

EcoXchange: AI-Powered Reuse & Thrifting Marketplace

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Abstract - The rapid increase in consumer waste and the lack of accessible recycling platforms have created significant environmental challenges worldwide. Many reusable products such as clothes, books, furniture, electronics, and household items are discarded despite having potential value. To address this issue, this paper presents EcoXchange, a Flutter-based mobile application that promotes sustainable consumption through donation, resale, recycling, and environmental awareness. The proposed system provides role-based access for Customers, Contributors, and Administrators, enabling users to donate or resell items, earn eco-points, redeem rewards, and access educational content related to sustainability. The application integrates Firebase Authentication, Cloud Firestore, Cloud Storage, QR-based payment mechanisms, real-time order tracking, and gamification features to encourage user participation. The application provides a comprehensive ecosystem for donation, resale, recycling, and environmental awareness, encouraging active participation in sustainable consumption practices. The proposed platform aims to reduce landfill waste, encourage responsible disposal practices, and foster a circular economy through technology-driven sustainability initiatives.

Key Words: Sustainability, Recycling, Circular Economy, Flutter, Firebase, Gamification, QR Payment, Waste Management, Mobile Application

1. INTRODUCTION

Environmental sustainability has become one of the most critical concerns of the modern world. Increasing urbanization, consumerism, and population growth have resulted in large volumes of waste generation. A considerable portion of discarded items such as clothing, books, furniture, toys, and electronics remain reusable but often end up in landfills due to the absence of convenient reuse and recycling mechanisms.

Traditional waste management systems mainly focus on collection and disposal rather than reuse and resource recovery. Consequently, valuable materials are lost, environmental pollution increases, and opportunities for sustainable consumption remain underutilized.

To overcome these challenges, EcoXchange is proposed as a comprehensive mobile platform that enables users to donate, resell, recycle, and responsibly manage reusable items. The platform combines marketplace functionality with sustainability awareness and reward-based engagement. Users can contribute items, purchase reusable products, earn eco-points, unlock achievements, and participate in environmentally conscious activities.

The application leverages Flutter for cross-platform development and Firebase services for secure authentication, real-time database operations, cloud storage, and scalable backend functionality. By integrating technology with sustainability practices, EcoXchange aims to encourage a circular economy and reduce environmental impact.

1.1 Motivation

Millions of reusable items such as clothes, books, furniture, and electronics are discarded every year even though they remain functional and useful. At the same time, many people are looking for affordable second-hand products or opportunities to receive donated items. However, there is often no simple and reliable platform that connects those who wish to give away reusable items with those who need them. EcoXchange is designed to bridge this gap by providing a user-friendly digital platform that encourages donation, resale, recycling, and environmental awareness while rewarding users for adopting sustainable practices.

1.2 Objectives

1. To encourage reuse and recycling of products.
2. To develop a sustainable platform for item donation, resale, and recycling.
3. To provide role-based dashboards for Customers, Contributors, and Administrators.
4. To increase user participation using gamification techniques.
5. To facilitate secure transactions using QR-based payment systems.
6. To offer educational content regarding recycling and sustainability.
7. To reduce landfill waste through reuse and resource recovery.

2. Literature Survey

Sr.No	Research Work	Technology	Key Contribution
1	WCycleBD (Banik et al., 2025)	Flutter, Firebase, Reward System, Community Campaigns	Recycling requests, reward points, community engagement
2	WasteWise (Lotlikar, 2025)	Flutter, Environmental Impact Tracking	Personalized reminders, recycling education.
3	Sustainable Product Application	Flutter, Firebase,	Eco-friendly product discovery and

	Using Flutter (Shirke et al., 2025)	Sustainability Ratings	sustainability awareness
4	Recycling as a Service (Ambrosio et al.)	Android, Firebase, Google Maps, Circular Economy	Connects waste generators and collectors using location services

1. WCycleBD: A Mobile Platform for Smart Recycling and Eco-Friendly Sustainable Environment

Banik et al. developed WCycleBD, a Flutter and Firebase-based recycling platform that allows users to submit recycling requests, earn reward points, and participate in environmental campaigns. The system integrates users, store owners, and administrators into a single ecosystem. The study demonstrated that reward mechanisms significantly improve user participation in recycling activities. However, the platform lacks AI-powered waste classification and recycling assistance features. [1]

