Project Synopsis

on

ECOSORT

In partial fulfillment of requirements for the degree

of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

Submitted by:

Aagam Dangi [22100BTCSFBI11294]

Divyanshu Kushwah[22100BTCSFBI11306]

Harsh Mandge [22100BTCSFBI11308]

Palkesh Shrivas[22100BTCSFBI11316]

Under the guidance of

Prof. Vishwas Dixit

DEPARTMENT OF INFORMATION SECURITY AND CLOUD COMPUTING

SHRI VAISHNAV INSTITUTE OF INFORMATION TECHNOLOGY

SHRI VAISHNAV VIDYAPEETH VISHWAVIDYALAYA, INDORE

JUL-DEC-2025

TABLE OF CONTENTS

ABSTRACT

EcoSort is an AI-powered mobile application designed to transform everyday waste management practices by making recycling both simple and accessible. With rising challenges of landfill overflow, plastic pollution, and contamination in recycling streams, EcoSort provides a practical solution by leveraging the power of smartphones rather than relying on costly IoT-based hardware. Instead of building dedicated camera-and-sensor waste bins, the app reuses the existing smartphone camera to capture and analyze waste items, making the solution more affordable, portable, and scalable.

Using advanced computer vision models from Hugging Face and Google Gemini APIs, EcoSort instantly classifies items into categories such as plastic, paper, glass, metal, organic, or e-waste. The backend, developed in Python (FastAPI) with PostgreSQL or MongoDB, securely stores user data, recycling history, and gamification progress. The app's dashboard provides real-time analytics on recycled items, impact metrics like CO_2 saved, and personalized recycling trends.

EcoSort also integrates engagement features such as reward points, achievement badges, leader boards, and community recycling challenges, while smart notifications encourage regular participation. By adopting a mobile-first approach, the app ensures accessibility to a wide audience, reduces dependency on additional infrastructure, and allows users to contribute to sustainability anywhere and anytime. Scale able by design, EcoSort can expand into future use cases such as integration with IoT smart bins, augmented reality recycling guides, and city-level dashboards for municipal waste planning. By combining AI, mobile technology, and sustainability principles, EcoSort empowers individuals and communities to reduce waste more effectively while promoting environmentally responsible habits**.**

INTRODUCTION

Waste generation has been rising at an alarming rate, with the World Bank estimating that global solid waste will increase to 3.4 billion tons annually by 2050. A significant portion of this waste is recyclable, yet due to improper segregation at the household and community levels, recyclable materials are often contaminated and rendered unusable. Traditional recycling awareness campaigns have had limited success, primarily because users lack real-time guidance on how to handle waste at the source.

In recent years, technologies such as **computer vision, artificial intelligence, and augmented reality** have shown immense potential in solving environmental challenges. Research efforts in intelligent waste classification (Zhou et al., 2020; Yang et al., 2021) demonstrate the effectiveness of deep learning models in accurately categorizing waste materials. Similarly, the rise of AR-based educational apps highlights the value of interactive interfaces in changing user behavior. However, most existing solutions are either lab-based prototypes or localized smart bin deployments, which are not scalable at the community level.

EcoSort addresses this gap by combining **AI-driven waste classification with AR-based user interaction** in a single mobile platform. This integration allows individuals to simply use their smartphone cameras to identify recyclability, receive instructions, and contribute to sustainable waste management. The project builds upon prior works in image-based object detection while expanding its scope with AR guidance and community reward systems. The result is a solution that is practical, accessible, and impactful for households, institutions, and urban ecosystems.

PROBLEM DOMAIN

The major problem in recycling lies in contamination of recyclable waste streams. Users frequently dispose of items without knowing whether they belong in recyclable or general waste bins. This leads to:

- Loss of recyclable material value.
- Increased processing costs for waste management companies.
- Landfill overflow and environmental pollution.

The specific problem statement is: “Lack of accessible and real-time tools for common people to identify recyclable items and dispose of them correctly.”

Objectives of the Proposed Work:

- To design an AI-based waste classification model that works with smartphone cameras.
- To integrate AR technology for step-by-step disposal instructions.
- To build a database that maps nearby recycling centers for user guidance.
- To motivate sustainable behavior through gamification and eco-reward systems.
- To reduce contamination in recycling streams and encourage eco-friendly lifestyles.

SOLUTION DOMAIN

EcoSort proposes a mobile-first architecture that integrates AI-based classification, AR visualization, and cloud analytics to assist users in waste sorting.

System Workflow:

1. Image Capture: User opens the EcoSort mobile app and scans an item using the camera.
2. AI Classification: A deep learning model (trained on Hugging Face datasets and optimized with TensorFlow/PyTorch) identifies the material type (plastic, paper, metal, glass, organic, or e-waste).
3. AR Overlay: Using ARKit/ARCore, the app overlays visual instructions on the scanned object (e.g., "This is recyclable – place in blue bin").
4. Recycling Centers: The app fetches geolocation data from the database (MongoDB/PostgreSQL with Google Maps API) to display nearby recycling centers.
5. Gamification: Users earn points for scans and eco-friendly actions, which can be tracked on leaderboards or redeemed in partnerships with eco-friendly brands.

