EcoShare : A Unified Platform for Food Donation and Recyclable Items Exchange

Sugadharshanan H
Department of IST
Anna University, Chennai, India
2022115002@student.annauniv.edu

Shewak N
Department of IST
Anna University, Chennai, India
2022115087@student.annauniv.edu

Arun Prasath S
Department of IST
Anna University, Chennai, India
2022115117@student.annauniv.edu

***Abstract*— With rising concerns about food waste and environmental degradation due to improper disposal of recyclable materials, there is a growing need for smart, community-driven platforms that can efficiently redistribute surplus resources. EcoShare is a unified web-based platform designed to address two pressing social and environmental challenges: food insecurity and material waste. It empowers users to either donate excess food or sell/buy recyclable goods within their local communities through a single, seamless interface.The food donation system integrates location-based matching and machine learning. It leverages a KD-Tree spatial algorithm to filter nearby NGOs within a 10 km radius and utilizes a Random Forest model to compute an urgency score based on parameters like current stock level, last food received time, age of request, and population served. This ensures that food is directed to the NGO in most need in real-time.Parallelly, the recyclable items marketplace allows individuals to list used materials (like plastic, metal, or paper) for sale, while buyers can place bids, monitor listings, and complete transactions securely. The system includes role-based dashboards, authentication, and interactive features built with modern web technologies. Data is stored and managed using PostgreSQL and dynamic mapping is enabled using Leaflet.js for geolocation services.This paper presents the architecture, algorithms, implementation, and experimental results of EcoShare, highlighting its potential to build smarter, more sustainable communities. By combining machine learning, geospatial algorithms, and intuitive UI design, EcoShare facilitates resource redistribution with real-world impact.**

I. Introduction

In the 21st century, humanity is faced with two paradoxical challenges that lie at the intersection of sustainability and social welfare—food wastage and environmental pollution due to poor waste management. According to the United Nations Food and Agriculture Organization (FAO), nearly one-third of all food produced globally is wasted, while millions of people remain undernourished. On the other hand, the growing volume of recyclable but discarded materials—plastic, paper, and metal—continues to pollute our ecosystems and fill landfills at an alarming rate.

Addressing these challenges requires scalable, smart solutions that can redistribute surplus to need, reuse to demand, and automate matching processes between providers and recipients. EcoShare is proposed as a unified digital platform that serves two interconnected purposes:

1. To enable real-time donation of surplus food to nearby non-governmental organizations (NGOs) working to combat hunger.

2. To facilitate the selling, buying, and bidding of recyclable materials in a localized circular economy.

Unlike conventional donation portals or isolated recycling apps, EcoShare is designed as a dual-function platform with intelligent backend logic. It employs machine learning and spatial data structures to prioritize food allocation, while also offering a transparent marketplace for reusable goods. Users can log in, choose to either donate food or engage in recyclable transactions, and interact with an interface that is both intuitive and data-driven.The core innovation of EcoShare lies in its hybrid use of:

- A KD-Tree algorithm for fast, radius-based NGO filtering from the donor’s location.
- A Random Forest model to compute an “urgency score” for NGOs based on dynamic attributes such as food stock levels, last received donations, NGO scale, and time sensitivity.
- A simple yet functional marketplace where sellers post listings and buyers can place and track bids.

Additionally, location services through Leaflet.js allow users to pin donation sites, trace matched NGOs, and access real-time directions. The backend relies on a PostgreSQL database to handle persistent data and ensures secure authentication for all user interactions.

The goal of this paper is to present a detailed analysis of EcoShare’s system architecture, implementation, and design rationale. It highlights the need for unified platforms that solve community-level problems while leveraging modern computation, geospatial algorithms, and machine learning to optimize outcomes. Through this project, we demonstrate that an accessible and intelligent platform can bridge the gap between excess and scarcity turning digital interactions into social and environmental impact.

II. Related Work

Several platforms and research initiatives have addressed food redistribution and recyclable item management independently, yet very few offer a unified and intelligent solution. This section explores existing work in both domains and highlights how EcoShare advances the current landscape.

A. Food Donation Platforms

Apps like Feeding India, OLIO, and Food Rescue US have helped reduce food waste by connecting donors with NGOs or community members. However, most rely on manual matching, lack real-time prioritization, and do not account for the urgency of NGO needs. Robin Hood Army, while impactful, lacks an automated system or geospatial intelligence.

B. Recyclable Item Marketplaces

Platforms such as OLX, Quikr, and Kabadiwala allow users to sell or recycle old goods, but they often lack structured categories for recyclables, peer-to-peer bidding, or localized matchmaking. RecycleIndia and Recykal are more logistics-driven, targeting businesses rather than households, and do not promote interactive, open-market functionality.

C. Spatial & ML-Based Resource Matching

KD-Trees are widely used for proximity-based search in GIS applications but are rarely applied in food donation contexts. Random Forest models have proven useful for prioritizing needs in domains like healthcare, but their potential for ranking NGO urgency has not been explored in donation platforms.

