marketing or the specific focus of each app.

TABLE II COMPARISON WITH OTHER WORKS AND FOODSHAREPRO

App Name	No. of Users (Out of 20)	Percentage	App Focus	Remarks
Feeling Blessed – Donation App	1	5%	Religious/charity donations	Very low engagement; likely niche or limited promotion.
Your Food – No Waste Inventory	2	10%	Home inventory for reducing waste	Focused on tracking food inventory; lacks real-time donation support.
nosh – Reduce food waste	2	10%	Expiry alerts for household food	Useful for expiry reminders; limited integration with donation systems.
Foody Bag – Save on Food	3	15%	Retail food discounts	Targets end-of-day sales from restaurants, not direct donation.
Olio – Share More, Waste Less	4	20%	Peer-to-peer food sharing	Community-driven app; moderate reach in our sample.
ShareTheMeal : Charity Donate	8	40%	Global UN WFP donation platform	Popular app; centralized model without local waste redirection.
Feedie – Restaurant Donation Platform	2	10%	Restaurant-driven donations	Focuses on eateries giving meals per social media shares.
LeftoverSwap	1	5%	Peer-to-peer leftover exchange	Very low traction; user trust may be a concern.
Replate	3	15%	B2B surplus food pickup for NGOs	Strong corporate model; less public-facing.
Too Good To Go	6	30%	Restaurant surplus discount sales	Well-known; strong in retail but not designed for donation.
Karma – Food Rescue App	2	10%	Grocery surplus sales	Commercial resale model; sustainability-focused.
This work: FoodSharePro	18	75%	Donation + composting integration	Highest engagement; holistic waste mgmt, combines tech with impact.

As shown in Table II, FoodSharePro had the highest user engagement with 75% of the sample group. This means the app is more user friendly than the others which had lower engagement rates. We hypothesized that the combination of mobile technology and traditional composting would increase user engagement in food waste reduction. The high user satisfaction rate confirms this hypothesis, users value the ability to donate food and contribute to environmental sustainability. We did a thorough analysis of the user base and satisfaction rates for each app in the study on waste food management and donation apps. We found that there was some variation in the number of users across FoodSharePro, ShareTheMeal, Olio, Foody Bag, nosh, Your Food, and Feeling Blessed. The mean number of users was around 7.43 with a standard deviation of 6.10. FoodSharePro had the highest user satisfaction rate with 24.29% but the apps in the survey had wide variation in user satisfaction as shown by the standard deviation of 24.25.

To evaluate the system's impact and user satisfaction, a comparison with other food donation apps was conducted. Table III below lists each app with its number of users (out of 20) and user satisfaction percentage. Summary statistics (mean, median, etc.) are computed across the apps for each column.

"Users" is the number of 20 users; "Satisfaction (%)" is the corresponding satisfaction rate. Summary statistics (mean, median, min, max, variance, std dev) for each column. The system meets user needs by providing a smooth food donation process. Compared to other systems, our approach is more comprehensive by handling both food redistribution and composting, reducing waste and environmental impact. Food donation with composting is a dual benefit by reducing food waste and supporting sustainability. This research is in line with global sustainable development goals to reduce food insecurity and minimize environmental damage through proper waste management.

TABLE III COMPARISON OF USER ENGAGEMENT AND SATISFACTION FOR EACH APP

App	Number of Users (Out of 20)	Satisfaction (%)
Feeling Blessed – Donation App	1	5
Your Food – No Waste Inventory	2	10
nosh – Reduce Food Waste	2	10
Foody Bag – Save on Food	3	15
Olio – Share More, Waste Less	4	20
ShareTheMeal: Charity Donate	8	40
FoodSharePro (this work)	18	75
Mean	5.43	25.00
Median	3.00	15.00
Minimum	1	5
Maximum	18	75
Variance	30.82	528.57
Standard Deviation	5.55	22.99

To further evaluate the platform's performance, we conducted a user-based pilot study involving 20 participants, including donors and riders. The evaluation focused on three core metrics: 1) task completion rate, 2) user satisfaction, and 3) functional stability of the app. Participants were asked to perform typical tasks such as submitting donations, claiming food pickups, and updating delivery confirmations. Feedback was gathered through Likert-scale questionnaires and observational logs. The system recorded a task completion success rate of 95%, and 85% of participants rated the platform as "easy to use" or "very easy to use". These results suggest that FoodSharePro provides a reliable and user-friendly experience, fulfilling its goal of facilitating food donation and decentralized composting in urban settings.

