

E-Waste Facility Locator

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Abstract. India is grappling with a serious challenge in managing electronic waste, producing over 1.71 million metric tons annually. When improperly handled, this e-waste contributes to significant environmental damage and public health hazards. Existing disposal methods lack comprehensive integration, making it difficult for both individuals and organizations to locate trustworthy e-waste recycling facilities. This paper proposes a solution in the form of the E-Waste Facility Locator, a web-based platform that aggregates e-waste recycling centers across India, enabling users to conveniently find and access these facilities. Beyond locating services, the platform also provides educational resources on responsible e-waste disposal practices and a centralized repository of regulatory information, encouraging compliance. This paper details the development, testing, and deployment processes, underscoring the platform's potential to facilitate sustainable e-waste management and safeguard public health.

Keywords. E-waste management, facility locator, environmental sustainability, public health, user education.

1 INTRODUCTION

As India's technological adoption accelerates, the volume of electronic waste (e-waste) the country generates continues to rise, with 2021 witnessing approximately 1.71 million metric tons of e-waste. Improper disposal of this waste poses severe environmental and health risks, releasing toxic substances like lead, mercury, and cadmium into ecosystems. For instance, cadmium exposure can lead to kidney damage, while lead is particularly harmful to children's brain development. Thus, effective e-waste management is an environmental and public health necessity. Currently, there is no easily accessible tool that allows people and organizations to locate e-waste disposal facilities. This research addresses that gap by proposing a web application—the E-Waste Facility Locator—designed to help users find nearby e-waste recycling facilities and educate them on the importance of responsible e-waste management while promoting adherence to environmental regulations.

1.1 Objectives:

1. To raise awareness on proper e-waste disposal

The application includes an educational section that informs users about the hazards of improper disposal and best practices for e-waste management.

2. To improve access to recycling facilities

Through location-based services, users can easily find the nearest recycling centers, making responsible disposal more convenient.

3. To promote compliance with e-waste management regulations

By providing a centralized repository of regulations, the application helps users stay informed about legal requirements and compliance measures.

4. To support sustainable practices

The platform encourages sustainable consumption and disposal habits, reducing environmental impacts and minimizing health risks associated with e-waste.

2 LITERATURE SURVEY

Current e-waste disposal methods include individual websites operated by recycling centers. While these sites provide basic information such as location and operating hours, they suffer from several limitations:

1. *Lack of Interconnected Facility Data*

Most facilities operate standalone websites, which restricts users to finding a single facility at a time. This fragmentation can make it challenging for users to access multiple disposal options.

2. *Limited Geographic Coverage*

Many e-waste facility websites focus on major urban areas, making it difficult for people in rural regions to find nearby options.

3. *Inconsistent User Experiences*

Facility websites vary widely in design and functionality, leading to an inconsistent user experience.

4. *Minimal Educational Resources*

Few existing platforms offer in-depth information on the dangers of improper disposal or best practices for e-waste management.

5. *Insufficient Regulatory Guidance*

Without access to comprehensive regulations and compliance information, users may not fully understand the legal implications of improper disposal.

Several studies have highlighted the need for a more unified approach to e-waste management. For instance, Shi et al. (2019) examined multi-period facility location models that optimize collection efforts across large areas, advocating for a unified strategy to mitigate environmental impact. Chaudhary and Vrat (2016) explored the challenges of facility location in the National Capital Region (NCR) of India, suggesting adaptable models to meet various geographic and logistical needs. Meanwhile, Doe (2017) proposed an integrated e-waste management platform to improve accessibility and user engagement.

3 PLATFORM DEVELOPMENT

1. *Frontend*

Built with HTML, CSS, JS, the frontend offers a responsive, dynamic user interface which allows for efficient updates and navigation and enables server-side rendering, enhancing load times.

2. *Backend*

The backend is powered by Express.js, a flexible web application framework for Node.js. With RESTful API support, it facilitates efficient data exchanges, providing users with real-time facility information.

3. *Database*

MySQL was selected for its scalability, reliability, and security, managing facility details, user data, blog content, and regulatory information for quick retrieval and easy access.

3.1 System Design

1. *Locate E-Waste Facility:*

- User inputs location or uses geolocation.
- System finds nearby e-waste facilities.
- If facilities are found, the system displays them.
- If no facilities are found, the system displays an error message.

2. *View Facility Details:*

- User selects a facility to view its details.

3. *Access Educational Blog:*

- User reads educational content.

4. *View Rules & Regulations:*

- User accesses the repository for rules and regulations related to e-waste disposal.

