

Scrapkart: Smart Waste Intelligence Platform

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Abstract

The challenge associated with managing the recycling of solid waste containing metal is a pressing issue in the context of rapid urbanization, higher waste generation and inadequate infrastructure to support waste collection. In fact, conventional scraps management systems can be characterized by poor waste resources utilization, lack of transparency of the operations and low efficiency of the recycle process, which contributes to environmental impact and postpones the adoption of circular economy. This paper introduces “ScrapKart,” an intelligent digitalized application that intends to bring together artificial intelligence, cloud computing and geolocation technologies to optimize the activities of collecting, valuating and recycling waste. It is composed of a mobile app (Flutter) for customers, a web app (React) for administrative tasks and a scalable system developed with the backbone of the framework node and express, secured with PostgreSQL and cloud storage Supabase. The automatic identification of scrap materials relies on a YOLOv8 network model for object detection and recognition, which not only distinguishes but also has a confidence score for the type of material; this way, the product will be classified as a scrap material. The identified material is subsequently compared to the price verification records and the market, giving the users an accurate and place-specific price estimate. Also, geolocation and route optimization are used to determine the available scrap collector most nearby, minimizing transportation time and enhancing efficiency. Results of the experimental evaluation showcase the effectiveness of the proposed platform, leading to 94.8% accuracy of classification of materials, average API response time of 185 ms, each image inference latency of approximately 1.2 s by YOLOv8 and collector assignment success rate of 98.2%. Based on these results, it is possible to conclude that ScrapKart is an efficient, scalable, and intelligent system for digital scrap management that supports both waste recycling efforts towards sustainability and Smart City development.

Keywords: Scrapkart, Waste Collection System, Digital Recycling Marketplace, Artificial Intelligence, Cloud Computing, Geolocation, Sustainability, Circular Economy

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INTRODUCTION

Handling recyclable waste has emerged as a critical challenge in modern metropolitan cities due to rapid population growth and increasing consumption patterns. Existing scrap collection systems are largely unorganized and rely on manual scheduling, price estimation, and communication between customers and scrap collectors. Such traditional approaches lack operational transparency, efficient logistics, and standardized pricing, resulting in lower public participation in recycling activities and reduced resource recovery efficiency [1].

ScrapKart is proposed as an integrated digital platform that addresses these challenges by connecting users with registered scrap collectors through a technology-driven ecosystem. The platform digitizes the complete scrap collection process, including material identification, price estimation, booking, and collector assignment, thereby improving operational efficiency and transparency.

The ScrapKart mobile application is developed using Flutter to provide an intuitive cross-platform interface for Android and iOS devices. The backend is implemented using Node.js with scalable cloud services based on PostgreSQL managed through Supabase, enabling secure data storage, real-time data processing, and efficient handling of concurrent user requests.

Artificial Intelligence (AI) is integrated into the platform through a CNN-based image classification model that automatically identifies scrap materials from user-uploaded images. The classified material is then processed by the pricing engine, which estimates its value using location-specific scrap rates stored in the pricing database.

Additionally, geolocation services are employed to identify nearby collectors and optimize the pickup assignment process, thereby improving collection efficiency and user experience [2][3].

LITERATURE REVIEW

The shift from the traditional, labor-intensive system of waste management to "Smart Waste Management" is an area of extensive research, mainly due to the requirement for sustainable urban development and a circular economy. The existing literature can be divided broadly into three categories: inefficiencies in the traditional process, use of Artificial Intelligence (AI) in waste sorting, and logistical optimizations.

Traditional Waste Management Inefficiencies

Traditionally, municipal and private scrap collection systems have been characterized by a non-systematic approach. Research suggests that the traditional approach has been inefficient due to the lack of price transparency, creating a deep level of distrust between residents and scrap dealers. The absence of an effective central body means that scrap collection scheduling is inefficient, causing greater carbon footprints from collector vehicle emissions and reducing household recycling.

Computer Vision and AI in Waste Classification

There has been considerable growth in the application of Machine Learning (ML) within the recycling industry. In recent research, researchers have successfully used CNNs to automate the process of segregating waste. As an example, in [4], the use of ResNet-50 and YOLO models was investigated to enable high-precision real-time object detection for the purpose of recycling. In another study [5], the use of deep learning methods through computer vision and CNN models such as VGG19 has been proposed for active identification of waste categories. Some recent developments in 2024 [6] have indicated advanced technologies through the application of sensor technology and neural networks. The limitation of the current applications is that all applications are restricted to industrial-scale hardware devices (smart bins) and do not link with consumer-oriented mobile apps.

