

**FORM - 2**  
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**COMPLETE SPECIFICATION**  
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**An Evolutionary Leap in Waste Management: Re-Bot with Its Role  
In Promoting Sustainability By Segregation**

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**The following specification particularly describes the invention and the way it is to be performed:**

# **An Evolutionary Leap in Waste Management: Re-Bot with Its Role In Promoting Sustainability By Segregation**

## **Field and Background of the Invention**

The global waste disposal crisis is among the principal challenges of our age. The increase in waste production can be largely attributed to rapid urbanization, exponential population growth, and growing consumerism. This increase has outstripped conventional waste management systems, resulting in depletion of natural resources, environmental pollution, and serious health risks for even entire communities, especially those close to landfills. Ineffective waste segregation contributes to an even larger challenge where recyclable and non-recyclable materials often get disposed of together, ultimately hindering the progress of recycling programs and filling landfills that are already at their capacity. Such landfills give off greenhouse gases, including methane, which only increases climate change and damages ecosystems. This complexity is also linked to the low level of public engagement in responsible waste disposal. The tangible mindsets people have towards waste segregation and recycling have remained largely unchanged, and a high number of citizens do not participate in existing programs. The conventional approach to waste sorting is heavily dependent on manual labour; thus, it tends to be tedious and subject to human errors, making the process inefficient and expensive.

Lately, we have been struggling to find smart solutions to manage waste, which are going to an uptick in waste generation and pollution, opening an immediate space for product innovation based on facts and data that provide alternative solutions that change the way we think about keeping the planet. An innovative technology-driven approach is required to transform waste management systems while motivating the general public to play an active role in reducing the waste we produce. In this work we present Re-Bot, a next-generation robotic system that revolutionises waste handling. Re-Bot aims to address major gaps in current waste management practices by combining automation with advanced sensor technologies and financial incentives. The system uses moisture, magnetic, and weight sensors to achieve a high level of separation between wet, dry, and metallic waste. Furthermore, with the help of mobile application compliments to Re-Bot that calculates the monetary value of the segregated waste, the app pays the user instantly into their wallets to recycle.

## Brief description of the system

The existing waste management methods do not have sufficient control over waste segregation and recycling. As a result, manual techniques are error-prone and discourage people from learning waste disposal behaviour. Moreover, segregation at source is rarely integrated into public engagement systems, compromising existing models of recycling. Skyrocketing volumes of waste are unsustainable for the planet, the public health, and even the economy, and without novel technological solutions enabling efficiency along with public participation, the crisis will only worsen.

## Research Objectives

1	To conceptualize and create Re-Bot.	It is an innovative robotic system that integrates automation, sensors, and incentivise for efficient waste segregation and recycling.
2	To evaluate the effectiveness of Re-Bot.	It improves waste management by accurately segregating waste into wet, dry, and metal categories using advanced sensors.
3	To explore the social and environmental effect.	It is the impact of linking waste segregation with financial incentives through a mobile application.
4	To propose a scalable framework.	It is for integrating Re-Bot into existing waste management systems.

## Research Questions

- How much is Re-Bot enhancing the accuracy and efficiency of waste segregation?
- How do financial incentives affect public participation in recycling?
- What is Re-Bot and how do they help reduce landfill/make the world more sustainable?

- What are some of the main challenges and opportunities for large-scale deployment of Re-Bot?

To meet the waste disposal crisis, advanced technologies and financial advantages were integrated to establish the current research work to mitigate the waste disposal crisis. By combining automations with public engagement, Re-Bot provides a unique way to address the environmental and social issues associated with improper waste disposal.

## **Summary of the Invention**

The study adopts a practical yet community-orientated approach that aligns with a more pragmatic evaluation of how well Re-Bot addresses the waste disposal crisis. Re-Bot prototypes will be trialled on the ground in selected communities you work in. The experimental setup involves collecting different types of waste (wet, dry, and metals) for evaluating the segregation accuracy of Re-Bot. We test the incentive system (integrated with a companion mobile application) to validate the levels of user engagement and user satisfaction.

**Technical Architecture:** Re-Bot is powered by intelligent automation and sensor integration:

**Weight Sensor:** This component helps in accurate weight measurement of the waste material, especially for metals to provide exact monetary values.

**Sensors:** (Moisture for wet waste, magnetic for metals, general for dry waste) to ensure effective segregation

**Microcontroller (Arduino Nano):** The brain of the system responsible for processing sensor data and controlling the motors directing waste into its respective bins.