2. WasteWise: A Mobile Application Framework for Enhancing Household Waste Management and Environmental Impact Awareness

Lotlikar proposed WasteWise, a Flutter-based application that helps users manage household waste through collection reminders, recycling guidelines, and environmental impact tracking. The application encourages sustainable behavior by providing personalized feedback and educational resources. Results showed improved waste sorting and recycling awareness among users. However, it does not support product resale, donations, or marketplace functionalities. [2]

3. Sustainable Product Application Using Flutter

Shirke et al. developed a Flutter and Firebase-based application that assists users in discovering eco-friendly products and understanding their environmental impact. The platform provides sustainability ratings, product categorization, and real-time data management. The study promotes informed purchasing decisions and environmental awareness. However, the system does not include recycling, donation, or waste management services. [3]

4. Recycling as a Service: A Mobile Application for Circular Economy

Ambrosio et al. proposed a mobile application that connects waste generators with waste collectors using Firebase and Google Maps services. Users can schedule waste collection requests, while collectors can locate and accept nearby tasks. The platform promotes circular economy principles and sustainable waste management. However, it lacks gamification, reward systems, and AI-based recycling support. [4]

3. SYSTEM ANALYSIS

3.1 System Architecture

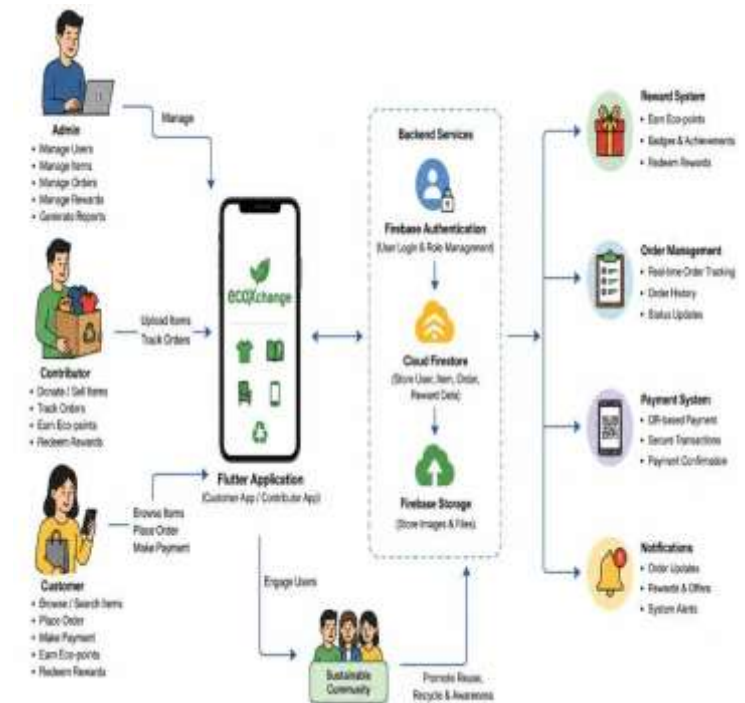


Fig -1: System Architecture of EcoXchange

3.2 Use case Diagram

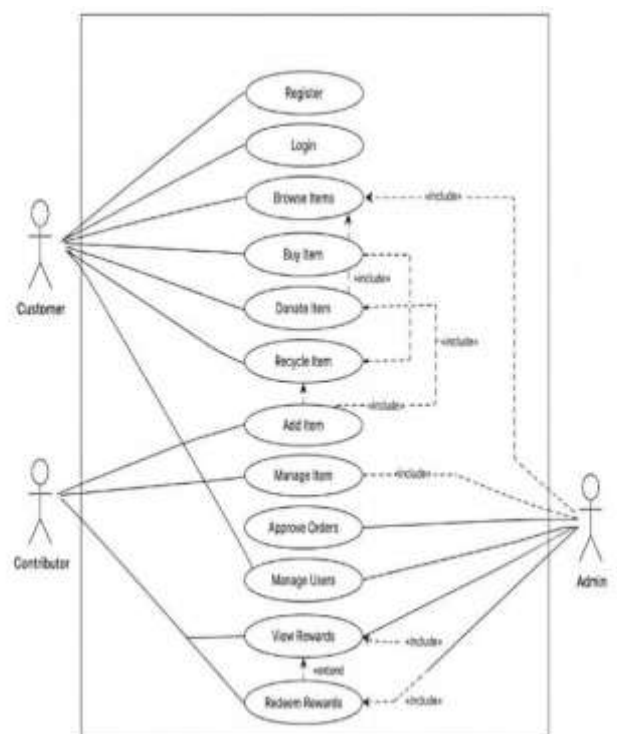


Fig -2: EcoXchange Use Case Diagram

3.3 Dataflow Diagram

DFD level 0

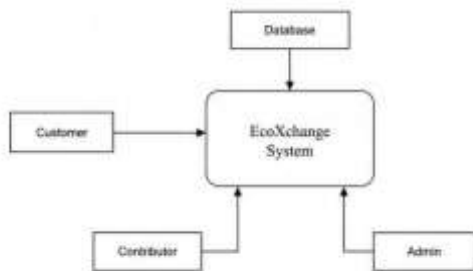