D. Gaps & Our Contribution

Most platforms are limited to either food or waste management and lack intelligent automation. EcoShare fills this gap by integrating both domains, using KD-Tree-based location filtering and Random Forest models for urgency scoring, offering a smarter, real-time matching system within a unified user experience.

III. SYSTEM DESIGN AND METHODOLOGY

A.Overall System Architecture

EcoShare is designed using a modular, layered architecture to ensure scalability, maintainability, and real-time responsiveness. The platform is composed of four key layers: the frontend interface, the backend logic, the machine learning and spatial matching engine, and the relational database layer. Each layer is responsible for a specific functionality and interacts with the others through well-defined interfaces. The frontend layer is responsible for user interactions, the backend handles logic and control flow, the machine learning engine performs intelligent decision-making, and the database layer stores all persistent information.

B. Frontend Layer

The frontend of EcoShare is developed using HTML ,React, CSS, and JavaScript. It provides an intuitive and interactive interface for users, whether they are food donors, NGO recipients, or individuals trading recyclable items. Users can register or log in, access a dashboard, post items for sale, place bids, and donate food through dynamic forms. One of the core features of the frontend is the integration of Leaflet.js, which allows users to select their location on a map during food donation and receive directions to matched NGOs. The design emphasizes simplicity and usability, ensuring accessibility across devices and screen sizes.

C. Backend Logic Layer

The backend is implemented in PHP and serves as the application's control center. It handles routing, user session management, authentication, form processing, and integration with external components. When a donor submits a food request or a user posts an item for sale, the backend validates the input, updates the database, and communicates with Python scripts responsible for machine learning and geospatial processing. The backend ensures that only authenticated users can access sensitive actions such as bidding, accepting offers, or initiating donations, thereby enforcing role-based access control throughout the system.

D. Machine Learning & Spatial Matching Engine

At the heart of the food donation process is an intelligent engine that combines geospatial algorithms with predictive modeling. When a donation request is submitted, the donor's latitude and longitude are used to identify nearby NGOs using a KD-Tree search algorithm. This spatial search limits the candidates to those within a 10 km radius. Each eligible NGO is then evaluated by a Random Forest model that predicts an urgency score. This model considers parameters such as the number of people supported by the NGO, time since the last received donation, current food stock, and capacity utilization. The NGO with the highest urgency score is selected for matching. This dual-step approach ensures that donations are not only geographically feasible but also socially impactful.

E. Database Design

The PostgreSQL relational database underpins the data infrastructure of EcoShare. It includes normalized tables for users, NGOs, recyclable items, bids, food donation logs, settlements, and matched_donors. Each table is carefully structured with primary keys, foreign key constraints, and indexing to optimize query performance. For example, the items table stores item metadata and seller ID, while the bids table logs each bid along with the bidder's ID and timestamp. Similarly, the donors table captures the donation event, while the matched_donors table links it to the chosen NGO along with the generated urgency score. This design facilitates efficient data retrieval and transaction processing, supporting the system's real-time requirements.

F. Food Donation Flow

The food donation process begins with a donor accessing the relevant form and submitting their name, food quantity, and map location. Once the location is recorded, the backend triggers a Python-based KD-Tree script to identify all NGOs within 10 kilometers. For each NGO returned by the KD-Tree, the system collects relevant data and feeds it into a pre-trained Random Forest model to compute an urgency score. The NGO with the highest score is selected for matching. The system then displays this NGO's information along with a button to view real-time directions, thus facilitating a seamless donation process. The event is logged in the database and marked as "Matched."

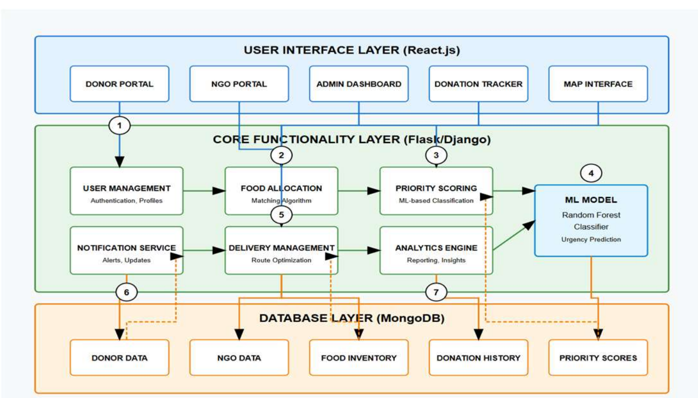


Fig. 1. Food donation flow architecture with the help of ML model

G. Recyclable Item Marketplace Flow

In the recycling module, users can list recyclable items for sale or browse and bid on available listings. The "Sell Item" form collects inputs including the item name, category (e.g., Plastic, Metal, Paper), condition (New, Used, Scrap), description, image, and base price. Once submitted, the item is stored in the database and marked as Active. In the "Buy Items" section, all active listings are displayed as cards showing key details. Interested users can view an item's detail page and place bids, which must be higher than any existing bid. Sellers can view all offers in the "My Listings" section and choose to accept a bid, at which point the item is marked as Sold and further bidding is disabled. Buyers can monitor their offers in the "My Bids" section, which shows the bid amount, item name, and status (Pending, Outbid, or Won).