**App integration:** A companion mobile app associated with Re-Bot track the weight and type of segregated waste to reward it.

## **Companion App Functionality:**

The mobile application improves user interaction and visibility in the waste management cycle:

**User Registration:** Users can register with their phone number for a smooth experience.

**Input Lives:** Take input through data in real-time, from Re-Bot which helps in timely calculation of rewards/points.

**Automated Rewards:** Automatically calculates and rewards monetary rewards according to predefined rates for each type of waste.

**Instant Payments:** Pays users directly when they recycle, motivating users to get involved again.

## Data Collection

The study employs both quantitative and qualitative data collection methods.

<b><i>Quantitative Metrics:</i></b>	Measure segregation accuracy, app usage rates, and payout accuracy to evaluate Re-Bot's performance.
<b><i>Qualitative Metrics:</i></b>	Assess user satisfaction with the incentive system and its impact on waste disposal behaviours through surveys and interviews.

## Evaluation Metrics

The research assesses Re-Bot such as efficacy indicators.

***Participation:*** The ability of the app to drive participation in recycling through the use of economic incentives.

***Accuracy:*** Transparency and Accountability of weight based rewards calculations.

***Impact on the environment:*** there was less to go into a landfill, and the recycling rate went up because people were motivated to participate. This multi-tiered framework allows for a holistic analysis of Re-Bot's technological and social implications as well as key insights for scaling the system to tackle global waste management issues.

## Performance Analysis

Re-Bot was evaluated in various aspects and showed remarkable performance.

***Segregation Accuracy:*** With an accuracy rate of 95% in the segregation of garbage (wet, dry, and metal), it signifies a significant enhancement compared to conventional methods.

***Weight Measuring:*** The weight sensor had an accuracy of  $\pm 0.5\%$ . This was good enough to calculate.

***App engagement:*** Within a 30-day roll-out in a population of 1,000 households, 72% of residents signed up on the app. Out of these users, 90% were actively claiming rewards on the app.

**Payout Success Rate:** With a 98% success rate in payout processing with a rare issue or delay, reinforcing the trust into the incentive mechanism.

## Environmental Impact

***Landfill Waste Reduction:*** The Re-Bot diverted 4.5 tonnes of waste from landfills over the deployment period. It is resulting in a 65% reduction in landfill contribution.

***Community Engagement:*** The community engaged actively in the incentivise program. It leads to the creation of 200 new jobs related to waste segregation, collection, and processing, helping maintain the 78% recycling rate.

***Environmental Risks:*** The Re-Bot's impact on reducing landfill waste directly correlated with a measurable decrease in environmental risks. It is most notably soil contamination and methane emissions. There was a 40% reduction in estimated methane emissions in the test area.

### **Social and Economic Impact**

***Public Engagement:*** There was a 60% increase in public engagement in the activity with households actively separating and depositing waste.

## **We Claim**

1. Re-Bot obtained 95% segregation accuracy in comparison to 70% of the traditional method, and as a result, it was very effective in segregating wet, dry, and metal waste.
2. An incentive-based system that paid out in points led to a 60% increase in public participation in recycling activities, with 72% of residents signing up on its companion app.
3. Re-Bot limited waste disposal rates to 65%, leading to the diversion of some four and a half tonnes of landfill materials during its 30-day trial period.
4. In the test community, the recycling rate went from 30% to 78% because of the Re-Bot's effectiveness and incentivize.

## **Abstract**

Re-Bot, a new self-sufficient robotic mechanism that leverages automation, cutting-edge sensors, and a financial reward framework to change the way we handle rubbish. Working towards the secondary goal of involving the community at every stage, the main focus was to eliminate inefficiencies in waste segregation and recycling. Re-Bot uses moisture, magnetic, and weight sensors and achieves a segregation accuracy of 95% as compared to the 70% that a traditional method achieves. It designs a mobile app that connects the amount of waste handled by system users to instant monetary benefits, leading to a 98% success rate and a 60% rise in the public engagement rate. Re-Bot diverted 65% of contributions from landfills. This has led to 4.5 tonnes of waste being diverted and an increase in recycling rates from 30% to 78%. The researchers estimate recyclers have witnessed 25% boost in profitability thanks to higher-grade recyclables. The session outcomes focus on Re-Bot as a game changer in waste management, sustainability, contributions to better recycling and tangible environmental and economic value.