# Smart waste bin using alarm notification System

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**A Project Submitted to the Department of Computer Science, Institute of Information and Communication Technology, Kwara State Polytechnic, Ilorin**

**In Partial Fulfillment of the Requirements for the Award of Higher National Diploma (HND) in Computer Science**

**July, 2025**

## CERTIFICATION

This is to certify that this project research was carried out by **HND/23/COM/FT/0532, HND/23/COM/FT/0253, HND/23/COM/FT/0389, HND/23/COM/FT/0585**, **HND/23/COM/FT/0431** has been read and approved as meeting part of the requirements for the award of Higher National Diploma (HND) in Computer Science.

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## DEDICATION

This project is dedicated to the creator of the earth and universe, the Almighty God. It is also dedicated to my parents for their moral and financial support.

## ACKNOWLEDGEMENT

All praise is due to the Almighty God the Lord of the universe. I praise Him and thank Him for giving me the strength and knowledge to complete my HND programme and also for my continue existence on the earth.

I appreciate the utmost effort of my supervisor, **MR MURITALA K,** whose patience support and encouragement have been the driving force behind the success of this research work. He gave useful corrections, constructive criticisms, comments, recommendations, advice and always ensures that an excellent research is done. My sincere gratitude goes to the Head of the Department and other members of staff of the Department of Computer Science, Kwara State Polytechnic, Ilorin, for their constant cooperation, constructive criticisms and encouragements throughout the programme.

Special gratitude to my parents who exhibited immeasurable financial, patience, support, prayers and understanding during the periods in which I was busy tirelessly in my studies. Special thanks go to all my lovely siblings.

My sincere appreciation goes to my friends and classmates.

## TABLE OF CONTENTS

Title Page i

Certification ii

Dedication iii

Acknowledgementsiv

Abstract v

Table of Contentsvi

CHAPTER ONE: GENERAL INTRODUCTION


1. Background to the Study1
2. Statement of the Problem3
3. Aim and Objectives of the Study4
4. Significance of the Study4
5. Scope of the Study5
6. Organization of the Report6


CHAPTER TWO: LITERATURE REVIEW


2.1Review of Related Works7

2.2 Review of Related Concepts11

2.2.1 Overview of waste and refuse11

2.2.2 Refuse Disposal and Management13

2.2.3 Smart Waste Bin15

2.2.4 Alarm Notification of Smart Waste Bin16


CHAPTER THREE: RESEARCH METHODOLOGY AND ANALYSIS OF THE EXISTING SYSTEM


1. Research Methodology19
2. Analysis of the Existing System 20
3. Problems of the Existing System21
4. Description of the Proposed System22
5. Advantages of the proposed system23


CHAPTER FOUR: DESIGN, IMPLEMENTATION AND DOCUMENTATION OF THE SYSTEM


1. Design of the System 24
    1. Output Design 24
    2. Input Design 25
    3. Procedure Design 27
2. Implementation of the System 28
    1. Choice of programming language28

2. Hardware Support28
3. Software Requirement29
3. Program documentation 30
1. Maintaining the System30

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

1. Summary 32
2. Conclusion 32
3. Recommendation33

References

## ABSTRACT

*The increasing volume of waste generated in urban environments poses a significant challenge to efficient waste management systems. In response to this, a Smart Waste Bin with innovative features, including Shuffle Refuse and Alarm Notification, has been developed to enhance the effectiveness of waste disposal and collection processes. The Smart Waste Bin employs sensor technology to detect and categorize different types of waste as they are disposed of. The Shuffle Refuse feature utilizes an automated mechanism within the bin to periodically rearrange the waste, preventing compaction and facilitating optimal use of bin capacity. This dynamic waste shuffling not only reduces the chances of overflow but also ensures that the bin remains accessible for users. Moreover, the Smart Waste Bin incorporates an advanced alarm notification system. When the bin reaches a predefined level or encounters an issue such as a malfunction, the system triggers real-time notifications to relevant stakeholders, such as waste management authorities or maintenance teams. This proactive approach enables swift response and resolution of potential problems, contributing to the overall efficiency of waste management operations. Furthermore, the system is integrated with a cloud-based platform, allowing remote monitoring and data analysis. Collected data, including fill levels, waste composition, and system health, can be analyzed to optimize waste collection routes, schedule maintenance, and make informed decisions for resource allocation. The Smart Waste Bin with Shuffle Refuse and Alarm Notification represents a technological leap towards creating sustainable and responsive waste management solutions. By leveraging sensor technology, automation, and real-time communication, this innovation addresses the challenges of urban waste management, promoting environmental sustainability and enhancing the overall efficiency of waste disposal processes.*