Fig-3:DFD level 0

DFD level 1

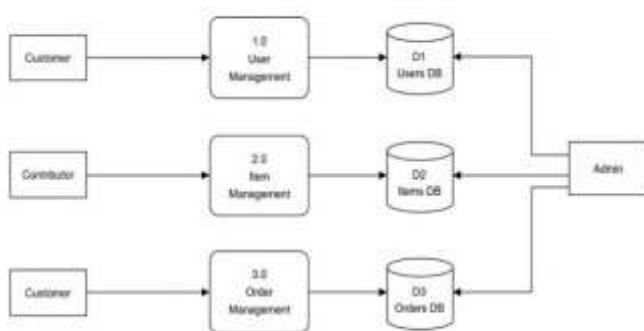


Fig-4:DFD level 1

3.4 Entity Relationship Diagram

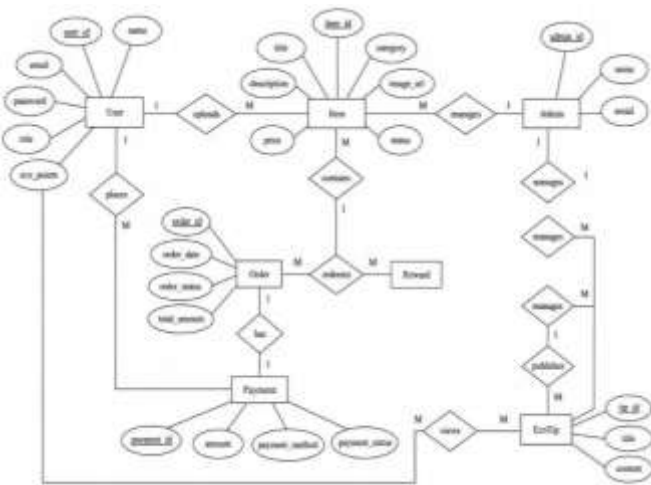


Fig-5:ER Diagram

4. IMPLEMENTATION

The EcoXchange application was implemented using Flutter as the frontend framework and Firebase as the backend platform to develop a secure, scalable, and user-friendly sustainable marketplace. The system incorporates role-based access control to provide separate functionalities for Customers, Contributors, and Administrators. Firebase Authentication was used to manage secure user registration and login, while Cloud Firestore served as the real-time database for storing user

profiles, item details, order information, rewards, and eco-awareness content. Firebase Storage and Cloudinary were integrated for uploading and managing item images and profile pictures. The marketplace module enables users to donate, resell, and purchase reusable products, while the order management module supports order placement, approval, tracking, and history maintenance. A QR-based payment mechanism was implemented to facilitate secure digital transactions between users. To encourage sustainable behavior, a gamification module consisting of eco-points, achievement badges, milestone tracking, and reward redemption was integrated into the platform. Real-time synchronization ensures that item availability, order status, and reward updates are reflected instantly across the application. The admin module provides centralized control for managing users, items, orders, rewards, and eco-awareness content. Overall, the implementation combines modern mobile development technologies with cloud-based services to create an efficient platform that promotes responsible consumption, resource reuse, and environmental sustainability.