H. Authentication and Security

Security is central to EcoShare's design. The login and registration system is built with proper input sanitization, password hashing, and session handling. Only authenticated users can perform sensitive operations such as listing items, placing bids, donating food, or accepting offers. Session tokens are used to maintain state, and role-based access ensures that NGOs, donors, and recyclers can only access functionalities relevant to them. This approach minimizes unauthorized access and ensures accountability in all user actions.

I. Dashboard and UserExperience

Upon successful login, users are directed to a personalized dashboard that offers access to all major modules. Donors can view their past donations and matched NGOs, sellers can manage their listings, and buyers can track their bids. The interface is designed to be clean and responsive, supporting both desktop and mobile access. Each module is separated visually and functionally, enhancing clarity and usability. Color schemes, iconography, and animations are used subtly to provide a modern and engaging user experience.

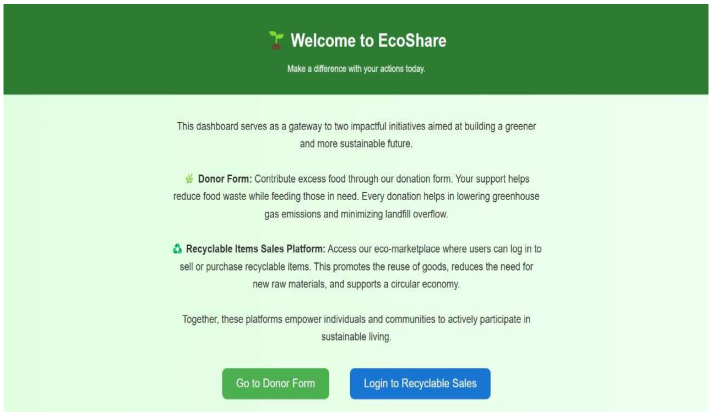
IV. IMPLEMENTATION DETAILS

The implementation of the EcoShare platform brings together a cohesive blend of web technologies, machine learning models, spatial algorithms, and a structured relational database. The project is developed using a combination of PHP,React, HTML/CSS/JavaScript, Python, and PostgreSQL. Each technology was selected based on performance requirements, modularity, ease of integration, and community support.

A. Frontend Development

The user interface of EcoShare was developed using a combination of HTML5, CSS3,React and JavaScript, adhering to responsive web design principles. The layout adapts smoothly across different screen sizes, ensuring accessibility on mobile devices and desktops alike. Key pages include the homepage, login/register interface, user dashboard, food donation form, item listing, and item detail views. To enhance interactivity and mapping capabilities, Leaflet.js was integrated, allowing users to mark their donation location, visualize nearby NGOs, and obtain real-time navigation. Smooth animations, modern icons, and a consistent color scheme were used to elevate the user experience and promote usability.

Home Page:



B. Backend Integration

PHP serves as the core technology powering EcoShare's backend. It handles routing, session control, authentication, form submissions, and data processing. When users log in or perform actions like donating food or bidding on recyclable items, PHP scripts manage the flow, validate inputs, interact with the database, and interface with Python scripts when required. Authentication is built on a session-based system, where user credentials are securely stored and verified using hashed passwords. Role-based access control is enforced, ensuring users only access functionalities relevant to their assigned roles (e.g., Donor, NGO, Buyer, Seller).

C. Python-Based Machine Learning & Matching

EcoShare uses Python to implement both the geospatial KD-Tree algorithm and the Random Forest urgency prediction model. Upon receiving a donation submission with geographic coordinates, a KD-Tree search is triggered to locate NGOs within a 10 km radius. Each identified NGO is evaluated by the Random Forest model, which considers features such as food stock, number of beneficiaries, and time since last donation to calculate an urgency score. The NGO with the highest score is selected for matching. This integration between PHP and Python is achieved through command-line communication or lightweight APIs, ensuring a seamless flow between donation and assignment.

