# Automatic Image Based Waste Classification

## 1. Executive Summary:

The management of solid waste in large urban environments has become a complex problem due to increasing amount of waste generated every day by citizens and companies. Current Computer Vision and Deep Learning techniques can help in the automatic detection and classification of waste types for further recycling tasks. In this work, we use Convolutional Neural Networks (CNN) for automatic classification of garbage types.

## 2. Problem Statement:

**Background:** Waste management is a critical issue in urban areas. Proper segregation of waste can significantly enhance recycling processes and reduce the environmental impact. Traditional waste segregation methods are labor-intensive. An automatic waste classification model segregates wastes into categories like plastic, paper, metal, glass, and organic waste.

**Objective:** To develop an automatic waste classification model using Convolutional Neural Networks (CNN) in Python for efficient waste segregation and recycling.

**Scope:** The model will classify waste images into predefined categories. The system will be designed for urban waste management, including household and industrial waste.

## 3. Data Sources:

**Primary Data:** Garbage Dataset (A Comprehensive Image Dataset for Garbage Classification) by Suman Kunwar on Kaggle is the primary data source for this project. This dataset features 10 distinct classes of garbage with a total of 19,762 images, distributed as Metal, Glass, Biological, Paper, Battery, Trash, Cardboard, Shoes, Clothes, Plastic.

## 4. Methodology:

**Data Collection & Preprocessing:**

- Ensure a balanced dataset with an equal representation of different waste categories.
- Perform image augmentation to increase dataset diversity.
- Resize images to a fixed resolution (e.g., 256x256 pixels).
- Normalize pixel values to a range of 0-1.

**Model Development:**

- Utilize Convolutional Neural Networks (CNNs) for feature extraction and classification.
- Implement the model using TensorFlow/Keras.
- Train and validate the model using a well-split dataset (e.g., 80% training, 10% validation, 10% testing).

**Model Evaluation & Optimization:**

- Use evaluation metrics such as accuracy, precision, recall, and F1-score.
- Tune hyperparameters to improve model performance.
- Compare results with traditional machine learning classifiers (e.g., SVM, Random Forest).

## 5. Expected Outcomes:

- An optimized CNN model capable of classifying waste into different categories with high accuracy.
- Improved efficiency in waste segregation and recycling processes.

## 6. Tools and Technologies:

- **Dataset:** Kaggle
- **Programming Language:** Python
- **Libraries:** TensorFlow/Keras, OpenCV, NumPy, Pandas, Matplotlib

## 7. Risks and Challenges:

- **Model Generalization:** Ensuring the model works effectively on different types of waste in real-world scenarios.
- **Environmental Variability:** Changes in lighting, background, and waste condition can affect classification accuracy.
- **Maintenance and Updates:** The model might need regular updates and maintenance to adapt to new types of waste and changing environmental conditions.

## 8. Conclusion:

This project aims to develop an automatic waste management through AI-based waste classification. By leveraging CNNs, we can enhance waste sorting efficiency, reduce manual effort, and contribute to a recycling processes and cleaner environment.