Tools and Technologies Used in EcoXchange Implementation

Component	Technology/Tool Used	Purpose
Frontend Development	Flutter	Cross-platform mobile application development
Programming Language	Dart	Application logic and user interface development
Authentication	Firebase Authentication	Secure user login and registration
Database	Cloud Firestore	Real-time NoSQL database management
Cloud Storage	Firebase Storage	Storage of user and item images
Media Management	Cloudinary	Image hosting and optimization
Backend Services	Firebase Functions	Server-side operations and automation
Payment Module	QR Flutter, QR Code Scanner	QR-based digital payment processing
Code Editor	Visual Studio Code	Source code management and development

5. METHODOLOGY

The EcoXchange application follows a systematic workflow that enables users to donate, resell, recycle, and purchase reusable products through a secure and user-friendly mobile platform. The methodology focuses on reducing waste generation while encouraging sustainable consumption practices through digital technology. The complete working process of the system is divided into the following stages:

Step 1: User Registration

The first stage of the system begins with user registration. New users are required to create an account by providing essential details such as name, email address, password, and user role. The application supports multiple user roles including Customer, Contributor, and Admin.

During registration, the system verifies the authenticity of the email address using Firebase Authentication services. This helps prevent unauthorized access and ensures secure onboarding of users into the platform. Once registration is completed successfully, user information is securely stored in Cloud Firestore for future access and management.

This registration process establishes a secure and personalized environment for every user interacting with the EcoXchange platform.

Step 2: Authentication

After successful registration, users can log into the application using their registered email and password credentials. Firebase Authentication is used to validate user identity and provide secure access to the system.

The authentication module also supports password recovery features for users who forget their login credentials. Role-Based Access Control (RBAC) is implemented to ensure that each user can only access features relevant to their assigned role.

Step 3: Upload, Donate, or Resell Item

Once authenticated, contributors or users can upload reusable items to the platform. The application allows users to add product details such as item name, description, category, price, and images.

Users can choose whether the item should be:

- Donated,
- Resold, or
- Marked for recycling.

Images of the products are uploaded through camera or gallery access and stored using Cloudinary and Firebase Storage services. The uploaded item data is synchronized in real time using Cloud Firestore. This feature encourages users to extend the lifecycle of products instead of discarding them as waste, thereby supporting sustainable environmental practices.

Step 4: Browse Marketplace

The marketplace module allows customers to browse all available products listed on the platform. Users can search and filter items based on categories, product type, availability, and pricing.

The marketplace interface is designed using Flutter's Material Design components to provide a smooth and user-friendly experience. Real-time database synchronization ensures that users always view updated product information.

This module helps create a digital ecosystem where reusable products can easily reach interested buyers or recipients.

Step 5: Order Placement

When a customer selects a product, the system enables order placement through a simple checkout process. The customer confirms the selected item and submits the order request.

The order details are then stored in Cloud Firestore and become visible to both contributors and administrators. Administrators can review and approve orders before processing them further.

Step 6: QR Code Payment

To facilitate secure digital transactions, the application integrates a QR code-based payment mechanism. During checkout, the system generates a QR code containing payment information.

Customers can scan the QR code using supported payment applications to complete the transaction securely. This reduces manual payment handling and enhances transaction efficiency.

Step 7: Reward Allocation

One of the key features of EcoXchange is its gamification and reward system. Users earn eco-points for participating in environmentally friendly activities such as:

- Donating items,
- Recycling products,
- Purchasing reusable goods, and
- Completing sustainable actions.

Based on accumulated points, users can unlock achievement badges, milestones, and reward vouchers. The reward management system motivates users to actively participate in sustainable practices and increases long-term engagement with the platform.

This feature transforms sustainability into an interactive and rewarding experience for users.

The methodology adopted in EcoXchange combines secure cloud-based technologies, real-time data synchronization, digital payments, and sustainability-driven features to create an efficient and environmentally responsible marketplace system.