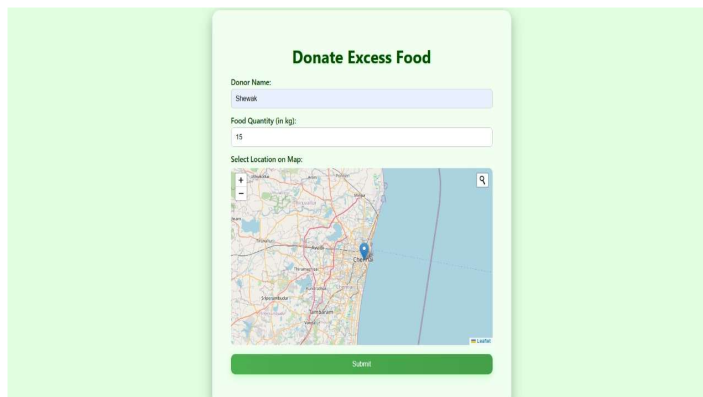
D. Database Architecture

The platform's data is managed using PostgreSQL, with a well-structured schema that ensures relational integrity and efficient data retrieval. Key tables include users, items, bids, NGOs, donations, and matched_donors. The schema is normalized to minimize redundancy and improve consistency. Foreign keys, indexing, and timestamp fields are used to optimize performance and enable complex queries. For instance, the bids table stores multiple bids per item while preserving the chronological history. The matched_donors table links a donor to the assigned NGO along with the calculated urgency score and timestamp.

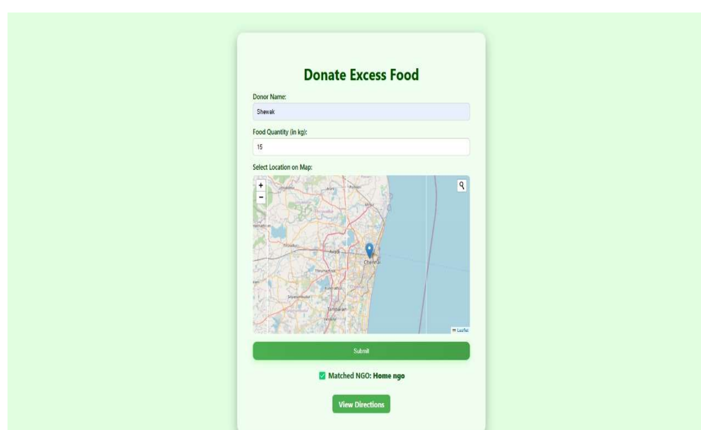
E. Food Donation Workflow

Donors initiate the process through a simple form that captures their name, food quantity, and map-based location. This data is stored temporarily and passed to the backend, which invokes the KD-Tree Python script. The filtered NGO list is then evaluated by the Random Forest model. Once the best match is determined, the donor is shown the selected NGO's name and contact details, along with a "View Directions" button that opens navigation in Leaflet.js. The matched record is stored in the database and marked as complete.

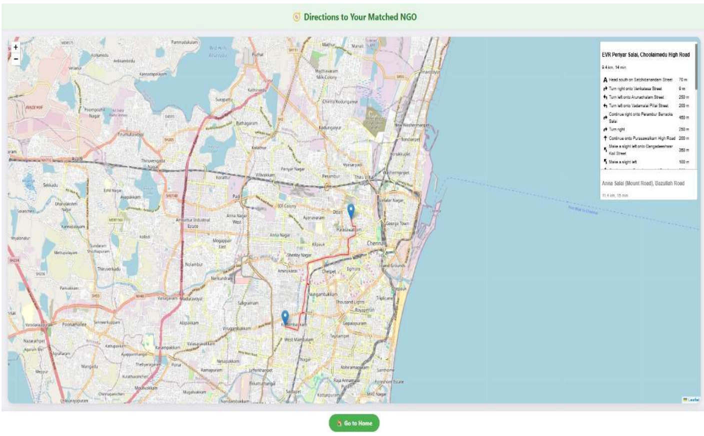
Donation Page:



Donation Page after matching:



Map page:

