

EcoCheck: Transforming Local Waste Management through Community-Driven Mobile Reporting

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Abstract

Waste volume and improper disposal present a tough social concern. In the Philippines, escalating waste volume compounds inadequate waste infrastructure. This situation requires integrated strategies for both refining disposal and easing sustainable consumption. This study developed EcoCheck, a community-driven mobile app for recycling and waste management reporting. It allows residents to report illegal dumping using geo-tagged photos and access proper recycling information. Local Government Units (LGUs) gain actionable data to inform waste infrastructure decisions. This approach uses "citizen science" to enhance environmental literacy and advocacy. The study used a quantitative research design. Researchers evaluated the app using the ISO/IEC 25010 software quality standard. Participants included residents, barangay officials, and IT experts. EcoCheck successfully met its objectives. It provides a practical, scalable model to increase public awareness and supply LGUs with real-time, geo-specific data. Future work should scale implementation and add reward systems to further increase participation. EcoCheck is a feasible, high-quality digital intervention for waste management.

Keywords: Waste Management, Citizen Science, Geo-tagging, Mobile Application, ISO/IEC 25010, Local Governance.

1. Introduction

Increasing waste volume and improper disposal are among the toughest concerns facing society today. Global municipal solid waste (MSW) reached 2.1 billion tons in 2023 and is projected to hit 3.8 billion tons by 2050 (UNEP, 2024). While high-income nations generate more waste, lower-income countries face a sharp surge in output burdens, often tripling their daily production (World Bank Group, 2025). In the Philippines, waste generation is projected to reach 77,776 tons per day by 2025, yet only 29.25% of LGUs are serviced by operational landfills (DENR-EMB, 2021; NSWMC, 2021).

To address these challenges, this study proposes EcoCheck, a community-driven mobile app designed to bridge the gap between residents and local governance. Using "citizen science" and "crowdsourcing," the platform empowers residents to report illegal dumping with geotagged photos and descriptions for quick analysis (Syafudin et al., 2023; Naccarella et al. 2023). By providing an all-inclusive digital design

solution, the app encourages local action against improper disposal and aims to improve community recycling habits.

In line with the United Nation Sustainability Goals, EcoCheck aligns with SDG 11: Sustainable Cities and Communities by providing technology-enabled solutions that bridge the digital divide in environmental governance. It also advances SDG 12: Responsible Consumption and Production by fostering ecological literacy and promoting sustainable habits through immediate feedback and digital monitoring (UNEP, 2024; Addas et al., 2024).

2. Methodology

2.1 Research Design and Study Approach

This study utilized a quantitative research design to evaluate the quality, effectiveness, and technical soundness of the EcoCheck mobile application. The approach centered on a system evaluation aligned with the ISO/IEC 25010 software quality model, which provides a structured framework for assessing software products. This design was selected to empirically measure technical performance and user satisfaction, ensuring that the application meets the standards required for public environmental reporting and local governance integration.

2.2 Participants and Study Setting

The study was conducted in Barangay Bulaon, City of San Fernando, Pampanga, a locale chosen due to its significant population density and the subsequent need for efficient waste management monitoring. A total of 98 respondents were involved in the evaluation: 90 local residents to assess usability, 4 barangay officials to evaluate administrative utility, and 4 IT experts to audit the system's technical architecture. Purposive sampling was employed to select experts and officials with the relevant knowledge to provide a high-level technical and operational critique.

2.3 Research Instrument

The primary research instrument was a structured evaluation survey based on the ISO/IEC 25010 Software Quality Model. The instrument was designed to measure nine key quality characteristics: Functional Suitability, Performance Efficiency, Usability, Reliability, Security, Maintainability, Portability, Compatibility, and Functional Effectiveness. Respondents rated the system using a four-point Likert scale, ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). This validated instrument ensured that the feedback collected was both objective and technically comprehensive.