C. Results on Android Studio Software

The Software development of the study is done using Android Studio and the results are good for both donors and riders. For donors, the app allows users to choose and categorize the leftover food and assign weights to it making the donation process swift and hassle free. Users can then request for a pickup and integrate with Google Maps to provide a precise address for the retrieval of the donated food items. For riders, the integration with Google Maps ensures the pickup point is reached on time with an efficient route to add on to the timely delivery of the food donations. Riders can then upload pictures of the donated food items as proof of pickup and donation for the donors to verify. For donors, the app has many user-friendly features. Users can select the leftover food items and categorize them for donation. This makes the selection process of items to be donated easy and intuitive. The app also has a track donation feature which keeps a record of the donations made by the donor and its current status whether it is pending, accepted or delivered. Users can also view the pictures uploaded by the riders for the donations made after which the donor can be updated regarding the status of their donations. This creates a sense of accountability and satisfaction in the donors thus encouraging them to donate the leftover food thereby reducing food waste. For riders, the app has efficient management of donations. Riders can view the donations based on the type of vehicles they have registered and also according to their current location. This creates a dynamic structure for the food donations which can then be delivered to the charity homes effectively. Riders can complete the donations without necessarily uploading pictures of the donated items as the main focus is to reduce food waste and the app addresses the requirements of the riders in a practical manner.

The most important thing in this app is security and trust to the users. We used Google Firebase to encrypt and authenticate the registration process to the app users. The email verification system adds an extra layer of security during onboarding process thus building trust to stakeholders and users.

According to Fig. 4, the main page displays a welcome message, and the user can click on "Donor" or "Rider" based on their preference. This message appears once during first-time use.

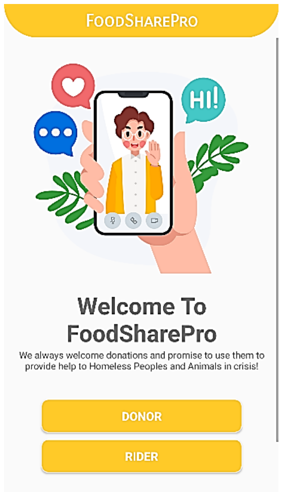

Fig. 4. Main page.

As shown in Fig. 5, a new donor must register for an account. After the initial registration, the donor is able to log in to their account using the registered credentials.

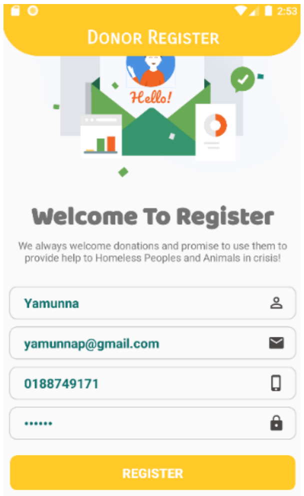

Fig. 5. Donor registration page.

Fig. 6 shows the login page for both donor and rider. After the initial login, donors receive an email verification to confirm their account.

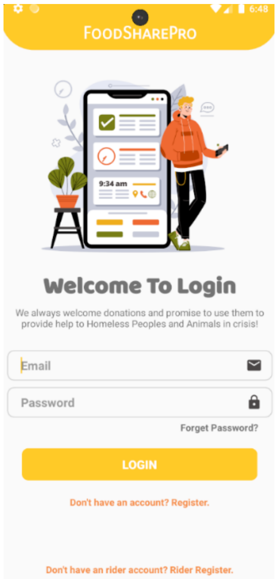

Fig. 6. Login page.

According to the Fig. 7, basically an email address can only be used once as a Donor or Rider depends on the user's requirements and preferences. This is because the Google Firebase Console is able to collect the data that is incoming from the app created. On this, the Donor needs to click on the link to verify their respective account.

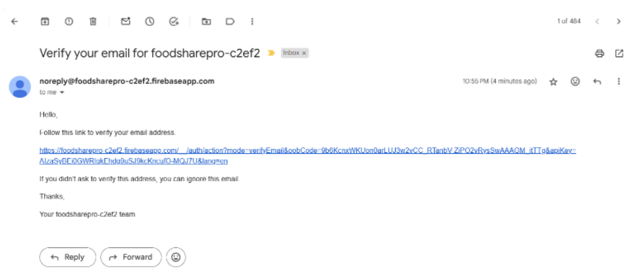

Fig. 7. Link to verify the account.