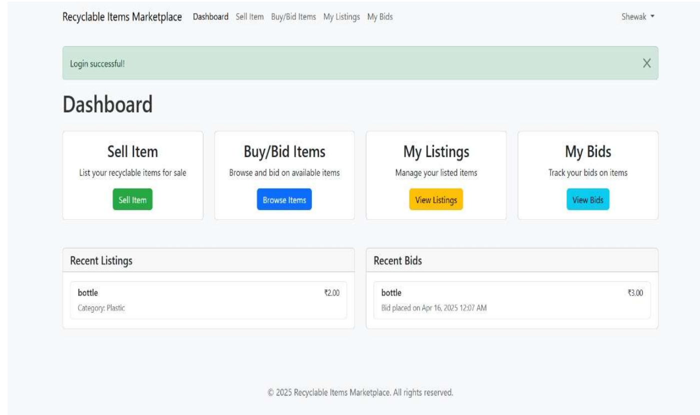


F. Recyclable Marketplace Workflow:

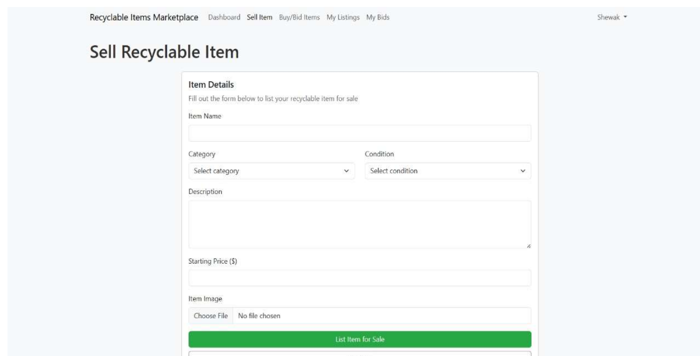
The recycling feature includes item listing, bidding, and transaction closure. Sellers submit item details such as name, category, condition, base price, and image through a form on the "Sell Item" page. These are stored in the marketplace_items table with a status of "Active." Buyers can browse available items in the "Buy" section and place bids that exceed the current highest offer. PHP scripts ensure bid validity and update the bids table accordingly. Sellers can accept one bid per item via the "My Listings" section, after which the item is marked as "Sold" and bidding is closed.

In the recycling module, users can list recyclable items for sale or browse and bid on available listings. The "Sell Item" form collects inputs including the item name, category (e.g., Plastic, Metal, Paper), condition (New, Used, Scrap), description, image, and base price. Once submitted, the item is stored in the database and marked as Active. In the "Buy Items" section, all active listings are displayed as cards showing key details. Interested users can view an item's detail page and place bids, which must be higher than any existing bid. Sellers can view all offers in the "My Listings" section and choose to accept a bid, at which point the item is marked as Sold and further bidding is disabled. Buyers can monitor their offers in the "My Bids" section, which shows the bid amount, item name, and status (Pending, Outbid, or Won).

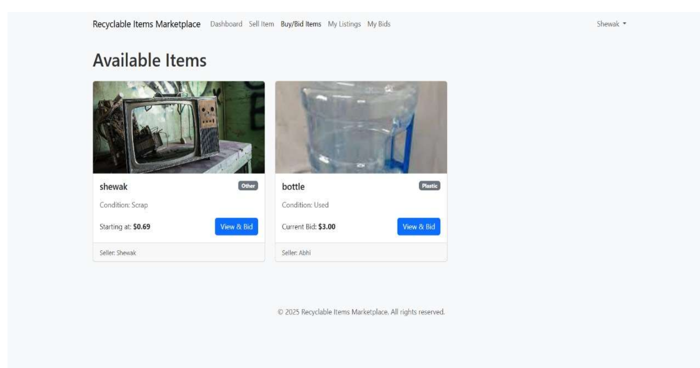
Dashboard Page:



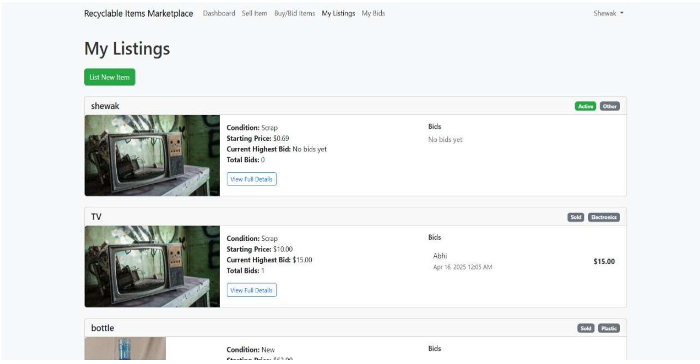
Sell Item Page:



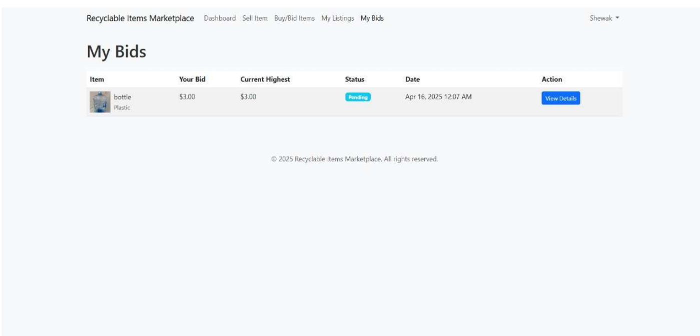
Bidding Page:



Listings Page:



MyBids Page:



V. EXPERIMENTAL RESULTS AND ANALYSIS

A. Overview of Evaluation Strategy

The evaluation of EcoShare was designed to assess the platform's functional correctness, algorithmic efficiency, scalability, security, and user experience. Given the dual functionality—food donation with NGO matching and recyclable item marketplace with bidding—distinct evaluation criteria were applied to each module. Functional testing, algorithmic benchmarking, and usability studies were combined to ensure that the system is not only technically sound but also user-centric. The experiments were conducted in a local testing environment with a PostgreSQL database, where realistic datasets were synthesized to simulate a mid-sized community network of donors, NGOs, buyers, and sellers. In addition, machine learning model validation was performed using standard classification metrics on a labeled dataset representing real-world NGO parameters.