2.4 Data Collection Procedure

Data collection began after securing necessary ethical clearances and permissions from local authorities. Participants were first given a walkthrough and a live demonstration of the EcoCheck application. Following the demonstration, they engaged in hands-on testing, where they simulated reporting illegal dump sites and navigating the recycling modules. After the testing phase, the survey instruments were administered. IT experts performed a deeper dive into the system's backend to assess security and maintainability, while residents focused on the front-end user experience. Feedback gathered during the sessions was documented for further system improvements.

2.5 Data Analysis

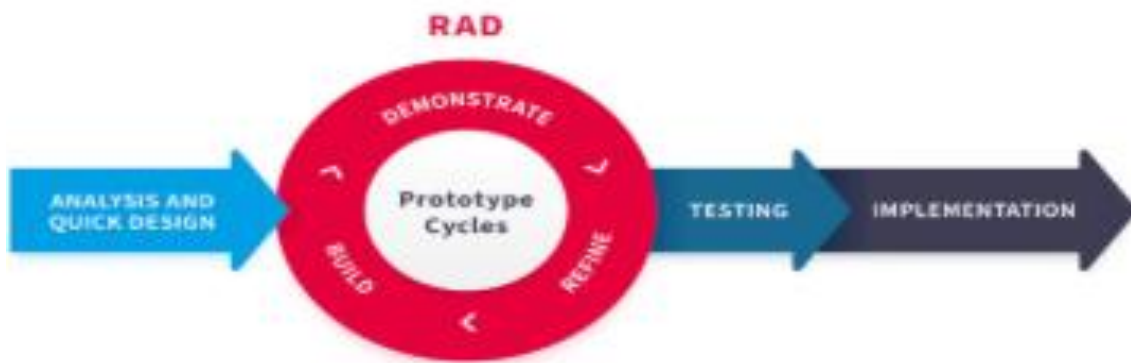
Quantitative data gathered from the surveys were analyzed using descriptive statistics, focusing on the weighted mean and standard deviation. These metrics were utilized to determine the overall quality rating and technical performance of the software. To interpret the results, a categorical mean range was established to provide a verbal interpretation of the system's effectiveness. High mean scores across the

evaluated categories signified that the application met or exceeded the standard requirements for specific software quality characteristics. This statistical analysis provided the objective basis for validating EcoCheck as a viable and effective digital tool for community-driven waste management.

3. System Development Methodology

The EcoCheck platform was developed using the Rapid Application Development (RAD) Agile Methodology under the System Development Life Cycle (SDLC). This iterative framework was chosen for its emphasis on rapid prototyping and continuous user feedback, which is essential for community-driven tools. The development process was divided into four distinct phases: (1) Requirements Planning, to define the scope of waste reporting features; (2) User Design, involving the creation of interface prototypes; (3) Construction, where the geotagging and database modules were built; and (4) Cutover, which involved final testing and deployment for user evaluation.

Figure 1: Rapid Application Development



4. Results and Discussion

The EcoCheck system is developed within a structured technical framework aligned with ISO/IEC 25010 to support effective, community-based waste management. The study evaluates the system using a dual-perspective approach, consisting of a comprehensive user assessment involving residents and an in-depth technical audit conducted by IT professionals. This approach ensures that the platform is both accessible and user-friendly for the public, while also satisfying key requirements for security, reliability, and long-term maintainability in government deployment. The system also promotes active community participation in environmental monitoring and reporting. Real-time data collection enhances the accuracy and efficiency of waste management operations. Furthermore, the platform supports data-driven decision-making for local government units and environmental agencies. It also encourages greater environmental awareness and responsibility among community members.

Table 1: Summary of User Evaluation Results

No.	Quality Characteristics	Mean	Standard Deviation	Verbal Interpretation
1.	Functional Suitability	3.68	0.47	Very High
2.	Usability	3.68	0.48	Very High
3.	Reliability	3.36	0.50	High

4.	Final Mean/SD	3.57	0.48	Very High
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Results in Table I show that residents in Barangay Bulaon perceive the overall quality of EcoCheck as Very High. While the app is considered highly available and appropriate for waste reporting, the lower score in Reliability (3.36) indicates a need for minor technical refinements regarding system consistency during intermittent network use. Despite this, respondents generally found the application responsive, easy to navigate, and effective in supporting community-based waste monitoring activities. The high ratings in usability and functionality suggest that the system successfully meets the needs and expectations of its intended users. These findings indicate that EcoCheck has strong potential for wider implementation and adoption in local environmental management programs.