Logistics and Route Optimization

Regarding the logistics of collector dispatch, much of operations research is concerned with the Vehicle Routing Problem (VRP) in a smart city paradigm. Although the existing methods have been very successful in tracking the bin level via IoT devices and minimizing Estimated Time of Arrival (ETA) in order to save fuel, they have not yet been applied to a two-way B2C interface, in which the individual household initiates demand for pickup.

Gap in the Existing Literature (Problem Statement)

Although significant progress has been made in standalone machine learning-based waste classification systems [7] [8] and logistics optimization techniques, there remains a considerable gap in

integrated smart scrap management solutions [9]. Existing systems primarily focus either on waste classification using computer vision or on booking and logistics services without incorporating material verification and automated price estimation within a unified platform. Furthermore, very few solutions combine computer vision-based scrap identification, location-aware pricing, geolocation-based collector assignment, and digital booking services into a single application [10].

The proposed **ScrapKart** system addresses these limitations by integrating a mobile and web application with a cloud-based backend that supports automated scrap identification, transparent price estimation, efficient request management, and geolocation-based collector assignment [11]. By combining computer vision, cloud computing, and real-time location services, ScrapKart provides an end-to-end digital platform that enhances the efficiency, transparency, and accessibility of the scrap collection process, thereby overcoming the limitations of existing standalone solutions [12].

PROPOSED ARCHITECTURE

ScrapKart platform architecture aims to make scrap recycling efficient with the help of artificial intelligence, live tracking, and booking. The architecture has been designed keeping scalability and microservices in mind to ensure that it works as a cloud-based platform [Figure 1].

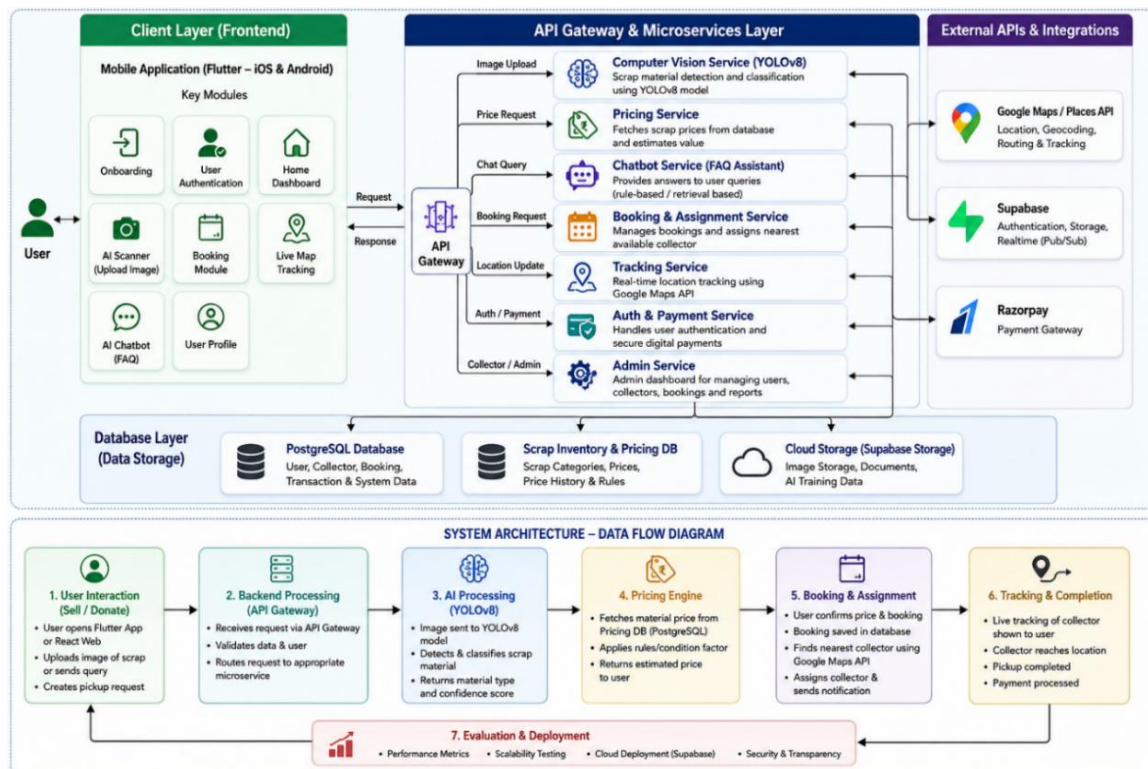


Figure 1. Architecture Diagram

The layers involved in the platform include:

