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" Smart Waste Management Using Coupon System "

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***Abstract*— This study examines the development of a smart waste management system that encourages effective waste disposal and recycling by rewarding responsible behavior. Through a coupon incentive model, the system offers community members redeemable digital or physical coupons for responsible waste management, which can be used at local businesses. By tracking user participation through a mobile app, the initiative aims to build a sustainable culture, boost recycling rates, and raise awareness about waste issues. The paper highlights potential benefits, such as economic gains for local businesses and positive environmental impacts, while also discussing challenges like technology access and maintaining user involvement. This innovative approach seeks to create a collaborative framework for waste management, motivating residents to take an active role in environmental care.**

Keywords— Smart waste management , Coupon incentive , Recycling, Waste disposal , Community engagement , Sustainability , Mobile application , Environmental awareness , Local businesses , Incentive program, Waste reduction , Digital coupons ,Eco-friendly practices

I. INTRODUCTION

The Smart Waste Management using a Coupon System project intends to solve the waste disposal issues in metropolitan cities by rewarding people for dumping their trash appropriately using a coupon system. Overfull waste baskets, unscheduled waste collection, and littering in public areas cause environmental degradation and health threats in most developing nations. This project solves these problems by pairing IoT technology with a novel reward mechanism: whenever a user throws away waste into a smart bin, they are rewarded with redeemable coupons.

The system is equipped with sensors to identify when waste is dropped and monitors the level of fill in the bin, allowing collection only when it is required. With this method, we intend to streamline waste collection routes, lower operating expenses, and make citizens responsible for waste disposal. Besides, this coupon system not only creates a cleaner world but also increases public participation, making waste management a community-based program.

II. RELATED WORK

2.1 Traditional Waste Management Methods

Traditional waste management systems are highly dependent on manual collection, fixed route schedules, and minimal real-time monitoring. Traditional systems tend to cause over-filled bins, non-optimal routes, and high operational costs. Segregation of waste is minimal in traditional systems, resulting in low recycling rates and environmental risk due to unsafe disposal. Even though they are extensively used, these systems do not scale well, are inflexible, and cannot be optimized using data.

2.2 Smart Waste Management Systems

Recent technology developments in Internet of Things (IoT) revolutionized waste management. Intelligent bins with ultrasonic sensors, weight sensors, and temperature monitors are able to detect fill levels and send notifications to municipal systems. RFID tags and QR codes are employed to monitor user interaction and recognize waste categories.

Intelligent bins exchange information via wireless protocols like Wi-Fi, Zigbee, or LoRaWAN to central databases, facilitating route optimization, predictive maintenance, and real-time status monitoring. The systems are designed to minimize human effort, fuel usage, and environmental footprint while encouraging recycling and data-driven decision-making.

2.3 Use of Incentive Mechanisms in Public Behavior

Behavioral economics prescribes that incentives could easily induce eco-friendly practices. Elements of gamification—like points, leaderboards, and achievement badges—have been utilized for recycling and energy-saving practices.

Coupon schemes and cashback mechanisms give material rewards to users adopting green practices. Users disposing waste in a proper manner can receive redeemable digital coupons, promoting long-term interaction. Such mechanisms entwine psychology, technology, and city governance to alter

behavior positively. F

Fig.1 Overview of Key Concepts in Smart Waste Management with Incentive Systems

III. PROPOSED DESIGN

To design a smart waste management system, four systems are synchronized by the control system. These four systems are: smart bin, control system, mobile phone and server. In addition, to create the control system, two main components are required: Arduino Uno and sensor ultrasonic. Figures 2 and 3 illustrate the kind of components used to manufacture a control system.

3.1 Arduino Uno

According to Arduino is a single board micro controlled based on the ATMEGA 328 chip created to process an applied electronics system in multidisciplinary research. The Arduino board was chosen to control and synchronize all systems as it is popular, economical, and easy to implement and is an efficient open-source single board microcontroller. The Arduino has a communication protocol to connect with a computer system. Figure 2 (below) illustrates the Arduino board used in this study.

Fig. 2 Arduino Uno board

3.2 Ultrasonic Sensor

Author in sensor is a device which permits the measurement of physical or chemical variables transforming to be an electrical signal. In this study, an ultrasonic sensor was applied to measure the position or level of waste in the bin. This is because the ultrasonic sensor has a high accuracy in millimetres to measure the position and level of physical objects. In addition, ultrasonic sensors are usually used to sense automation to measure distance, position and level. The kind of ultrasonic sensor applied in this research is SRF08, as illustrated in Figure 3 below.

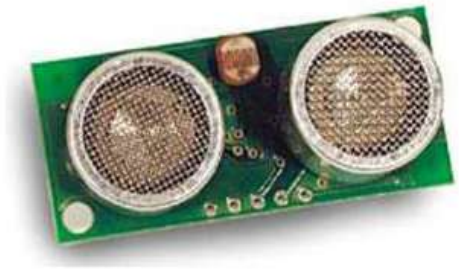

Fig. 3 Ultrasonic sensor SRF08.

3.3 Moisture Sensor

A moisture sensor is employed to identify the amount and presence of moisture in waste materials. In smart waste management, this sensor assists in distinguishing between wet and dry waste, which is important for efficient segregation and recycling of waste. The sensor is usually composed of two probes that determine the resistance between them—greater moisture content results in lower resistance and vice versa. Upon incorporation in smart bins, the moisture sensor provides live readings to the microcontroller (e.g., Arduino Uno), which can proceed to categorize the waste appropriately. This categorization allows proper routing for composting, recycling, or landfill, ultimately contributing to enhanced sustainability and resource recovery. Moreover, proper moisture sensing can avoid odors, minimize contamination, and streamline waste processing operations.