# CHAPTER ONE

# GENERAL INTRODUCTION

## 1. BACKROUND TO THE STUDY

One of the principle worries with our environment has been waste administration which impacts the wellbeing and condition of our general public. The detection, monitoring and management of wastes are one of the essential issues of the current time. The conventional method of manually checking the wastes in waste canister is a difficult process and takes more human exertion, time and cost which can easily be dodged with this current technology. This is the solution, a technique where waste management is automated. Generation of waste is everyday by households and also by local factories, artisans and traders, as the way of life increments because of development and technological advancement (Frances, 2020).

Rahman, *et al.*, (2022) claimed that, the unprecedented growth of urbanization and population in recent decades has led to a significant surge in municipal waste production, challenging traditional waste management systems. Inefficient waste collection, overflowing bins, and delayed issue resolution have become commonplace, contributing to environmental pollution and public health concerns.

To address these challenges, there is a pressing need for innovative technologies that can revolutionize waste management processes. The advent of the Internet of Things (IoT) and smart city initiatives has opened up new possibilities for integrating advanced technologies into urban infrastructure. Smart waste management systems have emerged as a promising solution to enhance the efficiency of waste collection and disposal (Rahman, *et al.*, 2022).

The integration of sensor technologies, data analytics, and real-time communication offers the potential to transform traditional waste bins into intelligent, proactive entities.

The conventional waste bins, often static and passive, lack the ability to adapt to changing waste volumes and compositions. This limitation results in inefficient use of bin capacity, frequent overflows, and increased operational costs for waste management authorities. Additionally, the lack of real-time monitoring and timely issue detection hampers the ability to respond promptly to maintenance needs or address potential system malfunctions. Effective solid waste management is one of the requirements in achieving the status of a developed nation. In the coming decade, foreign investment attraction to a nation will largely be influenced by healthy and clean environment, more so, a large percentage of the world's population will be residing in the cities. These aids development of smart cities perceptions geared towards decent urban living utilizing innovative know-hows. Management of solid waste is a vital process in any nation, it cut across every facets of the country for example standard of living, economy, healthcare, education, and pattern of living (Afolalu, *et al.,*2021).

The current global technological advancement, industrial revolution, and urbanization call for sustainable development policies and plans. Huge investment has been made by several nations of the world towards the establishment of smart cities. The present waste management schemes are not sufficing to control the significant increasing waste level. Smart waste management system is to keep our homes and communities clean from unwanted mess up. Smart garbage monitoring system gives a real time indicator of the garbage level in a bin and mobile application. The waste disposal can be managed more properly and efficiently by constantly monitoring the bin status and the garbage level. In addition, the municipality can be alerted when the bin is full or almost full, thus promoting dynamic scheduling and routing of the garbage collection (Cheema, *et al.,* 2022).

The proposed smart waste bin with shuffle refuse and alarm notification aims to bridge these gaps by introducing dynamic features that address both the capacity utilization and real-time monitoring aspects of waste management. The mechanism ensures optimal use of available space within the bin, preventing overflow and reducing the frequency of collections. Simultaneously, the Alarm Notification system provides immediate alerts to relevant stakeholders in the event of critical situations, allowing for swift response and issue resolution. This study seeks to evaluate the effectiveness of the smart waste bin in real-world urban environments, considering factors such as user acceptance, operational efficiency, and environmental impact. By combining technological innovation with practical waste management needs, this research endeavors to contribute valuable insights to the ongoing discourse on smart city development and sustainable urban living. The findings from this study are expected to inform future advancements in smart waste management solutions, paving the way for more resilient and responsive urban infrastructure.