1. Client Layer (frontend)

- **Mobile Application:** The mobile app is developed with the help of flutter and can run on both iOS & Android OS.
- **UI/UX:** Futuristic Anti-Gravity Soft UI/Neumorphism Design.
- **Components:** Onboarding Module, User Authentication Module, Home Dashboard, AI Scanner Module, AI Chatbot Module, Booking Engine Module, Live Map Tracking, and User Profile.

2. API Gateway & Microservices Layer

- **API Gateway:** Helps in routing the requests from the frontend of the user to the backend services.
- **AI/ML Service:** This microservice handles image detection as well as price prediction models.
- **Chatbot Service:** Provides conversational support for user queries related to scrap categories, pricing, and platform usage. [Fig. 2]
- **Booking & Assignment:** Manages all bookings as well as calculates the closest scrap collector location.
- **Tracking Service:** Integrates with map APIs to provide geo-tracing functionality.
- **Auth & Payment Service:** Deals with authentication and digital transactions.
- **AdminService:** This acts as the backend panel to monitor the overall platform performance.

3. External APIs & Third-party Integrations:

- **Geo:** Google Maps / Places API.
- **Backend:** Supabase (Authentication, Notifications, and Cloud Services)..
- **Financial:** Payment Gateway (Stripe / Razorpay).

4. Databases Layer (Data Storage):

- **RDBMS:** User & Collector Database (PostgreSQL).
- **Pricing DB:** Scrap Inventory and Price History.
- **Cloud Storage:** AI Training Data Storage (S3/Cloud).

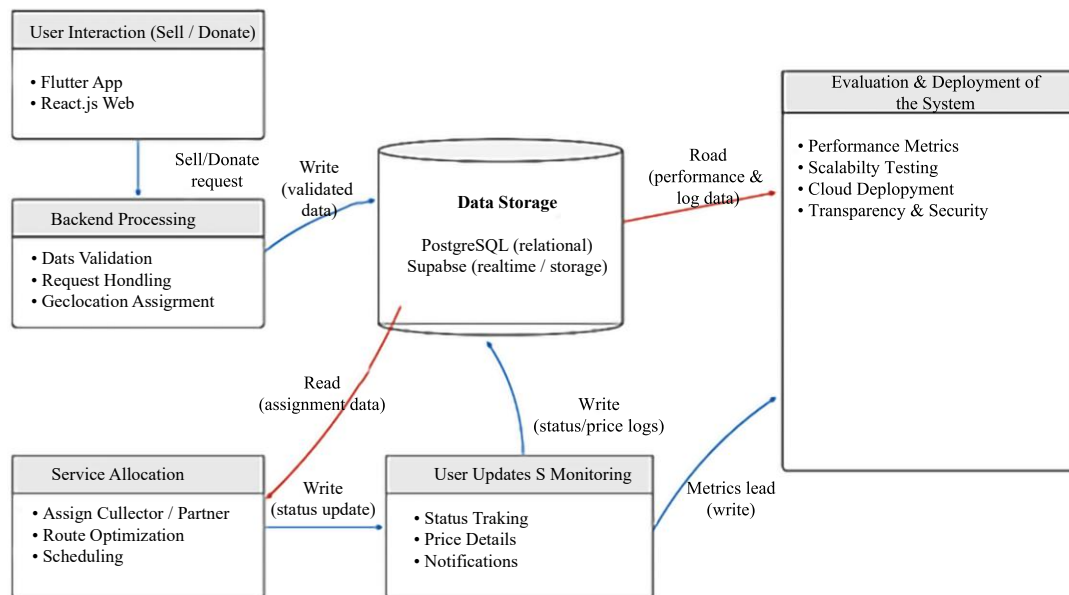


Figure 2. System Architecture Diagram

Proposed Data Flow Process

The proposed ecosystem consists of three main points of interaction between the actors: the User Application, Central Backend Processing System and Collector Interface.

The process works as follows:

- **User Input:** The end-user interacts with the Client Layer (mobile application). The user may upload an image of the scrap material through the AI Scanner or ask questions about scrap rates to the AI Chatbot.
- **Backend Gateway:** The client layer sends the request through the RESTful APIs to the Cloud Backend API Gateway that directs traffic towards the appropriate microservices.

