

# Design of AI Powered Waste Sorting Bin

## Available Bin options

1. <https://www.shopperspk.com/product/original-leifheit-hausrein-swing-dustbin-metallic-body-with-fiber-plastic-cap/>

**Dimensions:** 27.3 inches tall x 15.4 inches in diameter



2. <https://www.mjstraders.com/en/swing-70litre-top-round-stainless-steel-kitchen-paper-waste-garbage-dustbin>

**Dimensions:** 28x15 inch



H: 28inch x W: 15inch

3. [https://www.ubuy.com.pk/en/product/7Z0JBMKO-stainless-steel-trash-can-step-13-gallon-metal-trash-can-with-lid-large-garbage-cans-for-kitchen-bat?srsId=AfmBOorg4SGOFYndr0c6EXEUvgSzliU2rOSPbb4pbOGL8Cw2D\\_vKG9Wz](https://www.ubuy.com.pk/en/product/7Z0JBMKO-stainless-steel-trash-can-step-13-gallon-metal-trash-can-with-lid-large-garbage-cans-for-kitchen-bat?srsId=AfmBOorg4SGOFYndr0c6EXEUvgSzliU2rOSPbb4pbOGL8Cw2D_vKG9Wz)

**Dimensions:** 16.6 x 14.6 x 26 inches (42.2 x 37.1 x 66 cm); 13.64 Pounds (6.19 kg)

**Price:** PKR 36729



4. <https://www.ubuy.com.pk/en/product/4K279IXQK-trash-can-garbage-can-13-gallon-50l-stainless-steel-metal-bathroom-step-trash-can-for-home-and-kitchen-waste-and-recycling-with-lid-inner-bucket>

**Dimensions:** 18.7 x 16.7 x 28.3 inches



5. <https://www.ubuy.com.pk/en/product/T1RHI1C-eko-urban-commercial-ii-60-liter-15-8-gallon-open-top-trash-can-brushed-stainless-steel-finish?srsId=AfmBOorFowCzJj5RMMMcpAkZryQgj4Xt7dSUDYO0yQxzaWnVeVpq-b-J8>

**Dimensions:** 18.2"L x 12.4"W x 27"H



## Waste Classification and Compartmentalization Approach

The proposed Smart Waste Segregation System will classify discarded items into predefined waste categories and route them into corresponding compartments. The deep learning model will be trained on visually identifiable waste types such as plastic, paper, metal, glass, and organic waste. For practical implementation and mechanical feasibility in the prototype system, these categories will be grouped into three major compartments:

1. **Recyclable Waste**

Includes items such as plastic bottles, paper/cardboard, metals, and glass that can be processed for reuse. The system will identify these waste types with high priority to maximize recycling outcomes.

2. **Organic/Biodegradable Waste**

Consists of food scraps, tissues, and other decomposable materials that are suitable for composting and biological processing.

3. **General/Non-Recyclable Waste**

Covers contaminated materials, multi-material packaging, low-confidence classifications, or any waste that does not clearly fit into recyclable or organic categories.

A confidence-based decision strategy will be utilized, where the classification model must exceed a certain confidence threshold (e.g., 0.6–0.7) to determine the correct category. If the confidence falls below the threshold, the item will be directed to the General Waste compartment to avoid incorrect sorting. Additionally, user feedback and stored misclassified samples may be used to retrain the model, improving classification accuracy over time.

## **Mechanism Flow — Presence Detection and Classification Trigger**

The sorting process begins by identifying the presence of a waste item on the sorting plate. To ensure reliable and fast detection, a dual-sensor approach is used consisting of **an Infrared (IR) break-beam or Time-of-Flight (ToF) distance sensor** positioned above the plate, and a **load cell sensor** mounted beneath the plate. The IR/ToF sensor detects any object entering the bin by sensing interruption of the beam or a sudden decrease in distance, which enables rapid activation even for very lightweight materials such as paper or tissue. Once the initial detection is made, the system implements debouncing to eliminate false triggers caused by hand movement or accidental contact.

After brief stabilization, the load cell measures a change in applied weight to confirm the presence of a solid object. This secondary confirmation helps to avoid false activations and allows the system to log valuable data such as waste quantity and disposal patterns. If both conditions are satisfied, the plate is locked in its neutral position to ensure the object is fully stable before processing.

At this point, the top-mounted camera captures one or more images of the waste item under controlled lighting. These images are pre-processed and fed into the deep learning model deployed on the embedded controller. The trained model predicts the waste category along with a confidence score. If the predicted category exceeds a predefined confidence threshold, the system maps it to the corresponding compartment; otherwise, the object is considered uncertain and is directed to the General Waste bin to prevent misclassification.

Once the decision is made, the rotating plate aligns itself over the designated compartment using a servo motor and subsequently tilts to drop the waste item into the correct chamber. The plate then returns to its home position and the system resets to the idle state, ready for the next object.

This mechanism ensures reliable presence detection, reduces misclassification errors, and supports efficient real-time waste sorting with minimal user involvement.

### Sensors Available

IR Break Beam Sensor

<https://www.daraz.pk/products/nfrared-beam-sensor-dcac-single-infrared-beam-sensor-outdoor-waterproof-infrared-beam-alarm-for-security-system-factory-warehouse-i429191771.html>

**Price:** PKR 3,150

[https://www.ubuy.com.pk/en/product/H9MUDIK-adafruit-accessories-ir-break-beam-sensor-3mm-leds-1-piece?srsltid=AfmBOoo\\_vJzW9Q6rA--Z5sqSYtowffvUT91OrJfsrtsWSWznCMhT7zG0p](https://www.ubuy.com.pk/en/product/H9MUDIK-adafruit-accessories-ir-break-beam-sensor-3mm-leds-1-piece?srsltid=AfmBOoo_vJzW9Q6rA--Z5sqSYtowffvUT91OrJfsrtsWSWznCMhT7zG0p)

**Price:** PKR 5571

Load sensor

[https://digilog.pk/products/1kg-range-weighing-sensor-load-cell-sensor-for-electronic-ycz-131?srsltid=AfmBOorpakXMwCkdrHq5Y0NyFCo8\\_tUzeEcgggDJszyc-lXJxvdkv\\_Gr](https://digilog.pk/products/1kg-range-weighing-sensor-load-cell-sensor-for-electronic-ycz-131?srsltid=AfmBOorpakXMwCkdrHq5Y0NyFCo8_tUzeEcgggDJszyc-lXJxvdkv_Gr)

The load sensor will only work when the plate is stationary