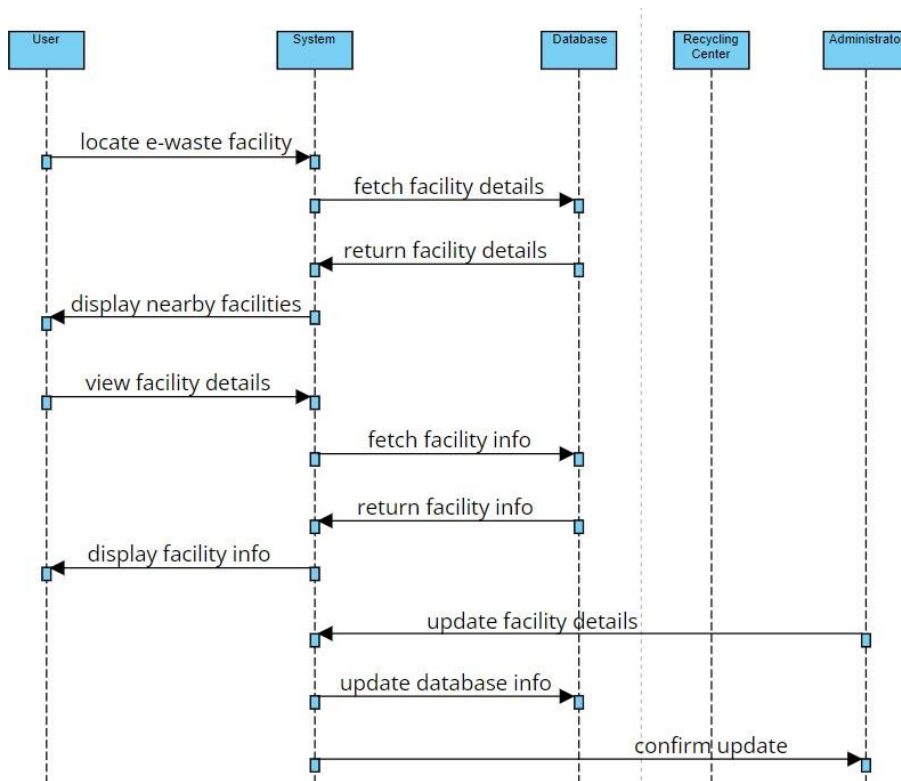


FIGURE 1: Sequence Diagram

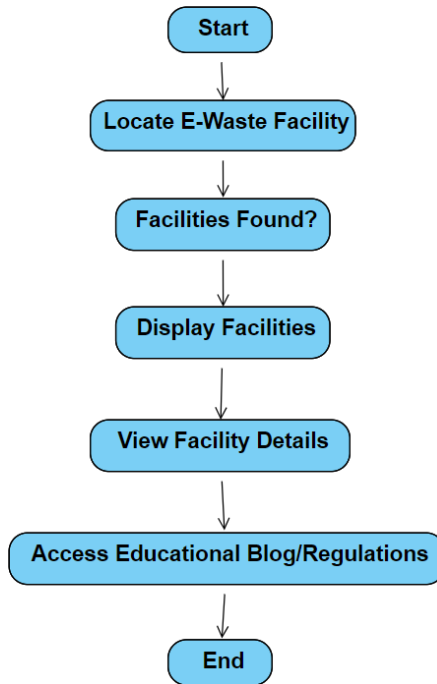


FIGURE 2: Activity Diagram

4 RESEARCH METHODOLOGY

A structured methodology was followed to ensure thorough development and testing:

4.1 Data Collection

Data from recycling centers, government bodies, and regulatory agencies was gathered, processed, and organized within the MySQL database, ensuring users have access to accurate and comprehensive information.

4.2 Platform Development

The application was developed in several phases:

Initial Setup: React and Next.js were used to establish the basic application structure and layout, focusing on a user-friendly interface.

Location-Based Services: GPS integration allowed the facility locator to provide users with accurate location data.

Educational Content and Regulatory Repository: Informational content was created for the blog, while the regulatory repository was populated with data on e-waste laws and compliance guidelines.

4.3 Testing and Debugging

Rigorous testing across devices and browsers ensured a seamless user experience. Functional testing verified feature performance, while usability testing refined the interface for ease of use.

4.4 Deployment

After testing, the application was deployed on a cloud platform to ensure nationwide access. Ongoing maintenance keeps the platform current with evolving e-waste regulations and facility data.

5 RESULTS AND DISCUSSION

5.1 Prototype Testing

Evaluations with a sample group revealed positive feedback on the platform’s usability. Most users reported that the locator significantly improved their ability to find recycling centers, and many appreciated the educational content, noting it increased their understanding of responsible disposal practices.