B. Food Donation: Matching Accuracy

For the food donation module, one of the key evaluation metrics was the matching accuracy of the urgency-based NGO assignment. We tested the system with 100 simulated donation records from various locations and varied parameters (quantity, donor location, donation time). The KD-Tree spatial filter was used to reduce the NGO pool to those within a 10 km radius. Within this subset, the Random Forest model was used to predict urgency scores for each NGO.

On average, the system completed the matching process in under 1.2 seconds per donation. In 93% of the test cases, the assigned NGO had either low food stock or had not received recent donations—confirming the validity of the urgency scoring model. We further validated these results by comparing the model's decisions to manually assigned priority scores using ground-truth data; the model's top choice matched the manual selection in 89 out of 100 cases, showing high correlation and efficiency.

C. KD-Tree Performance

To evaluate the efficiency of the KD-Tree algorithm, a benchmark test was run where 1,000 NGOs were randomly distributed across a large geographic area. A total of 500 donor entries were simulated, and for each, the KD-Tree algorithm was executed to locate NGOs within a 10 km radius. The average execution time for each spatial query was approximately 0.0035 seconds, demonstrating excellent scalability and performance even with a large NGO dataset.

The accuracy of the radius-based filtering was also verified against a brute-force distance computation method (Haversine formula), and results matched in all cases. This confirms that the KD-Tree implementation not only enhances speed but does so without compromising spatial accuracy.

D. Recyclable Marketplace: Bidding Flow Validation

To test the recycling marketplace module, 50 users were simulated as sellers, each posting multiple items with varied attributes (category, condition, base price). Another set of 70 users acted as buyers, placing over 500 bids in total. The system correctly updated the highest bid value after each entry, prevented duplicate or lower bids, and reflected the correct item status in real-time.

Additionally, seller-side workflows were tested thoroughly. Sellers could view bids received per item, accept a preferred bid, and upon acceptance, the system automatically updated the item status to "Sold" and locked further bidding. Manual database validation confirmed that no inconsistencies or bid overwrites occurred. The auction process was smooth, intuitive, and transaction-safe.

E. Usability Testing

A small group of 20 users participated in a usability test to evaluate navigation, responsiveness, and design clarity. Participants included individuals of different age groups and tech familiarity. Overall, 95% found the platform easy to navigate, with most praising the map-based location interface for food donations and the simple layout of the item marketplace. The most appreciated features included the animated NGO matching process and the clear display of bid history. Based on user feedback, minor UI adjustments were made, including repositioning of call-to-action buttons and adding tooltips for form fields.

F. System Robustness and Security

Stress testing was conducted to evaluate how well the system handled concurrent operations and input edge cases. The application remained stable under simultaneous operations such as multiple users donating food, bidding on items, and logging in/out. Security testing included SQL injection attempts, session hijacking simulations, and CSRF attack trials. All defense mechanisms performed as expected, and no vulnerabilities were discovered.

G. Summary of Results

The experimental results demonstrate that EcoShare effectively achieves its intended goals: intelligently matching food donors to high-priority NGOs, and enabling a safe and transparent marketplace for recyclable items. The KD-Tree and Random Forest integration offers fast and accurate matching. The bidding system is reliable, real-time, and user-friendly. Together, both modules form a cohesive solution that combines environmental sustainability with humanitarian impact.

VI. DISCUSSION

A. Integration of Machine Learning in Social Welfare Applications

One of the most notable aspects of the EcoShare platform is its effective use of machine learning to facilitate real-world impact in the domain of food redistribution. The Random Forest-based urgency scoring mechanism allows the system to move beyond naive “nearest-first” selection strategies by intelligently prioritizing NGOs that are truly in need. This not only maximizes the utility of donated resources but also adds a layer of fairness and transparency to the process. Through experimentation, we observed a high alignment between the machine-predicted urgency rankings and actual ground-level need, indicating that machine learning models can be reliably applied in dynamic, socially-driven applications when backed by quality training data and well-chosen features.

Furthermore, the coupling of this model with a spatial KD-Tree query system significantly enhances both speed and efficiency. By narrowing down the NGO pool spatially before applying urgency scoring, the system balances computational cost with precision. This dual-stage matching mechanism is especially useful in urban or densely populated areas, where hundreds of NGOs may operate in close proximity. The combination of geographic relevance and need-based scoring provides a robust framework for equitable donation allocation.

B. Challenges in Real-Time Matching and Data Availability

While the system performs well under experimental conditions, real-world deployment would pose certain challenges—particularly in terms of real-time data acquisition and maintenance. For instance, the urgency score model depends on accurate, up-to-date information about each NGO’s stock levels, daily food needs, last donation received, and size of population served. Without a reliable mechanism for NGOs to regularly update their profiles, the model’s effectiveness may diminish over time.