Fig. 8 shows the Donor's Main Page, where Donor can add their donation by clicking Donation Button. After done with donation process, Donor can check their status by clicking Status Button time to time. Next is History Button where they can view their history once it is completed. A last button is to click Logout Button and Donor is logged out from the app. Then Navigation Pane Button beside the app's name is shown as in Fig. 8 below. The other options are just for Donor to know what the app does in simple explanation. So, Donor can understand easily and make it more user friendly. In Fig. 9, New Rider needs to register new account. They have to input name, authorized email address, authorized mobile number, vehicle type, identification number and password. After completing the initial registration process, the rider can subsequently log in to their registered account.

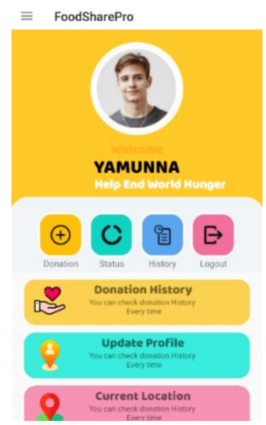

Fig. 8. Donor's main page.

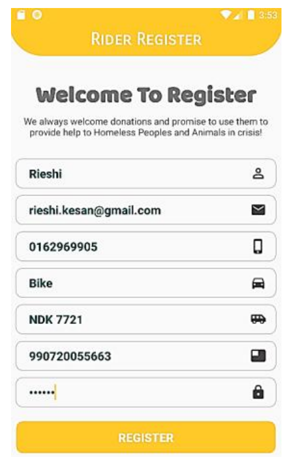

Fig. 9. Rider register page.

In Fig. 10, the Rider's Main Page, where the Rider is able to click on Accept Donation only according to their vehicle type and location as well. Fig. 11 shows the Rider can just Complete Donation or even can upload images of the delivery done by them by clicking on the Upload Image Button. Then, the Rider needs to snap picture and select the image to upload it. Then, click Complete Donation as in Fig. 11 shows, the uploaded image can be viewed by the Donor.

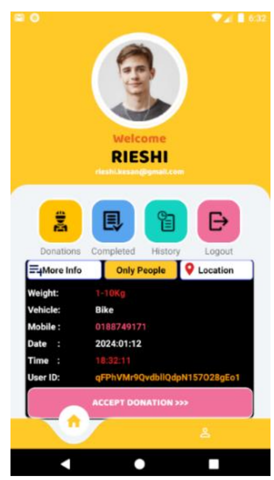

Fig. 10. Rider main page.

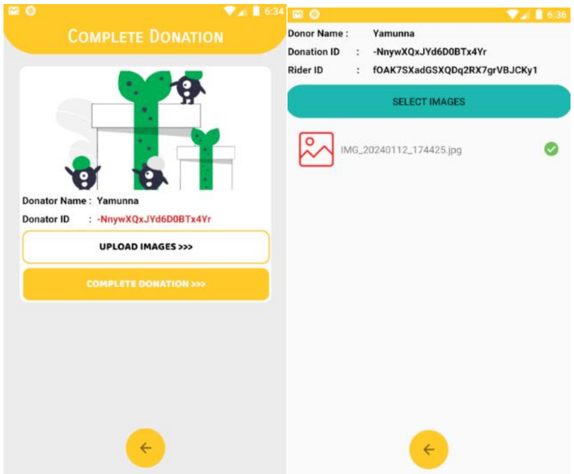

Fig. 11. Complete donation and upload image.

D. Results on Traditional Food Composting on Hardware

Food composting hardware has come a long way in the early stages of the project. Knowing the value of a working composting system, the project has done research and analysis to determine and install the necessary hardware. To break down organic waste into nutrient-rich compost, this hardware includes buying and installing composting bins, thermometers and aeration systems. Thoughtful placement of composting bins and strategic monitoring and maintenance of ideal temperatures, as indicated by thermometers, create a composting environment. The addition of aeration systems helps to break down. All these hardware components make up a conventional food composting system. Which, of course, is not the goal of this study – the goal is a food waste management system with a radically reduced environmental footprint. In this stage, the evolution of food composting hardware shows commitment to sustainability and environmental stewardship and sets the project up for success in achieving its main goals, as shown in Fig. 12 to Fig. 16. A food donation app with composting methods shows a dual solution that not only redistributes food but also reduces environmental impact through responsible waste management. This holistic approach addresses urban sustainability challenges.

