EcoSort: A Mobile Application for Accurate Waste Segregation Using Image Recognition Technology

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1 Background of the Study

Waste management has been acknowledged since ancient times, as demonstrated by early cities like Rome and Athens. Nevertheless, this mainly focus in only removing the waste rather than recycling or segregation. With time, especially during industrialization and city growth processes, there was an increase in quantities of wastes leading to more systematic waste management approaches. It was only the end of the 20th century that waste categorization emphasizing on biodegradable, non-biodegradable, and recyclable materials became importance hence transitioning towards a recycling and usability in modern waste management systems.

In today's world, waste management has become a critical global issue due to rapid increase in urbanization, industrialization, and population growth. Especially in the Philippines, where it has been reported to increase more than 59.24 thousand tons per day. in 2022. Poor waste segregation, on one hand, contributes much to environmental degradation through soil and marine pollution. Various policies have been implemented to encourage proper waste disposal. However, public awareness and participation in proper segregation practices are still at a minimal rate.

Since mobile phone technology is increasingly becoming parts of people's live, it can provide a way to address such practical issues like waste management. This research proposes that a mobile application which will use an image recognition for sorting waste into biodegradable, non-biodegradable, and recyclable should be developed to help improve waste segregation practices. Through technology usage, this research aims to encourage people to properly segregate there waste and create an environmentally conscious behaviors.

Previous studies have explored various waste management approaches such as manual classification, recycling programs, and automated sorting systems. Most of the existing research on mobile applications used for real-time waste classification through image recognition is minimal. However, research by Papageorgiou et al. (2021) have carried out significant study which investigated the possibility to classify solid waste materials by use of mobile pictures through deep learning. In another study conducted by Li et al(2024), it has been indicated that effective user experience and interaction design in mobile application may help enhance user engagement and influence behavior change positively. For this reason, there is still no comprehensive waste classification system in combination with the capability of real-time image recognition focusing largely on mobile devices. This study aims to address this gap by developing an educational and practical mobile application for daily waste segregation purposes.

2 Statement of the Study

3 Objective of the Study

3.1 General Objective

The primary purpose of this Study is to develop a mobile application that will assist users in accurately classifies waste materials into biodegradable, non-biodegradable, and recyclable using an image recognition technology.

3.2 Specific Objective

- To develop an image recognition model, utilizing Google's AI training platform to accurately classifies waste items into biodegradable, non-biodegradable, or recyclable classes by training the model with uploaded images of various waste materials.
- To design a user-friendly mobile application interface using Android Studio, which will simplifies the process of identifying and categorizing of waste items.
- To evaluate the performance and accuracy of the trained model under various real-world conditions such as lightning and background interference.
- To assess the app's impact on users' environmental awareness and waste segregation behavior through feedback and usability testing.
- To provide a foundational study that can serve as a guide or inspiration for future developers working on related projects, such as automated waste sorting machines or other waste management innovations.

4 Significance of the Study

The proposed system holds significant potential by addressing environmental challenges through technological innovation. By developing a system capable of accurately categorizing waste as biodegradable, non-biodegradable, or recyclable, the study aims to enhance waste sorting practices and contribute to effective waste segregation. The following sections detail the benefits of the system:

- **Contribution to Knowledge:** The system's use of artificial intelligence represents a valuable advancement in the technological sector, particularly in environmental science. By offering an innovative approach to waste classification, it will fill gaps in current waste management practices and contribute to the body of knowledge on AI applications in environmental sustainability.
- **Practical Implications:** The system's features can assist users in more accurately classifying waste, potentially leading to:
  - Improved waste segregation, which enhances waste collection, disposal, recycling, and composting practices.
  - Increased environmental awareness and better segregation practices within households.
  - Integration into educational institutions for teaching proper waste management, thereby enhancing student engagement.
  - Benefits to government authorities and waste management professionals by improving waste sorting, recycling programs, and overall waste management systems.
  - Utilization by environmentalists for awareness campaigns and promoting environmental responsibility.
- **Theoretical Implications:** The development of this system may contribute to new theories or models in AI-enhanced waste management and human-computer interaction. It can provide insights into how technology influences human behavior and supports the evolution of personal-level waste management systems.
- **Policy Implications:** The successful implementation of this application could prompt local governments to revise waste collection policies, incorporating pre-collection waste separation. Such changes could include rewarding compliant households and imposing penalties on those that do not adhere to waste segregation guidelines.
- **Social and Economic Impact:** The system has the potential to alter individual behaviors regarding waste management, increase environmental awareness, and inspire communities to adopt cleaner environmental policies. Economically, it could lead to increased recycling rates, reduced landfill waste, and the production of natural composts beneficial for agricultural use.

- **Future Research Directions:** The system could pave the way for future research into advanced technological solutions for environmental sustainability. Future developments may include features for classifying additional types of waste and integrating more sophisticated models into broader waste management systems.

5 Scope and Limitation

5.1 Scope

- **Research Focus**: The study aims to develop and evaluate a mobile application designed to assist users in waste segregation by recognizing and categorizing waste as biodegradable, non-biodegradable, or recyclable. The app will utilize image recognition technology in alongside with a comprehensive database of waste items to ensure accurate classification. Additionally, the effectiveness of the user interface in guiding users and enhancing environmental awareness through educational content will be assessed.
- **Geographical Scope and Time Frame**: The research will be conducted in the Philippines, specifically targeting residents of Malolos, Bulacan. The study will span six months, covering both semesters of the academic year. This includes testing the app across different regions within the Philippines to ensure its functionality and adaptability.
- **Population and Sample**: The target population comprises residents of Malolos, Bulacan. A sample size of 50 individuals will be selected to provide insights into the app's usability and effectiveness across diverse communities.
- **Variables and Concepts**: Key variables include the app's accuracy in waste classification and the impact of its educational features on users' waste disposal behaviors. Concepts under examination include waste segregation, environmental awareness, and the role of mobile technology in promoting effective waste management.
- **Methodology**: The study involves developing a mobile application using Google's AI platform for image recognition. The model will be trained with images of waste to ensure accurate classification. Android Studio will be used to create a user-friendly interface. The app's performance will be tested under real-world conditions such as varying lighting and backgrounds. Usability testing and feedback will evaluate the app's impact on users' waste habits and environmental awareness. The study aims to provide a foundational framework for future waste management technologies.

5.2 Limitation

- **Methodological Limitations**: The image recognition technology may struggle with accurately classifying waste items that are damaged, dirty, or otherwise unrecognizable. This could result in incorrect classifications and recommendations.
- **Sample Size and Selection**: With a sample size of only 50 participants, the study's findings may not fully represent the diverse population of the Philippines. Focusing on Malolos, Bulacan, may also limit insights into waste management practices in more remote areas.

- **Data Availability**: The app's database of waste items may initially be incomplete, potentially leading to misclassification of new or uncommon items. Inadequate documentation of local recycling facilities or waste management systems could also limit the app's effectiveness in certain regions.
- **External Factors**: Changes in local or national waste management policies during the study could affect the app's recommendations, leading to inconsistencies. Additionally, variations in users' access to waste segregation resources could impact the app's effectiveness.
- **Time Constraints**: The six-month timeframe may limit the depth of the app's testing and refinement. This could affect the expansion of the database and the accuracy of the image recognition model, potentially resulting in a less comprehensive final product.