

SMART PLASTIC MANAGEMENT SYSTEM FOR ECO-FRIENDLY ENVIRONMENT

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Abstract- The rapid increase in plastic consumption has created serious environmental challenges related to waste disposal and pollution. Traditional waste management systems often lack transparency, accountability, and active public participation, resulting in ineffective recycling practices. This paper presents a Smart Plastic Management System for Eco-friendly Environment, designed to encourage responsible plastic disposal through digital tracking and reward-based incentives. The system registers users with unique barcode-based identification and records plastic product details at the time of purchase. During disposal, user ID and product barcodes are scanned and verified through a centralized backend system. Valid disposal actions are confirmed, and reward credits are allocated automatically to users. The system operates through a web-based platform integrated with barcode scanning hardware, making it scalable, cost-effective, and suitable for real-time deployment. Performance evaluation shows fast response time, high verification accuracy, stable operation, and reliable reward allocation. The proposed system demonstrates an effective approach to improving plastic waste management through digital accountability and incentive-driven participation.

Keywords- Smart Waste Management, Plastic Recycling, Barcode-Based Identification, Reward System, Environmental Sustainability, Web Application, Digital Tracking

INTRODUCTION

Plastic waste has become one of the most critical environmental issues due to improper disposal practices and lack of accountability in waste handling systems. With increasing urbanization and consumer-driven lifestyles, plastic products are widely used, but effective mechanisms to track and manage plastic waste remain limited. Traditional waste collection and recycling methods often operate without individual-level verification, leading to poor participation and low recycling efficiency.

Smart technology-driven solutions offer new opportunities to address these challenges by integrating digital tracking, automated verification, and incentive mechanisms. While several waste management initiatives exist, many lack real-time tracking of plastic products from purchase to disposal and fail to motivate users to adopt responsible disposal habits. To overcome these limitations, this paper proposes a **Smart Plastic Management System** that digitally tracks plastic products and rewards users for proper disposal, thereby promoting eco-friendly behavior and environmental sustainability.

RELATED WORK

Several studies have focused on waste management systems, recycling technologies, and smart city initiatives. Traditional waste management systems rely heavily on manual segregation and centralized collection, offering limited accountability at the user level. Barcode-based and RFID-based tracking systems improve monitoring but are often limited to industrial applications.

Some digital recycling platforms introduce incentive mechanisms; however, they depend on manual verification and lack integration with purchase-level tracking. Smart bins equipped with sensors improve automation but are expensive and difficult to deploy at scale. The proposed system integrates the strengths of these approaches by combining barcode-based tracking, centralized verification, and reward allocation into a unified, cost-effective digital platform suitable for community and municipal deployment.

SYSTEM ARCHITECTURE

The proposed system follows a modular architecture consisting of five main layers:

- **User Interaction Layer:** Handles user registration and barcode scanning at disposal points.
- **Input Layer:** Captures user ID and plastic product barcodes.
- **Processing Layer:** Verifies user identity, product purchase, and duplicate disposal attempts.
- **Transaction Layer:** Confirms disposal and allocates reward credits.
- **Logging Layer:** Stores disposal history, rewards, and system analytics.

This layered architecture ensures scalability, maintainability, and reliable system operation.

METHODOLOGY

The system workflow begins with user registration and barcode ID generation. Plastic product details are recorded at the time of purchase through barcode scanning. During disposal, the user scans both the ID and product barcode at a smart disposal unit. The backend system verifies the data, checks for duplicate disposal attempts, and validates the transaction. Upon successful verification, reward credits are allocated to the user account. All transactions are logged for reporting and analytics.

SYSTEM IMPLEMENTATION

The system is implemented using a web-based backend integrated with barcode scanning hardware. User registration, product entry, disposal verification, and reward allocation are handled through modular

components. A centralized database stores user details, product records, disposal history, and reward transactions. The modular approach simplifies testing, maintenance, and future expansion.

PERFORMANCE EVALUATION

Performance evaluation was conducted to assess system responsiveness, verification accuracy, and operational stability. The system demonstrated quick response times for barcode scanning and disposal validation. Verification accuracy remained consistently high under normal operating conditions. The system maintained stable performance during repeated disposal operations, confirming its suitability for real-time waste management environments.

RESULTS AND DISCUSSION

The system successfully tracked plastic products from purchase to disposal, verified user actions, prevented duplicate disposals, and allocated rewards accurately. Visual feedback through dashboards improved transparency and user engagement. The results show that incentive-based digital tracking significantly enhances participation in responsible plastic disposal and recycling activities.

CONCLUSION AND FUTURE SCOPE

The **Smart Plastic Management System for Eco-friendly Environment** successfully demonstrates how digital tracking and incentive mechanisms can improve plastic waste management. The system promotes

accountability, encourages responsible behavior, and supports environmental sustainability. Future enhancements may include integration with IoT-based smart bins, expansion to multiple waste categories, city-wide deployment, advanced analytics using machine learning, and mobile application support for broader accessibility.

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