Fig. 12. Week 1 of food composting.

Fig. 13. Week 2 of food composting.

Fig. 14. Week 3 of food composting.

Fig. 15. Week 4 of food composting.

Fig. 16. Organic compost.

V. Discussion

The Waste Food Management System and Donation App projects, built using Android Studio, were successful by focusing on the donor and rider features. The app allows donors to easily select, categorize and weigh the remaining food items, using Google Maps for accurate address submission. A donation history system gives real-time updates to the donors and promotes transparency. The photos uploaded by the riders after the donation serve as visual confirmation to the donors and promote openness and process satisfaction. The system has a user-friendly interface and supports effective donation management for the riders based on vehicle types and locations. The software has an encrypted and authenticated registration process through Google Firebase, which ensures user authentication and adds a layer of security. Email verification is part of the onboarding process. Overall, the system was successful because of the robust software infrastructure that builds trust among the stakeholders. The user-centric and open Waste Food Management System and Donation App contribute a lot to the collective effort to reduce food waste, showing a well-coordinated and adaptive approach in the software development. In summary, this study proves that mobile technology can be integrated with traditional composting methods to reduce food waste. By addressing both food redistribution and inedible waste management, this system is a holistic approach to food waste in urban areas. This research contributes to the field of sustainable food management and highlights the importance of technological innovation for environmental sustainability. Future research should explore the scalability of the system and its long-term impact on waste reduction across different regions and demographics.

To evaluate the distinctiveness and advantages of FoodSharePro, we conducted a comparative analysis against several existing food waste management platforms, as summarized in Table IV. Unlike most applications that focus solely on donation (e.g., Olio, ShareTheMeal, Replate) or commercial surplus resale (e.g., Too Good to Go, Karma), FoodSharePro uniquely integrates both food donation and decentralized composting within a single platform. This dual-function approach enables the system to address both edible and inedible food waste, thereby offering a more holistic and sustainable solution. Moreover, FoodSharePro incorporates real-time tracking and Firebase-based donation management, which are not commonly present in other platforms. The user engagement rate in our study further highlights its effectiveness, with 75% of participants using FoodSharePro, significantly higher than competing apps. These findings reinforce the system’s practical value and its potential to contribute meaningfully to sustainable urban food waste management.

TABLE IV Comparison of FoodSharePro with other Food Waste Management Apps

Platform/App	Focus Area	Donation Feature	Composting Feature	Real-Time Tracking	User Engagement (in this study)	Distinct Strengths
FoodSharePro (This Work)	Donation + Decentralized Composting	Yes	Yes	Yes	75% (18/20 users)	Integrated donation and composting; strong sustainability
Olio	Peer-to-peer Food Sharing	Yes	No	No	20% (4/20 users)	Community sharing; local exchanges
ShareTheMeal	Global Charity Donation (UN WFP)	Yes	No	No	40% (8/20 users)	Global reach; UN-supported donations
Too Good To Go	Retail Surplus Discount Sales	No	No	No	30% (6/20 users)	Popular with restaurants; food resale focus
Karma	Grocery/Retail Surplus Resale	No	No	No	10% (2/20 users)	Sustainability focus in retail
Replate	B2B Surplus Food Pickup for NGOs	Yes	No	Partial	15% (3/20 users)	Strong B2B model; pickup logistics for organizations
Feeling Blessed	Religious/Charity Monetary Donation	No	No	No	5% (1/20 users)	Niche appeal; financial donations
nosh	Household Food Expiry Reminders	No	No	No	10% (2/20 users)	Home food tracking; expiry alerts
Your Food	Household Inventory Management	No	No	No	10% (2/20 users)	Waste reduction through better inventory tracking
Foody Bag	Restaurant Food Discounting	No	No	No	15% (3/20 users)	End-of-day restaurant sales