Fig-6: EcoXchange WorkFlow

6. RESULTS AND DISCUSSION

6.1 : Result



Fig-7: Login

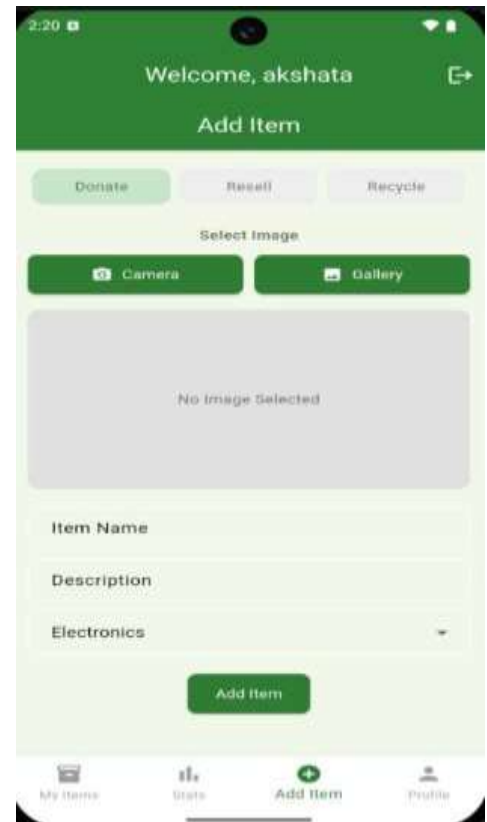


Fig-8: Add Item

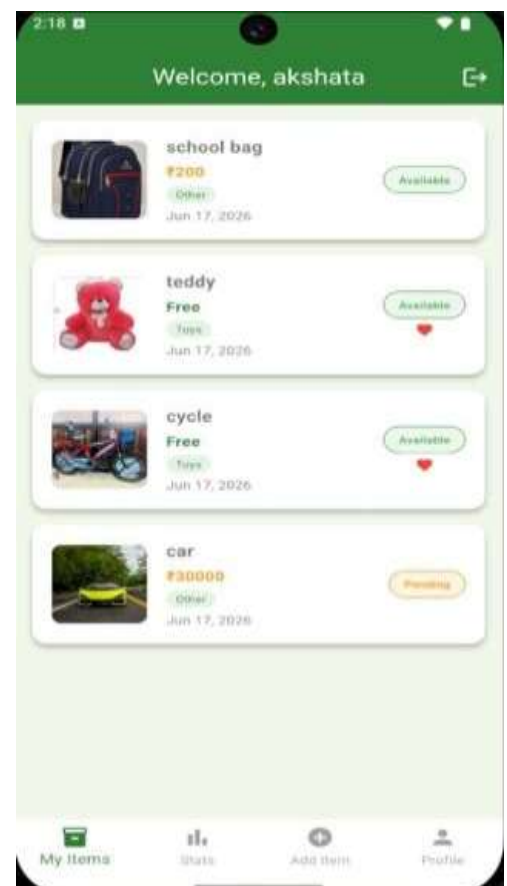


Fig-9: My Items

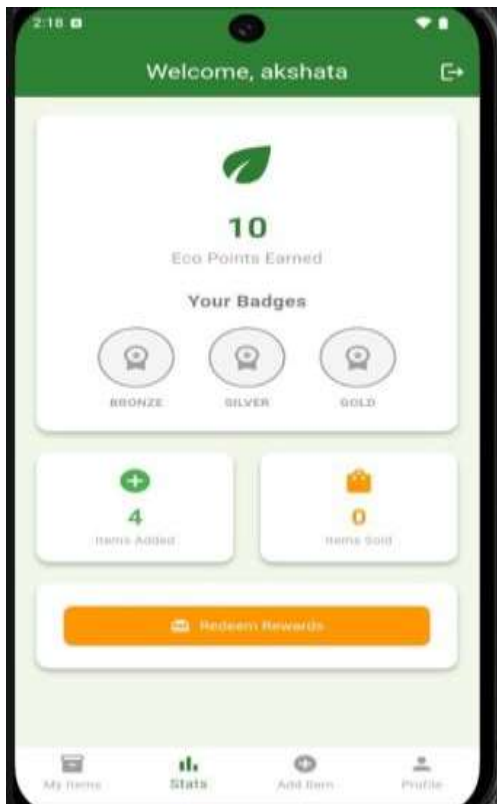


Fig-10: Contributor Stats

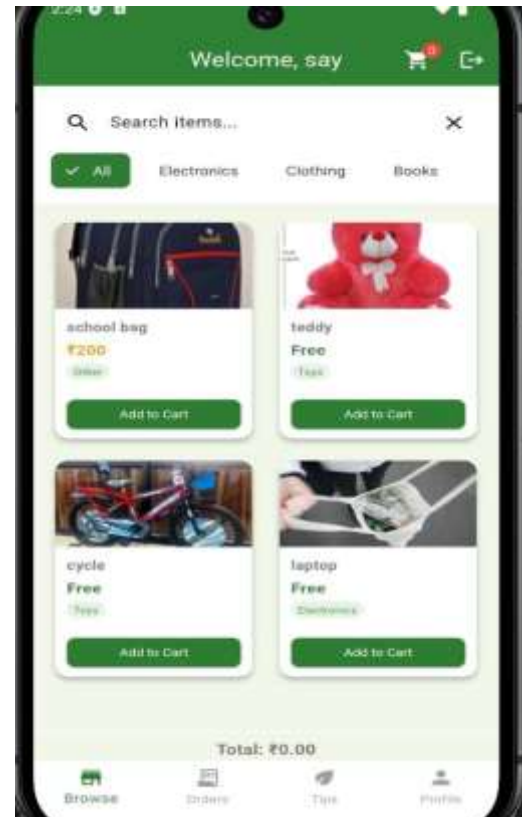


Fig-12: Marketplace

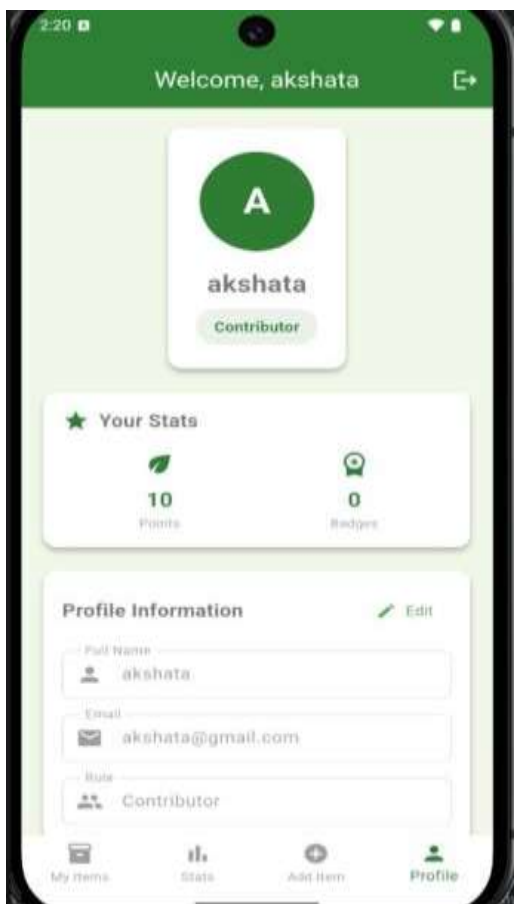


Fig-11: Contributor Profile

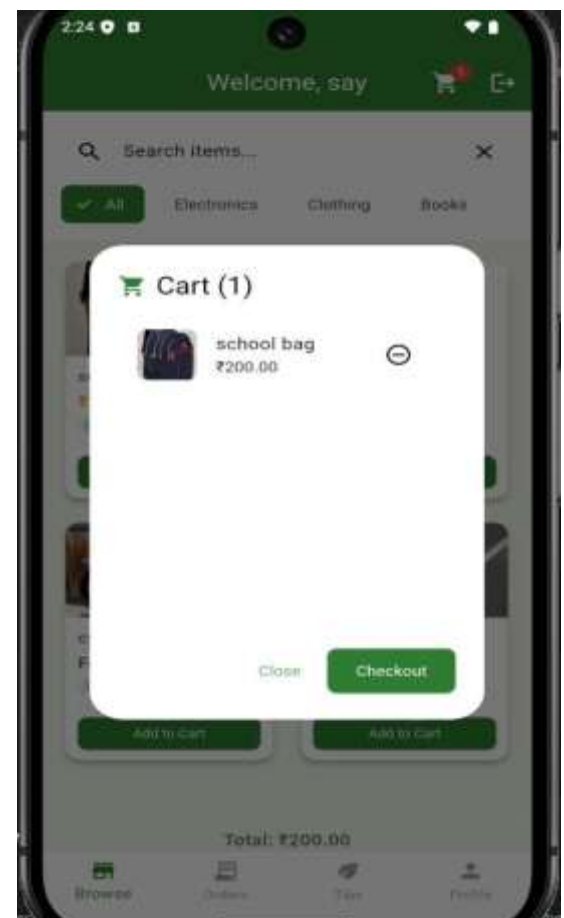


Fig-13: Cart



Fig-14: QR Payment

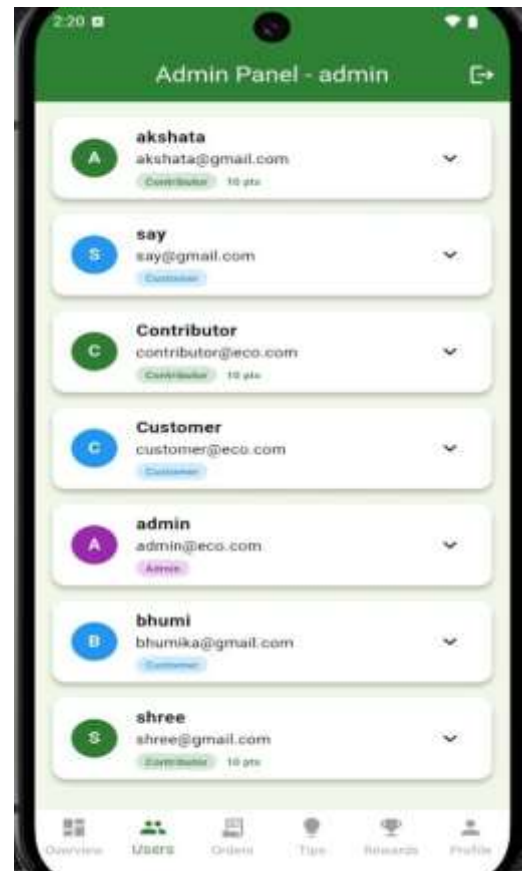


Fig-16: Users