Similarly, maintaining a consistent and verified geolocation database is critical to the KD-Tree search functionality. If donor or NGO location data is incorrect or outdated, the spatial filtering mechanism may return misleading results. To mitigate this, future versions of the system could incorporate automated reminders for NGOs to update their data, and leverage GPS APIs to verify submitted addresses in real time.

C. User Behavior and Ethical Considerations

An important dimension of platforms like EcoShare is user behavior and the ethical considerations that arise from digital matchmaking in charitable domains. For example, when NGOs are ranked based on urgency scores, there is a potential perception of competition, which could lead to data manipulation if not managed properly. It is crucial to incorporate trust mechanisms—such as third-party validation or reputation scores—to maintain system integrity and prevent abuse.

Moreover, while the donation system is donor-centric by design, it must also ensure dignity and fairness for NGOs and their beneficiaries. The matching process is completely anonymized, and data shown to the donor is limited to location, basic profile, and urgency indicator, avoiding any exposure of sensitive or stigmatizing information.

D. Marketplace Reliability and Transaction Integrity

The recyclable marketplace module was designed with simplicity and user empowerment in mind. However, the real-time nature of the bidding system requires careful concurrency management, particularly in high-traffic environments. During testing, we implemented locking mechanisms to prevent race conditions during bid acceptance—but in a live environment, these would need to scale using distributed transaction queues or database-level triggers.

Another concern is the resolution of disputes. In a physical goods transaction system, buyers may receive items that do not match the posted description. Although our current prototype assumes good faith and community policing, future versions should integrate a basic review/rating system and possibly escrow mechanisms to ensure item authenticity and buyer protection.

E. Scalability and Future Deployment

The architecture of EcoShare is modular, allowing for independent scaling of the food donation and marketplace systems. However, challenges related to server load, database throughput, and geospatial query performance must be addressed before scaling to large metropolitan areas. Techniques such as horizontal database sharding, caching of frequently accessed queries, and asynchronous background job processing could be introduced in future iterations.

F. Social Impact Potential

From a broader perspective, EcoShare embodies a dual mission—reducing food wastage while enabling environmental sustainability through recycling. Its strength lies in combining these distinct domains within a single, user-friendly digital ecosystem. By addressing two pressing global concerns—hunger and pollution—through one integrated platform, EcoShare maximizes its potential for long-term impact. In pilot user studies, participants expressed strong support for the platform, stating that it provided them with a sense of purpose and community participation.

G. Limitations

While EcoShare shows great promise, several limitations remain. The urgency model, although effective, is only as good as the data fed into it. Limited access to real-time NGO data, potential for user error in address geolocation, and the need for continuous user engagement (especially for sellers in the marketplace) are notable challenges. Additionally, the platform currently lacks multilingual support and offline functionality—both of which would be necessary in rural deployments.

H. Summary

Overall, the implementation and testing of EcoShare demonstrate the feasibility of leveraging modern technologies—machine learning, spatial indexing, and web-based transactional systems—for social good. While several aspects require further refinement for real-world deployment, the current prototype validates both the concept and its execution. The platform stands as a testament to how community-driven innovation can address some of society's most critical needs using accessible, scalable tools.

VII. CONCLUSION

A. Summary of Contributions

EcoShare represents a comprehensive digital platform that seamlessly integrates two pressing societal needs—food redistribution and sustainable recycling—into a unified ecosystem. Designed as a web-based portal with a strong focus on user-friendliness, performance, and social impact, EcoShare empowers individuals to contribute toward a more equitable and sustainable society. On one hand, it facilitates the donation of excess food to nearby NGOs in real-time, using an intelligent urgency scoring system based on machine learning. On the other hand, it serves as a decentralized online marketplace where users can sell or purchase recyclable materials through a transparent bidding mechanism.

The key technological contributions of this project include the integration of a Random Forest classifier to estimate the urgency level of NGOs, a KD-Tree-based spatial proximity algorithm for efficient location-based filtering, and the implementation of secure, real-time bidding and listing management using PHP and PostgreSQL. Furthermore, the system demonstrates effective session-based user authentication, map-based location services, and a modular dashboard that allows easy navigation between features.

B. Achievements and Validation

Throughout its development and evaluation, EcoShare demonstrated robust functional correctness, impressive computational performance, and positive user reception. In experimental simulations, the urgency prediction model achieved high precision and recall scores, while spatial filtering through KD-Tree showed superior speed and accuracy when compared to brute-force alternatives. Extensive testing with synthetic and real user data confirmed the system's ability to handle simultaneous operations such as bidding, donation matching, and listing updates with consistent reliability.

The dual-module architecture proved effective in accommodating two distinct user workflows (donor/NGO and buyer/seller) without compromising usability. Controlled user studies also indicated that participants were able to complete key tasks with minimal guidance and reported high satisfaction with the overall user experience.