Techniques & Algorithms:

- Convolutional Neural Networks (CNNs) for waste classification.
- Transfer learning with pre-trained models (EfficientNet, ResNet).
- AR frameworks for overlaying real-time guidance.
- Cloud database & analytics for tracking user behavior and recycling patterns.

Architecture:

- Frontend: React Native for cross-platform app development.
- Backend: Python (FastAPI/Flask) connected with AI inference APIs.
- Database: MongoDB/PostgreSQL for user and recycling data.
- Cloud Integration: AWS/Firebase for real-time updates and scalability.

This framework ensures a balance between technical feasibility, user accessibility, and societal impact. The system is modular and scale able, enabling future extensions such as IoT integration (smart bins) and enterprise-level adoption.

SYSTEM DOMAIN

Tools & Technologies:

- Programming Languages: Python (AI, backend), JavaScript (React Native frontend).
- AI/ML Frameworks: TensorFlow, PyTorch, Hugging Face APIs.
- AR Tools: ARCore (Android), ARKit (iOS).
- Database: MongoDB/PostgreSQL for flexible and scalable data storage.
- Backend Framework: FastAPI/Flask for lightweight API integration.
- Cloud Services: AWS / Firebase for real-time sync and hosting.

Hardware/Software Requirements:

- Smartphones with working cameras (Android/iOS).
- Minimum 4GB RAM devices for smooth AR rendering.
- Development hardware: Laptops with GPU-enabled training capability (optional cloud GPUs).

Justification:

- Python & Hugging Face are chosen for robust AI model support.
- React Native ensures cross-platform availability.
- MongoDB/PostgreSQL allow structured storage of user & recycling data.
- ARCore/ARKit provide stable frameworks for AR-based user instructions.

APPLICATION DOMAIN

EcoSort can be applied in multiple domains:

- Households: it empowers families to easily identify recyclable items and segregate waste correctly, reducing contamination and improving the efficiency of recycling.

- Schools/Colleges: In educational institutions, EcoSort can be used as an interactive tool to teach students about sustainability, waste segregation, and environmental responsibility through gamification and AR visualization.

- Public Places: At the municipal level, local bodies can adopt EcoSort to promote citizen participation in waste management initiatives, leading to cleaner neighborhoods and reduced landfill pressure.

- Municipal Corporations: EcoSort can be integrated as part of CSR (Corporate Social Responsibility) programs, helping them track employee engagement in eco-friendly practices.

Additionally, EcoSort has potential in public spaces such as malls, parks, and event venues where users often face confusion in disposal choices. Its versatility ensures that EcoSort not only benefits individuals but also scales up to community and smart city initiatives.

EXPECTED OUTCOME

The expected outcomes of the EcoSort project are as follows:

1. A fully functional mobile application that identifies recyclable and non-recyclable items using AI.

2. An AR-based guidance system that overlays clear instructions on the scanned object.

3. Integration of geolocation services to provide users with the nearest recycling centers and collection points.

4. Development of a gamified eco-points reward system to motivate sustainable habits.

5. A cloud-connected database that stores user activity and generates recycling analytics.

6. User-friendly dashboards to visualize personal and community impact.

7. A system that reduces contamination in recycling streams by educating users.

8. Promotion of eco-friendly practices at individual, institutional, and municipal levels.

9. Contribution to sustainable urban living and alignment with global goals such as UN SDG 11 and 12.

10. A scalable framework adaptable for future IoT integration and smart city deployments.

REFERENCES

1. Zhou, Y., et al. (2020). *Deep learning-based waste classification for environmental sustainability*. Journal of Cleaner Production.

2. Yang, J., et al. (2021). *AI and IoT for smart waste management systems*. IEEE Access.

3. World Bank (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*.

4. Recykal (2023). *Tech-driven recycling platforms in India*.

5. CleanHub (2022). *Digital traceability in plastic waste management*.

6. Mittal, S. & Sharma, A. (2021). *AR-based learning applications for sustainability awareness*. International Journal of Emerging Technologies.

7. Kaza, S.,et al. (2019). *The future of waste management: Policy and technology approaches*. World Bank Publications.

8. Geyer, R., et al. (2017). *Production, use, and fate of all plastics ever made*. Science Advances, 3(7).

9. Chen, Y., et al. (2020). *Smart bins and AI-assisted recycling: A review*. Waste Management Journal.

10. Pires, A., Martinho, G. (2019). *Waste education and awareness in sustainable management*. Environmental Research Letters.

11. Ellen MacArthur Foundation (2021). *Circular economy and plastics: A vision for a sustainable future*.

12. Jambeck, J., et al. (2015). *Plastic waste inputs from land into the ocean*. Science, 347(6223).

13. Sharma, R., & Garg, S. (2020). *Role of ICT in solid waste management in smart cities*. Springer, Sustainable Computing.

14. StartUs Insights *Top 8 Recycling Technology Trends in 2025*

15. Waste Metal report *https://ewastemonitor.info/the-global-e-waste-monitor-2024/*