## 1.2STATEMENT OF THE PROBLEM

Waste disposal are a part of our everyday life and mostly its condition are improper managed due to improper waste dumping, collection and management, which leads in foul smell and unhygienic condition, thus inherently results in pollution of the environment. The conventional waste management systems are grappling with the escalating challenges posed by burgeoning urban populations. Overflowing bins, inefficient waste collection, and delayed issue resolution not only contribute to environmental degradation but also strain municipal resources. The absence of adaptive features in traditional bins exacerbates these issues. This study addresses these shortcomings by investigating the potential of the smart waste bin with shuffle refuse and alarm notification in mitigating challenges associated with waste management.

## 1. AIM AND OBJECTIVES OF THE STUDY

The aim of this project is to design a smart waste bin using alarm notification system. The objectives are to:

i. Automate lid operation for hygienic use.
ii. Monitor waste levels to optimize collection schedules
iii. Enhance user interaction and feedback.

## 1.4SIGNIFICANCE OF THE STUDY

This study holds substantial significance in the realm of urban infrastructure and waste management. The implementation of the smart waste bin has the potential to revolutionize how cities handle waste, promoting sustainability, reducing environmental impact, and enhancing the overall efficiency of waste management systems. The findings will inform policymakers, waste management authorities, and urban planners, contributing to the development of smarter and more adaptive urban environments.

**1.5 SCOPE OF THE STUDY**

The study will primarily focus on the evaluation of the smart waste bin with Shuffle Refuse and Alarm Notification in a selected urban setting. User feedback, operational data, and environmental impact will be assessed to provide insights into the effectiveness of the technology. However, the study acknowledges that variations in urban infrastructure and waste management practices may exist, and generalization to all contexts may require additional research. The scope will extend to assessing the feasibility of scaling this technology to diverse urban environments, taking into consideration factors such as cultural, economic, and infrastructural differences.

**1.6ORGANIZATION OF THE REPORT**

This is the overall organizational structure of the work as presented in this project. Chapter one of this project deals with the general introduction to the work in the project. It also entails the aim and objectives of the project, significance of the study, the scope and organization of the project. Chapter two deals with the literature review and discussion of related aspect of the project topic. Chapter three covers the methodology, the analysis of the existing system, description of the current procedure, problems of existing system (procedure) itemized, description of the proposed system and the basic advantages of the proposed smart waste bin using SMS notification. Chapter four entails design, implementation and documentation of the system. The design involves the system design, output design form, input design form, database structure and the procedure of the system. The implementation involves the implementation techniques used in details, choice of programming language used and the hardware and software support. The documentation of the system involves the operation of the system and the maintenance of the system. Chapter five deals with summary, conclusion and recommendation.

1. **Definition of Technical Terms**

**Actuator:** A device that converts electrical signals into physical action, such as a motor that moves the lid of a smart dustbin.

**Arduino:** An open-source microcontroller platform used for building digital devices and interactive projects.

**Cloud Platform**: A network of servers hosted on the internet to store, manage, and process data remotely, often used in IoT applications.

**DC Motor:** An electric motor powered by direct current (DC), commonly used to control moving parts like a smart dustbin lid.

**ESP8266/ESP32:** Microcontrollers with built-in Wi-Fi and Bluetooth capabilities, widely used for IoT devices.

**Firmware:** Software programmed into hardware devices to control their operations, like the code running on a smart dustbin's microcontroller.