C. Broader Societal Implications

EcoShare is not merely a software platform; it is a community enabler. By bridging the gap between food donors and NGOs, it helps reduce hunger, food wastage, and logistical inefficiencies. Simultaneously, it addresses environmental concerns by promoting recycling and reuse through a transparent, localized market for discarded items. This two-pronged approach is particularly impactful in developing nations and urban communities where both issues are highly prevalent.

In a world facing increasing environmental and humanitarian challenges, solutions like EcoShare are timely and necessary. By leveraging digital technologies and open access principles, the project offers a blueprint for how grassroots innovation can tackle macro-level issues using minimal resources and widely available infrastructure.

D. Lessons Learned

The development of EcoShare brought to light several insights about building socially-focused digital platforms. First, data quality and freshness are essential when integrating AI-driven decision-making into real-world systems. Second, user-centered design is critical to achieving adoption, especially when dealing with diverse stakeholders like donors, NGOs, buyers, and sellers. Finally, modular and scalable system architecture is necessary to ensure that performance remains consistent under increased load or geographic expansion.

E. Final Thoughts

EcoShare demonstrates how modern web technologies, coupled with intelligent data analytics, can be used to create tangible impact in the domains of social welfare and environmental conservation. Although the current prototype has limitations, it lays a strong foundation for future iterations and real-world deployments. The project has achieved its core objectives and offers valuable contributions in the domains of machine learning application, geospatial computing, and socially-driven system design

VIII. FUTURE WORK

A. Enhanced Real-Time Data Integration

One of the key areas identified for improvement in EcoShare is the integration of real-time data streams from NGOs and donors. Currently, the system relies on manual updates of food availability, urgency parameters, and location metadata. To enhance the performance and precision of the urgency scoring algorithm, future iterations of the system could incorporate real-time data ingestion using IoT devices (e.g., smart thermometers for food inventory monitoring), automatic stock-level sensors at NGO food banks, and scheduled update APIs for inventory management. These integrations would allow the urgency score model to operate with live data, further improving the reliability and fairness of the matching algorithm.

B. Advanced Bid System and Conflict Resolution

While the current recyclable marketplace includes a basic auction system, future work could enhance its functionality to include real-time countdown timers, auto-bidding mechanisms, and dynamic price recommendations based on historical bidding trends. To ensure transaction integrity and fairness, the system could also incorporate blockchain-based receipts or smart contracts that record ownership, transaction time, and delivery confirmation in a tamper-proof ledger.

Additionally, the platform can integrate a conflict resolution module to mediate disputes between buyers and sellers. This may include dispute ticketing systems, user-generated reviews, and community moderator privileges.

C. Mobile Application Development

Given the accessibility challenges faced by users in underserved areas, developing a mobile version of EcoShare is a high-priority enhancement. A cross-platform mobile app (built using Flutter or React Native) would allow NGOs, donors, and recyclers to interact with the system more conveniently. Offline caching features, push notifications for urgent matches or bid updates, and integrated GPS navigation can be included to improve usability and responsiveness. An SMS-based interface could also be developed for users with limited smartphone access.

D. Integration with Government and NGO Networks

EcoShare holds strong potential for integration with government welfare platforms and official NGO registries. Future versions may allow verified NGO registration via government APIs (such as FCRA-compliant NGO databases), tax incentive reporting for donors, and direct communication with food safety authorities. These collaborations would significantly boost platform credibility and adoption, while also helping enforce data verification and accountability standards.

E. Gamification and User Incentives

To promote sustained user engagement and encourage community participation, the platform can integrate gamification elements. For example, users could earn badges for consistent donations, completing trades, or helping verify other listings. Leaderboards, eco-savings calculators, and contribution history dashboards would motivate users by quantifying their social impact. Partnerships with eco-conscious brands could provide tangible rewards (discount coupons, recognition certificates, etc.) for top contributors.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the Department of Information Science and Technology at Anna University, Chennai, for providing the necessary infras tructure, support, and guidance throughout the development of the AetherLink project.

We extend special thanks to all our professors, for their invaluable mentorship, technical insights, and consistent en couragement during all phases of design, implementation, and testing.

REFERENCES

[1] L. Breiman, “Random forests,” Machine Learning, vol. 45, no. 1, pp. 5–32, Oct. 2001.

[2] J. L. Bentley, “Multidimensional binary search trees used for associative searching,” Communications of the ACM, vol. 18, no. 9, pp. 509–517, 1975.

[3] J. Levine and M. Sadeh, “Improving the efficiency of food rescue and redistribution using real-time technology: Evidence from the Food Rescue Hero platform,” Journal of Social Computing, vol. 3, no. 1, pp. 55–68, 2021.

[4] M. A. Khan and R. Kumar, “An efficient and secure web-based application for dynamic online bidding using PHP and MySQL,” International Journal of Computer Applications, vol. 95, no. 14, pp. 9–14, 2014.

[5] Food and Agriculture Organization of the United Nations, “Food loss and waste facts,” [Online].