- **AI Service Processing:** The image processing requests are forwarded to the Computer Vision model for material classification and condition estimation. Simultaneously, the Pricing Engine requests data from the Database Layer to estimate scrap material price based on real-time market trends.
- **Booking and Assignment:** With the approval of the user, the Booking Service records the transaction in the Relational Database. The Assignment Engine instantly queries the External Location APIs to find the nearest collector.

METHODOLOGY AND REQUEST PROCESSING

ScrapKart platform's core pipeline connects physical material collection with powerful Generative AI logic in the following way:

Data Collection & Large Language Model Grounding

For precise and accurate pricing, the basic Scrap rates were collected from verified local scrap dealers and manually validated before being stored in the pricing database. The database is periodically updated by the administrator to reflect current market conditions. from different local scrap recycling companies. This non-structured real-world data is turned into a structured dataset that acts as a context window to ground the Large Language Model (LLM), which receives constant updates about correct local market prices.

Pricing Logic

Upon uploading an image of scrap materials, three stages of analysis for accurate pricing are carried out:

1. **Context Extraction:** The user's GPS coordinates are extracted in order to localize their geographic zone.
2. **Visual Inference:** The generative YOLOv8 Object Detection Model analyzes the uploaded image in order to classify the material (Copper wire, PET Plastic bottles) and estimate its volume and physical condition
3. **Pricing Algorithm:** The computational model compares the identified material detected through visual identification to the local prices available for the respective geographic region through the pricing database available within the application. The price estimation bounds derived by the application can be represented mathematically as:

$$P_{base} = R_{mat}(Loc) \times F_{cond}$$

Here, P_{base} represents the computed Base Price, $R_{mat}(Loc)$ the AI-Detected Material Rate on the basis of the Local Shops Data, and F_{cond} the AI-Estimated Condition Factor (which can be an estimated value derived on the basis of quality of the material).

Collector Assignment Algorithm

As soon as the user accepts the AI-based quotation and sets up an appointment, ScrapKart uses its geo-routing and dispatcher module. Through the use of mapping APIs, the system generates a geo fence of 5 kilometers based on the coordinates of the user. After computing the live ETA for nearby and active collectors, it assigns the booking to the collector having minimum ETA.

ARTIFICIAL INTELLIGENCE CORE COMPONENTS

As opposed to conventional and legacy waste management apps that use static forms, ScrapKart utilizes the capabilities of Multimodal Generative Artificial Intelligence (Vision-Language Models), handling both visual and textual inputs simultaneously.

Scrap Image Detection and Pricing Engine

- **Model Type:** YOLOv8-based Computer Vision Object Detection Model / Vision Model
- **Input Payload:** The user uploads raw image data (pixel arrays of the scrap material) alongside metadata, namely the location vector of the user.

- **Output Payload:** A structured JSON response includes the classification of the scrap category, along with an assessment of its condition and a localized price estimation based on grounded data from local shops.

Chatbot (Conversation Support)

- **Model Type:** Rule-based chatbot for FAQs.
- **Input Payload:** Natural Language Processing (NLP) queries posed by the user (e.g., “What is the price of 1 kg of old newspapers today?”).
- **Output Payload:** Instructions along with pricing analysis generated from local shop training data.