**Infrared (IR) Sensor:** A sensor that uses infrared light to detect objects or measure distances.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1REVIEW OF RELATED WORKS

Frances (2020) developed a smart waste bin with monitoring system. In the paper, the design and implementation of smart waste bin with monitoring system

is proposed utilizing the ongoing innovation of automation and GSM. The ultrasonic sensor in the bin persistently screens the level of the waste in the bin and communicates to the waste administration organization when the bin filled and the

Ultrasonic sensor is also used to open and close the cover of the bin whenever persons are nearby the bin. Thus the research has better level of smartness compared to existing ones in metropolitan cities in a centralized manner.

Rahman,*et al.,* (2022) implemented an Intelligent waste management system using deep learning with IoT. The developed system reflects a capable architecture of the waste management system based on deep learning and IoT. The proposed model renders an astute way to sort digestible and indigestible waste using a convolutional neural network (CNN), a popular deep learning paradigm. The scheme also introduces an architectural design of a smart trash bin that utilizes a microcontroller with multiple sensors. The proposed method employs IoT and Bluetooth connectivity for data monitoring. IoT

enables control of real-time data from anywhere while Bluetooth aids short-range data monitoring through an android application. To examine the efficacy of the developed model, the accuracy of waste label classification, sensors data estimation, and system usability scale (SUS) are enumerated and interpreted. The classification accuracy of the proposed architecture based on the CNN model is 95.3125%, and the SUS score is 86%.

Sunday, *et al.,* (2021) proposed a smart waste bin for solid waste management. The aim of the paper was to design a smart dustbin for proper disposal of waste without any human intervention by providing a smart technology for waste system monitoring, reducing human time, effort, and intervention. The paper presented a smart waste bin integrated with a microcontroller-based Arduino board which is interfaced with ultrasonic sensors, MQ-2 sensor, servo motor, LCD and GSM modem. The Arduino microcontroller is programmed using Arduino C which measures the height of the dust bin using the ultrasonic sensor. Once the waste gets to the pre-set level, the microcontroller activates the GSM modem to send a message to a designated number. The status of the waste in the bin is transferred to the designated line and display on the LCD whenever it exceeds the pre-set value. The replacement of the traditional waste bin with smart waste bin help in efficient management of waste by assuring that filled waste bin are emptied when the pre-set value is exceeded. This also help in reducing time involve in checking the status of the waste bin and number of trips embarked by the waste collection vehicle and total expenditure associated with collection is minimized. It eventually helped to maintain cleanliness in our environment. Therefore, the system makes the waste collection more efficient.

Cheema, *et al.,* (2022) implemented a smart waste management and classification systems using cutting edge approach. They proposed a real-time smart waste management and classification mechanism using a cutting-edge approach (SWMACM-CA). It uses the Internet of Things (IoT), deep learning (DL), and cutting-edge techniques to classify and segregate waste items in a dump area. Moreover, they propose a waste grid segmentation mechanism, which maps the pile at the waste yard into grid-like segments. A camera captures the waste yard image and sends it to an edge node to create a waste grid. The grid cell image segments act as a test image for trained deep learning, which can make a particular waste item prediction. The deep-learning algorithm used for this specific project is Visual Geometry Group with 16 layers (VGG16). The model is trained on a cloud server deployed at the edge node to minimize overall latency. By adopting hybrid and decentralized computing models, we can reduce the delay factor and efficiently use computational resources. The overall accuracy of the trained algorithm is

over 90%, which is quite effective. Therefore, our proposed (SWMACM-CA) system provides more accurate results than existing state-of-the-art solutions, which is the core objective of this work.

AbdElminaam, El-Ashmawi and Elsayed (2019). Designed a fabrication smart garbage management and monitoring system using automatic unloading robot in residential area. Their research mainly concentrates on offering an easy, reliable solution to the common problem of inefficient garbage disposal faced within institutes, schools, hospitals or any other closed space. In the proposed model, three main devices are considered. The first device is a smart bin that will automatically open to put trash inside it, allow the user to know whether the bin is full or empty and send the level of trash to the program. In addition, it sends a notification of its trash level and makes alarm and shows its location when it becomes full. The Second device is a garbage collector robot which starts its process and empties the bin after receiving the radio signal from the remote controller application installed in the server. The third device is the controller device connected to the server to control the robot and display data of each bin. The results showed the superiority of our proposed model over other related models.