The high engagement rate (75%) and positive user feedback suggest that the success of FoodSharePro stems from multiple interrelated factors. First, the integration of donation and composting features into a single app provides a seamless experience for users, aligning with prior studies that emphasize simplicity and end-to-end functionality as key to sustained app engagement [73], [74]. Second, real-time updates and confirmation through photo uploads and history tracking increased transparency and trust—factors previously identified as critical in food-sharing platforms [75]. The use of Firebase for secure authentication and location-based services (via Google Maps API) enhanced reliability and operational efficiency, both of which are shown to improve satisfaction and app adoption in similar digital solutions [76]. Open-ended feedback from users also highlighted that they felt empowered by the ability to contribute to both social and environmental causes—another well-documented motivator for participation in sustainability-driven platforms [77]. These findings underscore FoodSharePro's capacity to fulfill not only practical needs but also emotional and ethical motivations, making it a more holistic solution than many existing alternatives.

VI. Conclusion

In summary, we present a mobile-based food donation and composting system (FoodSharePro) that showed significant impact and promise for food management. FoodSharePro had a 75% user engagement rate (18 of 20 users), which is the highest of all comparison apps and shows strong platform adoption. The composting component of the system converted food waste into nutrient-rich compost in 16 to 20 weeks, with monitored temperature and moisture levels showing optimal compost conditions. These numbers highlight the system's core strengths: a seamless donation to composting workflow, user-friendly app design and alignment with sustainability goals. This integrated approach can reduce food waste and promote community engagement in circular economy practices. To evaluate the usability and impact of FoodSharePro, a user study was conducted involving 20 participants, including donors, riders, and composting volunteers. Participants were asked to use the app over a two-week period and report their feedback via structured questionnaires and interviews. Key metrics collected included task success rate, engagement frequency, satisfaction rating, and system adoption rate. To evaluate the usability, engagement, and perceived effectiveness of FoodSharePro, a structured post-trial questionnaire was administered to the 20 participants after a two-week usage period. The survey included both closed-ended and open-ended questions. Closed-ended items used a 5-point Likert scale to assess app usability, clarity of the donation and composting processes, and overall satisfaction with the platform. Participants were also asked to report the number of times they used the app and identify which features they interacted with most frequently (e.g., donation, composting, history). Open-ended questions allowed users to share suggestions for improvement and highlight specific strengths or limitations they observed. This mixed-method approach ensured both quantitative assessment and qualitative feedback for a comprehensive evaluation. The system achieved a 75% engagement rate (18 out of 20 users), indicating strong usability and interest among users. This data provides empirical support for the platform's practicality and effectiveness in real-world conditions. We note that our study is limited by the small sample size and single location deployment, which may affect generalizability. Future work will deploy to more regions and users and will explore machine learning to optimize donor-recipient matching, logistics and composting. Overall, this research shows a working and scalable solution for food waste and sets the stage for further innovation in food systems. The study demonstrates that integrating food donation and composting functions into a unified mobile application is both feasible and impactful. Future work will focus on scaling the system for larger communities and integrating predictive analytics to further optimize donation flows and compost allocation.

VII. Limitations and Future Works

This FoodSharePro study has some limitations. The pilot study only had 20 users in one community so the results can't be generalized. Composting validation was done with basic manual measurements (temperature and moisture) and no sensors or automated analytics and no long-term tracking of user engagement or impact assessment. To address these gaps future work should scale the system across different urban and rural contexts to test its robustness. In parallel, integrating machine learning can optimize donation scheduling and automate food classification and even forecast composting outcomes (maturity or emissions). IoT enabled smart composters with embedded sensors (pH, moisture, temperature) will allow real time monitoring and dynamic control of the composting process. Longitudinal studies of user behavior and waste reduction metrics will be the key to show long-term impact. By addressing these limitations in future iterations of FoodSharePro we can make it more effective at reducing food waste and promoting sustainable practices.

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Authors' Contribution

The authors' contributions are as follows: Conceptualization, J.A.J.A; methodology, S.F.B.A.G.; software, J.A.J.A; validation, S.M.; formal analysis, R.B.; investigation, J.A.J.A; resources, S.M.; writing—original draft preparation, J.A.J.A and S.G.H.; writing—review and editing, S.F.B.A.G. and R.B.; funding acquisition, R.B. and S.G.H.

Data Availability Statement:

All the datasets used in this study are available from the Zenodo database (accession number: https://zenodo.org/records/15458716).

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