

Smart Waste Bin Prototype for University Waste Management

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Abstract. Waste mismanagement remains a critical issue in Indonesian campuses, where ineffective segregation and collection practices contribute to environmental pollution. Smart technologies offer opportunities to improve waste handling efficiency and monitoring in university environments. This study developed a smart waste bin prototype that integrates Internet of Things (IoT) sensors, machine learning–based image classification (MobileNetV2 with TensorFlow Lite), GPS tracking, and LoRa communication. The system was designed to classify three types of waste—plastic bottles, snack packaging, and cans—while enabling fill-level monitoring, automated sorting, and real-time location reporting. Experimental results showed strong classification accuracy for plastic bottles (100%), but lower performance for snack packaging (53–80%) and cans (40–67%), especially in low-light conditions or with darker materials. The overall real-time testing accuracy reached 45.1%. LoRa communication provided long-range connectivity but was affected by electromagnetic interference, while GPS tracking was reliable in open areas but inconsistent indoors. The prototype demonstrates the feasibility of integrating AI and IoT for scalable campus waste management. Despite environmental and hardware limitations, it offers a modular framework that can be refined with improved lighting, EMI shielding, and enhanced datasets. This research contributes a practical model for smart campus initiatives and supports the adoption of sustainable waste management practices in higher education environments.

Keywords: Smart Waste Bin, Machine Learning, LoRa communication, Waste -Classification, Internet of Things, IoT, Automated-Segregation, GPS