Mohd-Yusof, *et al.,* (2017) implemented a Smart Garbage Monitoring System for Waste Management. The project presented the development of a smart garbage monitoring system in order to measure waste level in the garbage bin in real-time and to alert the municipality, in particular cases, via SMS. The proposed system is consisted by the ultrasonic sensor to measure the waste level, the GSM module to send the SMS, and an Arduino Uno which controls the system operation. It supposes to generate and send the warning messages to the municipality via SMS when the waste bin is full or almost full, so the garbage can be collected immediately. Furthermore, it is expected to contribute to improving the efficiency of the solid waste disposal management.

Mohd-Yusof, *et al.,* (2018). Proposed a smart waste bin with real-time monitoring system**.** The paper presented IoT innovation project of a smart waste bin with real time monitoring system which integrates multiple technologies such as solar system, sensors and wireless communication technologies. The aim of this project is to provide an efficient and cost-effective waste collection management system hence providing clean, healthy and green environment. This study proposed a new framework that enables remote monitoring of solid waste bin in real-time via Wi-Fi connection, to assist the waste management activity. The system framework is based on wireless sensor network [WSN] contains three segments: renewable energy source, WSN and control station. Within this framework there are four developed subsystems: solar power system, smart waste bin, short messaging service [SMS]

notification system and real-time monitoring system that are interrelated to each other to perform as an efficient, cost-effective waste management system that yield to a green and healthy living environment.

Vinodha, I*et al.,* (2020) implemented a smart garbage system with garbage separation using object detection. The smart bin was implemented using IoT as a solution to these problems. The bins are equipped with Raspberry-Pi integrated with ultrasonic sensor for garbage level detection and pi camera which separates garbage by object detection using YOLO algorithm and opens the respective bin lid automatically using servo motor. The intelligent bin is connected with mobile application via cloud for monitoring and clearance of waste which is done using optimized routing.

ALFoudery, *et al.,* (2018) worked on trash basket sensor notification using arduino with android application. The researchers introduced Trash Sensor Android Application to help waste management companies detect trash levels to collect it and help citizens from undesired odours. Using mobile and electronic technology to enable waste management companies to finish its work and make it easier for collecting trash in a simple and an easy way.

## 2.2REVIEW OF RELATED CONCEPTS

### 2.2.1 Overview of Waste and Refuse

Waste and refuse constitute a critical and pervasive issue in modern society, posing significant environmental, economic, and public health challenges. The term "waste" refers to any unwanted or discarded material, ranging from household garbage and industrial by-products to hazardous materials. As global population and consumption patterns continue to rise, the generation of waste has also increased exponentially, putting immense pressure on waste management systems worldwide. One major aspect of waste is municipal solid waste (MSW), which includes everyday items like packaging, food scraps, and discarded household goods. In many regions, inadequate waste disposal infrastructure leads to improper dumping or burning of MSW, contributing to air and water pollution. The accumulation of plastic waste, in particular, has become a global concern due to its persistence in the environment, causing harm to wildlife and ecosystems.

Industrial waste, another significant category, arises from manufacturing processes, construction activities, and other industrial operations. Improper disposal of industrial waste can result in soil contamination, groundwater pollution, and the release of harmful chemicals into the air. Efforts to promote sustainable practices in industries, such as recycling and responsible waste management, are crucial to mitigating these environmental

impacts. The concept of waste extends beyond physical materials to include electronic waste (e-waste), which consists of discarded electronic devices. Rapid technological advancements contribute to the accelerated obsolescence of electronic products, leading to the accumulation of hazardous materials like lead and mercury. Proper recycling and disposal methods for e-waste are essential to prevent the release of toxic substances into the environment.