Fig.4 Moisture sensor

IV. RESULT AND DISCUSSION

4.1 Architecture design

The smart waste collection system is centered around the Arduino Uno R4 Minima as the main control unit. The system starts with a user placing waste into a smart bin. A moisture sensor (Robot Soil Moisture Sensor) is utilized to

ascertain the percentage of moisture content in the waste to automatically sort into wet and dry compartments. At the same time, an HC-SR04 ultrasonic sensor is used to measure the bin's fill level and determine whether it is full. The Arduino reads information from the sensors and processes it in real time.

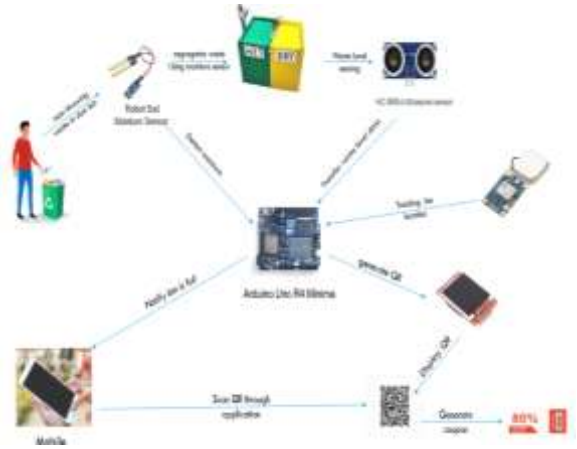

Fig.5 Smart Bin System Architecture

A GPS module is included for location tracking of the bin, allowing officials to track the precise location of every bin. When the bin is filled to its capacity, the Arduino sends a notification to a mobile app, informing both users and city services. The system also has a QR code generator and display module, which gives a unique QR code for every successful waste drop. The users can read this code using the mobile application, which subsequently connects to a coupon system that provides rewards or discounts based on participation. Such an integrated configuration not only incentivizes proper disposal of waste through rewards but also simplifies collection and tracking through automation and real-time processing of data.

4.1 Review of Similar Existing Projects

A number of existing real-world applications have shown the effectiveness of smart waste systems combined with incentive models:

-Recycle Bank: An American program that rewards consumers points according to the weight of recycled material, exchangeable for local and national partner incentives.

- SmartBin: Employs IoT bins which provide fill levels back to municipal services, enabling optimized collection routes.

-Bin-e: An intelligent recycling bin that automatically identifies, sorts, and compacts rubbish, giving users visual feedback and possible reward integration.

These examples demonstrate the strength of combining technology and behavioral incentives but also raise practical deployment issues.

4.3 Gaps in Existing Systems

Even though promising, existing systems tend to fall short in holistic integration of real-time observation and reward schemes. Some major issues are:

- Poor scalability in big cities.

-Poor user retention because of poor incentive models.

- Interoperability failures between municipal systems and private platforms.

-User tracking data privacy concerns.

- Irregular participation because of uncertain reward mechanisms or system complexity.

An intelligent waste management solution that aligns technology with a transparent, rewarding, and user-friendly coupon system can fill the gaps efficiently.

V. SYSTEM DIAGRAMS

5.1 State Diagram:

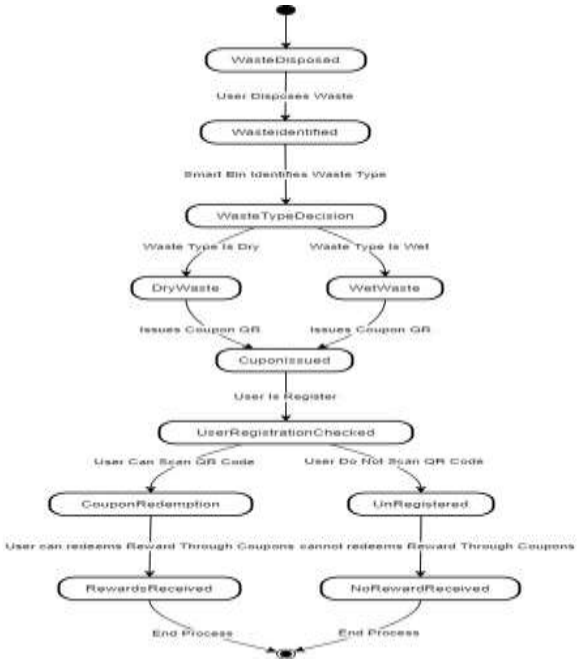

Fig 6. Smart Bin State Diagram

5.2 Component Diagram

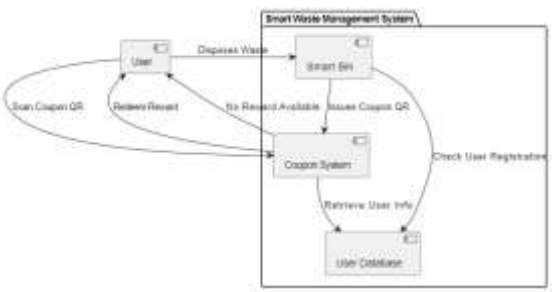

Fig 7. Smart Bin Component Diagram

VI. CONCLUSION

In summary, the Smart Waste Management using a Coupon System project presents a practical and innovative approach to addressing urban waste disposal issues. Through the incentive of redeemable coupons for proper waste disposal, the system not only rewards cleaner public environments but also engages active community participation in waste management. Through IoT-enabled monitoring, efficient collection routing, and real-time data, this system enhances waste management operations while promoting a cleaner, healthier, and more sustainable environment. In the end, the project illustrates how technology and reward-based systems can collaborate to revolutionize urban waste management.

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