5.2 Comparative Analysis

The E-Waste Facility Locator offers a more integrated and user-centric experience than standalone recycling websites. The centralized repository of regulations was a unique feature that made information more accessible.

5.3 Impact

By consolidating information on e-waste facilities, regulations, and best practices, the platform fosters a more sustainable approach to e-waste management, reducing environmental and health risks. It also aids in regulatory compliance, supporting the enforcement of e-waste management laws.



FIGURE 3: Home page of E-Waste Facility Locator Application

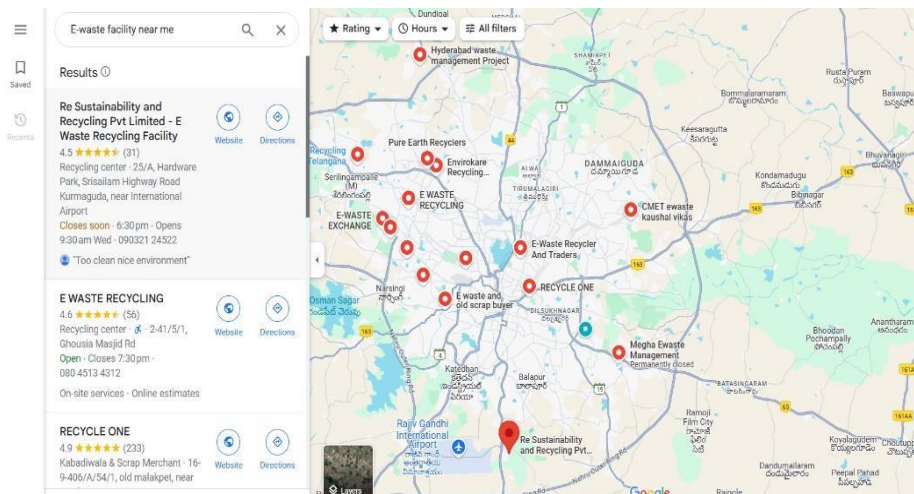


FIGURE 4: Facility Locators



FIGURE 5: User Education Web page



FIGURE 6: Educational Blog Posts Web page

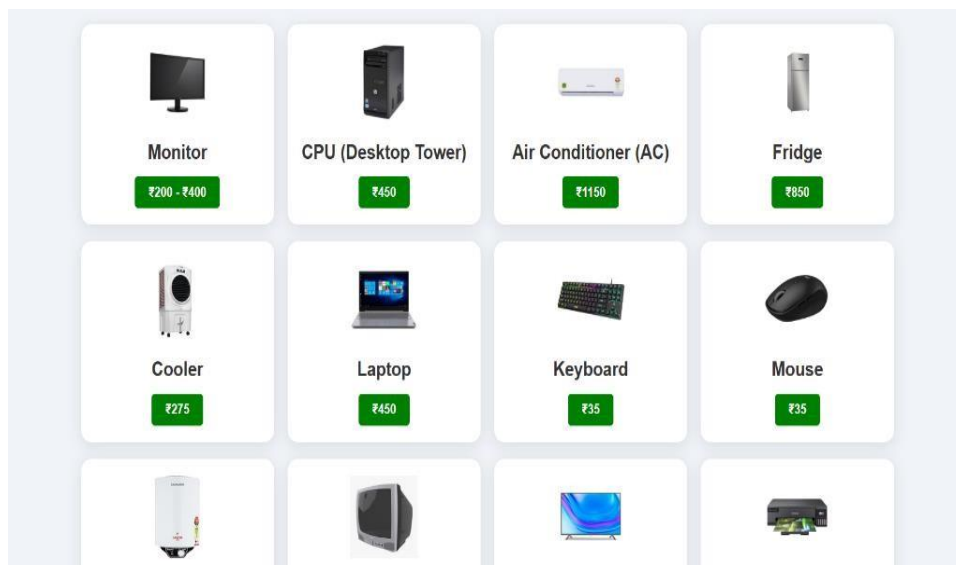


FIGURE 7: Average Costs of Electronic Appliances for recycling



FIGURE 8: Rules and Regulations of E-waste management

6 CONCLUSION:

The E-Waste Facility Locator is a significant step forward in e-waste management, offering a centralized platform with location-based services, educational resources, and regulatory information. This solution addresses key challenges like limited facility access and low awareness of proper disposal practices. Future developments could include expanding facility coverage, adding real-time data, and using AI to predict and manage disposal needs. This platform ultimately supports sustainable development goals by encouraging responsible e-waste disposal, protecting public health, and fostering environmental stewardship.

7 DECLARATIONS

Study Limitations: Limited regional data may affect coverage.

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