To address the multifaceted challenges posed by waste and refuse, governments, businesses, and communities are increasingly focusing on waste reduction, recycling programs, and sustainable waste management practices. Education and awareness campaigns play a vital role in encouraging responsible consumption and waste disposal habits among individuals. Innovations in waste-to-energy technologies and the development of circular economy models offer promising solutions to minimize the environmental impact of waste while promoting resource efficiency. A comprehensive and collaborative approach is essential to create a sustainable and resilient future in the face of mounting waste-related issues (Bano, *et al.*, 2020).

### 2.2.2 Refuse Disposal and Management

Refuse disposal and management involve the systematic handling, collection, transportation, and disposal of waste materials generated by human activities. The goal is to minimize environmental impact, prevent the spread of diseases, and efficiently utilize resources. Effective refuse disposal and management are critical for maintaining public health, safeguarding the environment, and promoting sustainable practices. The process typically involves several key stages:

i. **Generation of Waste:** Waste is generated from various sources, including households, industries, commercial establishments, and construction sites. This waste can be categorized into different types, such as municipal solid waste (MSW), industrial waste, hazardous waste, and electronic waste.
ii. **Collection:** After waste is generated, it needs to be collected from its source. Municipalities or private waste management companies often deploy collection services to gather waste from residential and commercial areas. The collection process may involve regular scheduled pickups or on-demand services.
iii. **Transportation:** Once collected, the waste is transported to designated facilities for further processing. Transportation methods vary and can include waste trucks, conveyor belts, or even pipelines for certain types of waste.
iv. **Processing and Treatment:** Different types of waste undergo various processing and treatment methods. Recycling facilities handle recyclable materials, composting sites

manage organic waste, and hazardous waste treatment centers process potentially harmful materials. Effective processing helps recover valuable resources and reduces the volume of waste sent to landfills.

v. **Disposal:** Disposal is the final stage where waste that cannot be recycled or treated is safely disposed of. Common methods include landfilling, incineration, or other advanced waste-to-energy technologies. Landfills are designed to contain and isolate waste from the environment to prevent contamination.
vi. **Landfill Management:** Landfills play a significant role in waste disposal, particularly for non-recyclable and non-biodegradable materials. Proper landfill management involves engineering measures to control leachate, gas emissions, and land use, minimizing environmental impact.
vii. **Regulatory Compliance and Monitoring:** Refuse disposal and management are subject to various regulations and standards to ensure environmental protection and public health. Regulatory compliance involves adhering to guidelines for waste handling, disposal methods, and environmental monitoring.

**Public Education and Awareness:** Public engagement is crucial for the success of refuse disposal and management programs. Educating communities about proper waste segregation, recycling practices, and the importance of reducing waste generation contributes to more sustainable waste management practices (Salang, *et al.,* 2021).

### 2.2.3 Smart Waste Bin

Smart waste bins represent a technological advancement in waste management, utilizing innovative features to enhance efficiency, sustainability, and overall waste collection processes. These intelligent bins are equipped with various sensors, connectivity options, and data analytics capabilities to revolutionize traditional waste management systems. The primary component of a smart waste bin is its sensor technology. These sensors can detect the fill level of the bin in real-time, allowing for precise monitoring of waste accumulation. When a bin reaches a predetermined capacity, the system triggers an alert, enabling timely and optimized waste collection schedules. This real-time monitoring not only enhances operational efficiency but also reduces unnecessary collection trips, saving both time and resources.

Connectivity is a key aspect of smart waste bins, as they are often equipped with IoT (Internet of Things) technology. This connectivity allows the bins to transmit data wirelessly to a centralized management system. Municipalities, waste management companies, or facility managers can remotely monitor multiple bins across a city or facility, gaining insights into waste patterns, optimizing collection routes, and making data-driven

decisions to improve overall waste management effectiveness. Smart waste bins also contribute to environmental sustainability. By optimizing collection routes based on real-time data, fewer vehicles are needed for waste collection, resulting in reduced fuel consumption and lower carbon emissions. Additionally, the efficient use of resources helps minimize the environmental impact associated with traditional waste management practices.