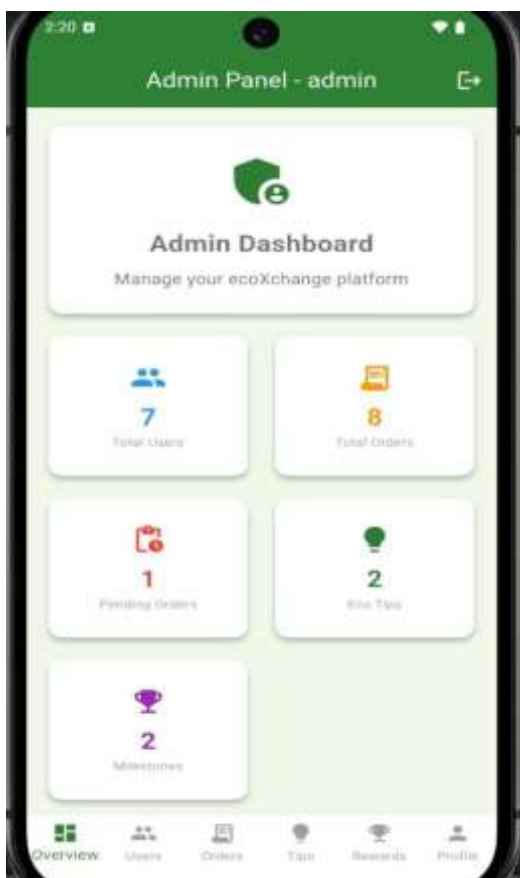


Fig-15: Admin Dashboard

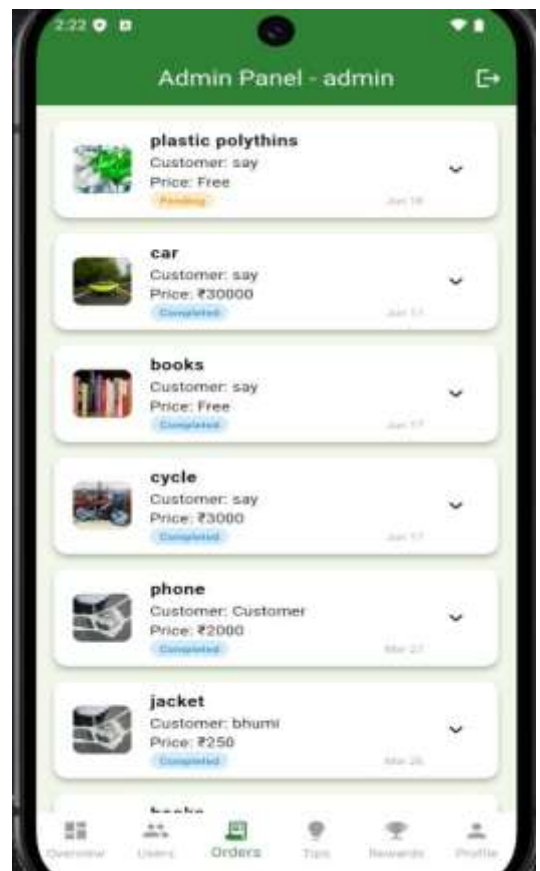


Fig-17: Orders



Fig-18: Tips

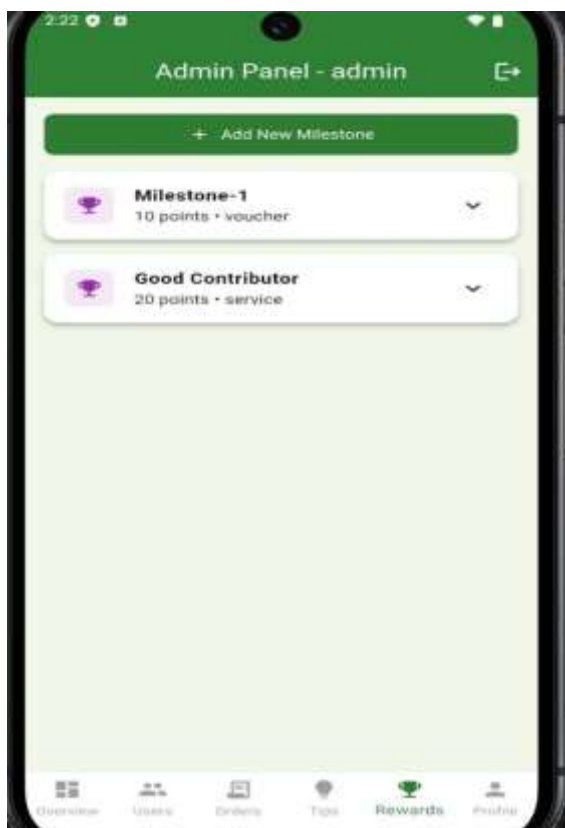


Fig-19: Rewards

6.2 :Discussion

The EcoXchange application successfully provides a digital platform for donation, resale, and recycling of reusable products. The system enables secure user authentication, real-time data synchronization, QR-based payments, and efficient order management using Firebase services. The gamification and reward mechanism encourages users to participate in sustainable activities by earning eco-points and rewards. The application also improves environmental awareness through recycling guidance and eco-friendly practices. Overall, the proposed system demonstrates how modern mobile technologies can support sustainable waste management and promote a circular economy.

7. CONCLUSIONS

EcoXchange presents an innovative approach toward sustainable waste management by combining donation, resale, recycling, education, and gamification within a single mobile platform. The system encourages responsible consumption and promotes a circular economy by extending the lifecycle of reusable products. Through role-based access, secure cloud infrastructure, real-time operations, reward mechanisms, EcoXchange has the potential to significantly reduce waste generation while increasing public participation in sustainability initiatives. The proposed platform demonstrates how modern mobile technologies can be leveraged to create meaningful environmental and social impact.

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