Table 2: Consolidated IT Experts Evaluation Summary

No.	ISO Characteristics	Mean	Standard Deviation	Verbal Interpretation
1.	Functional Suitability	3.67	0.53	Very High
2.	Performance Efficiency	3.58	0.55	Very High
3.	Compatibility	3.63	0.54	Very High
4.	Usability	3.71	0.46	Very High
5.	Reliability	3.81	0.38	Very High
6.	Security	3.80	0.32	Very High
7.	Maintainability	3.80	0.40	Very High
8.	Portability	3.67	0.39	Very High
9.	Safety	3.85	0.30	Very High
10.	Final Mean/SD	3.72	0.43	Very High

Table II highlights that IT experts have a Very High level of confidence in the system’s technical architecture. Notably, Safety (3.85) and Reliability (3.81) were the highest-rated attributes, validating that the app rigorously protects user identity and handles sensitive location data with high integrity. These results indicate that the backend design is robust and adheres to secure development practices suitable for public deployment. Furthermore, the system demonstrates strong resilience in handling data transactions even under varying network conditions. Overall, the evaluation confirms that EcoCheck meets essential technical standards required for government-level implementation.

5. System Features

The EcoCheck system provides residents with a user-friendly digital platform for reporting illegal waste dumping and accessing recycling information. It allows users to submit reports quickly with location-based details for faster response. The system also promotes proper waste disposal practices through accessible educational content.

Figure 2: EcoCheck Homepage and Reporting Features



EcoCheck provides a secure experience by requiring account registration and email verification, ensuring only verified residents can access the platform. The homepage serves as the main hub, allowing users to monitor their participation through a progress tracker and access educational modules on waste segregation. Through the report waste interface, residents can capture photographic evidence and automatically tag precise geo-locations, while the tracking screen provides real-time updates on the status of their submissions to ensure LGU accountability.

Figure 3: Admin Dashboard



The EcoCheck Admin Dashboard provides barangay officials with a centralized overview of environmental monitoring and waste reporting analytics. It displays key metrics such as total reports, active cases, and resolved reports, alongside a tracker to identify environmental hotspots. The interface also features status distribution charts and submission trends to help LGUs make data-driven decisions and manage case resolutions. It also improves monitoring efficiency and coordination among officials. Additionally, it supports faster response and prioritization of reported environmental concerns. This enables more effective and timely environmental interventions at the barangay level. It also strengthens transparency in tracking environmental compliance and response actions.

6. Conclusion

The EcoCheck digital platform is designed to empower local residents by directly involving them in environmental governance, reducing the prevalence of illegal dumping, and promoting transparent waste management practices. By creating a direct reporting channel between citizens and local government units, the system helps bridge the long-standing gap between community observations and official environmental response mechanisms. Findings from the study revealed that while technical challenges such as system consistency under intermittent connectivity were identified, there was an overwhelmingly positive response regarding the app's usability, accessibility, and functional suitability.

With features such as geotagged reporting, educational recycling modules, and tracking mechanisms for waste disposal sites, EcoCheck strengthens real-time environmental monitoring and improves the accuracy of reported violations. It also enhances ecological awareness by encouraging residents to actively participate in proper waste segregation and disposal practices. These capabilities allow LGUs to respond more efficiently and make data-driven decisions based on verified field reports.

Ultimately, EcoCheck positions itself as a practical and scalable tool for strengthening local environmental governance and community participation. However, its long-term effectiveness depends on sustained user engagement, continuous technical refinement, and the potential integration of incentive-based mechanisms to encourage consistent adoption and reporting behavior.

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