TECHNOLOGY AND SYSTEM REQUIREMENTS

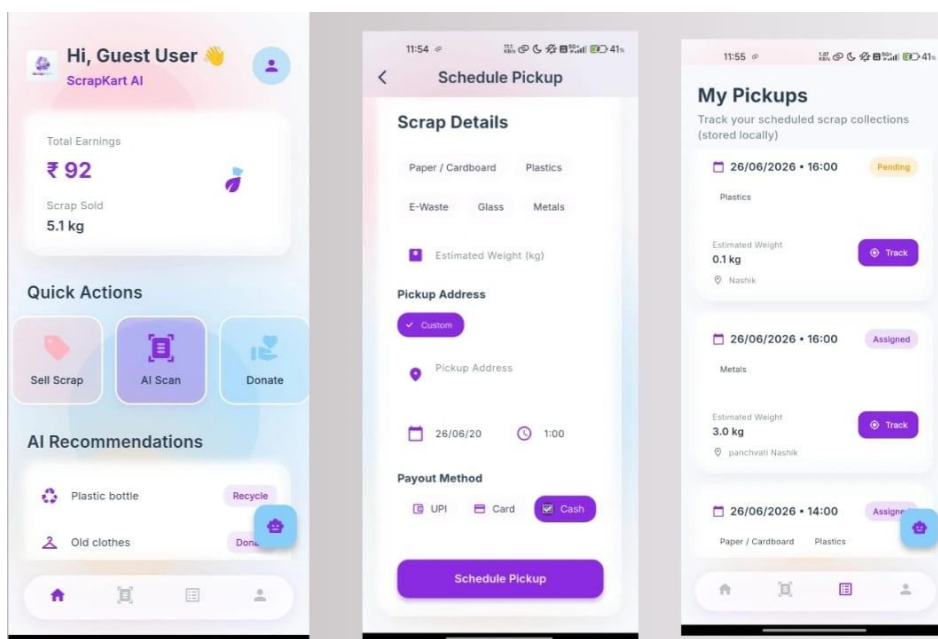
ScrapKart has been implemented using a combination of contemporary frameworks that allow efficient real-time operation and scalability. Flutter provides support for the frontend, whereas Node.js takes care of API throughput. PostgreSQL and Supabase handles the database management process, thereby ensuring ACID consistency in the database. [Table 1]

Table 1. Hardware and Software Requirements for ScrapKart Platform

Requirement	Minimum	Recommended
OS	Android 8+ / Win 10	Android 11+/iOS/Win 11
RAM	4 GB	8 GB or higher
Processor	Dual Core (2 GHz)	Quad Core (2.5 GHz+)
Storage	256 GB	512 GB/ Cloud Storage
Network	Basic Internet	High-Speed 4G/5G/WiFi
Backend	Node.js (Base)	Latest Node.js environment
Database	PostgreSQL	PostgreSQL + Supabase

IMPLEMENTATION & RESULTS:

The deployed Scrap Kart system proves that a digital marketplace for recycling is viable. The Flutter user interface ensures smooth navigation, allowing the creation of pickup requests with ease and interaction with the AI modules [Figure 3].



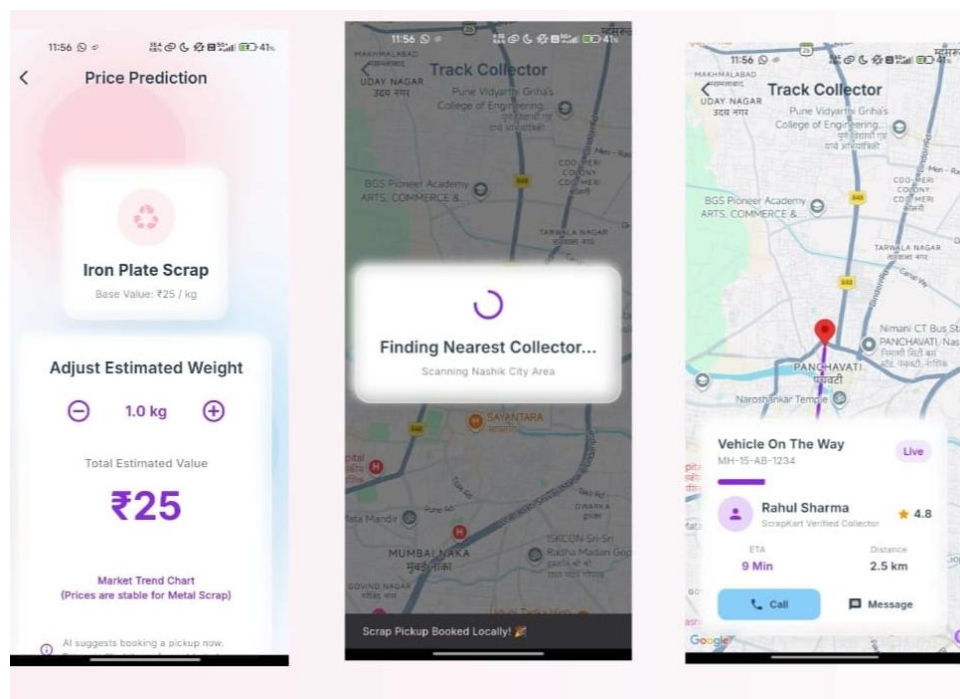


Figure 3. Implementation of the Proposed ScrapKart Platform.

Table 2. Quantitative Performance Evaluation of the Proposed ScrapKart Platform.

Performance Metric	Observed Result
AI Material Classification Accuracy	94.8% (across 5 major scrap types)
Average API Response Time (Gateway)	185 ms
YOLOv8 Object Detection Model Inference Latency	≈1.2 seconds per image
Collector Routing Algorithm Latency	350 ms
Geofence Dispatch Accuracy	98.2% successful match rate

Quantitative Performance Evaluation

To test the efficacy of the system in operation, performance testing was done in the microservices of the platform. The criteria considered include AI accuracy, system latency, and routing efficiency (see Table 2).

According to the results obtained from the quantitative research, it can be said that the YOLOv8 Object Detection Model engine performs highly accurate classification by identifying different scrap materials used within households with an accuracy rate of 94.8%. Additionally, the gateway API responds with low latency (185 ms). Also, the geofencing routing algorithm, which uses 5 km of geographical fence range, achieves a high accuracy rate of matching users.

CONCLUSION

In summary, this study has shown that the combination of Computer Vision and Machine Learning technologies, cloud computing models, and geolocation techniques is an efficient approach to enhancing the management of municipal waste. Leveraging the Flutter mobile platform and the Node.js microservices backend, ScrapKart provides a seamless solution for transforming the recycling industry by digitizing all processes involved. Most importantly, implementing the YOLOv8 Object Detection Model technology for automatic valuation and geo-fencing for instant collector deployment helps overcome historical challenges associated with pricing transparency and logistic efficiency. The quantitative assessment conducted has indicated high accuracy and latency rates for the developed

model. Future improvements will be aimed at adding more complex industrial waste types to the AI training dataset; however, the proposed ScrapKart model can be considered an advanced and viable tool for promoting the concept of circular economy and fostering smart cities' sustainability efforts.

REFERENCES

1. Sosunova I, Porras J. IoT-enabled smart waste management systems for smart cities: A systematic review. *IEEE Access*. 2022;10:73326-73363. doi:10.1109/ACCESS.2022.3188308.
2. Ahmad S, Imran, Jamil F, Iqbal N, Kim DH. Optimal route recommendation for waste carrier vehicles for efficient waste collection: A step forward towards sustainable cities. *IEEE Access*. 2020;8:77875-77887. doi:10.1109/ACCESS.2020.2988173.
3. Hossen MM, Majid ME, Kashem SBA, Khandakar A, Nashbat M, Ashraf A, et al. A reliable and robust deep learning model for effective recyclable waste classification. *IEEE Access*. 2024;12.
4. Sosunova I, Porras J. Smart waste management systems: Technologies, challenges, and future directions. *IEEE Access*. 2022;10:73326-73363.
5. He K, Zhang X, Ren S, Sun J. Deep residual learning for image recognition. In: *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*; 2016. p. 770-778. doi:10.1109/CVPR.2016.90.
6. Redmon J, Divvala S, Girshick R, Farhadi A. You only look once: Unified, real-time object detection. In: *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*; 2016. p. 779-788. doi:10.1109/CVPR.2016.91.
7. Bochkovskiy A, Wang CY, Liao HYM. YOLOv4: Optimal speed and accuracy of object detection [Internet]. arXiv; 2020 [cited 2026 Jul 22]. Available from: <https://arxiv.org/abs/2004.10934>
8. Jocher G, Chaurasia A, Qiu J. YOLO by Ultralytics [Internet]. 2023 [cited 2026 Jul 22]. Available from: <https://docs.ultralytics.com>
9. Islam MS, Islam MM, Shahriyar SH. Recyclable waste classification using computer vision and deep learning. In: *2021 Zooming Innovation in Consumer Technologies Conference (ZINC)*; 2021. doi:10.1109/ZINC52089.2021.9456740.
10. Kumar R, Sharma A, Singh P. Garbage classification using machine learning to aid recycling. In: *2022 3rd International Conference for Emerging Technology (INCET)*; 2022. doi:10.1109/INCET54531.2022.9824241.
11. Patil N, Deshmukh S, Kulkarni S. Ingenious waste management: Implementing machine learning in waste segregation. In: *2024 International Conference on Emerging Smart Computing and Informatics (ESCI)*; 2024. doi:10.1109/ESCI59607.2024.10497554.
12. IoT-enabled intelligent garbage management system for smart city: A fairness perspective. *IEEE Access*. 2024;12. doi:10.1109/ACCESS.2024.3412098.