These bins can incorporate additional features such as compacting mechanisms or solar-powered components. Compacting mechanisms enable bins to accommodate more waste, reducing the frequency of collections and further optimizing operational costs. Solar-powered capabilities provide an environmentally friendly energy source for the sensors and connectivity components, making smart waste bins more sustainable and less dependent on traditional power sources. The implementation of smart waste bins represents a significant step towards creating smart cities and fostering sustainable urban development. As technology continues to advance, the integration of artificial intelligence, machine learning, and data analytics into waste management systems will likely enhance the capabilities of smart waste bins, leading to even more efficient and sustainable waste collection and disposal processes (Bano, *et al.,* 2020).

### 2.2.4 Alarm Notification of Smart Waste Bin

Alarm notification in the context of smart waste bins refers to the capability of these intelligent waste management systems to generate alerts or notifications based on predefined conditions or events. These notifications are typically sent to relevant stakeholders, such as waste management personnel, municipal authorities, or facility managers, to prompt timely and appropriate actions. The goal is to improve the overall efficiency, responsiveness, and effectiveness of waste collection and management processes.

Here are key aspects of alarm notification in smart waste bins:

i. **Fill Level Alerts:** One common trigger for alarm notifications is the fill level of the smart waste bin. Sensors within the bin continuously monitor the waste levels, and when the content reaches a predefined threshold, an alert is generated. This information helps optimize waste collection schedules by ensuring that bins are emptied before reaching full capacity, reducing the risk of overflow or inefficient use of resources.
ii. **Maintenance Alerts:** Smart waste bins may also include sensors to monitor their own health and functionality. For instance, if a sensor malfunctions or if there is a mechanical issue with the bin, an alarm notification can be sent to alert maintenance

personnel. This proactive approach allows for timely repairs, minimizing downtime and ensuring the continued functionality of the waste management system.

iii. **Environmental Sensors:** Some advanced smart waste bins incorporate environmental sensors to detect factors like temperature, humidity, or the presence of hazardous materials. If unusual conditions are detected, an alarm notification can be triggered. This is particularly important in scenarios where environmental factors may impact waste handling or pose risks to public health.

iv. **Connectivity:** The alarm notifications are often sent through wireless connectivity, utilizing technologies like Internet of Things (IoT). This connectivity allows for real-time communication between the smart waste bins and a centralized management system. Notifications can be received via email, text message, or through dedicated software platforms, providing flexibility in how stakeholders are informed.

v. **Data-Driven Decision Making:** Alarm notifications contribute to data-driven decision-making in waste management. By receiving timely alerts, authorities and organizations can analyze patterns, optimize collection routes, and make informed decisions to enhance overall efficiency and resource utilization.

Alarm notifications in smart waste bins play a crucial role in ensuring that waste management processes are responsive, proactive, and well-coordinated. This capability is fundamental to the development of smart cities and sustainable urban environments by minimizing the environmental impact of waste and optimizing the use of resources Salang, *et al.*, 2021).

# CHAPTER THREE

# RESEARCH METHODOLOGY AND ANALYSIS OF THE EXISTING SYSTEM

## 3.1RESEARCH METHODOLOGY

The method that will be employing in the implementation of automatic control of the smart waste bin is using the top to bottom approach method. The various units that will be considered are listed below:

i. A sensing unit for monitoring trash level in the bin,
i. A controlling unit which acts as the brain for the control system and is responsible for doing the core work in the control of the system,
ii. An indicating unit which shows the level of trash and act as a visual aid to user in the trash bin,
iii. A switching unit that simply triggers the servo motor ON and OFF, depending on the signal received from the microcontroller to OPEN or CLOSE the bin,
iv. A GSM modem to send and receive SMS to/from the appropriate waste disposal body,
v. A PIR sensor unit to detect the presence of coming human close to the bin for waste disposal.

The system design and implementation will be carried out according to the system's block diagram below:

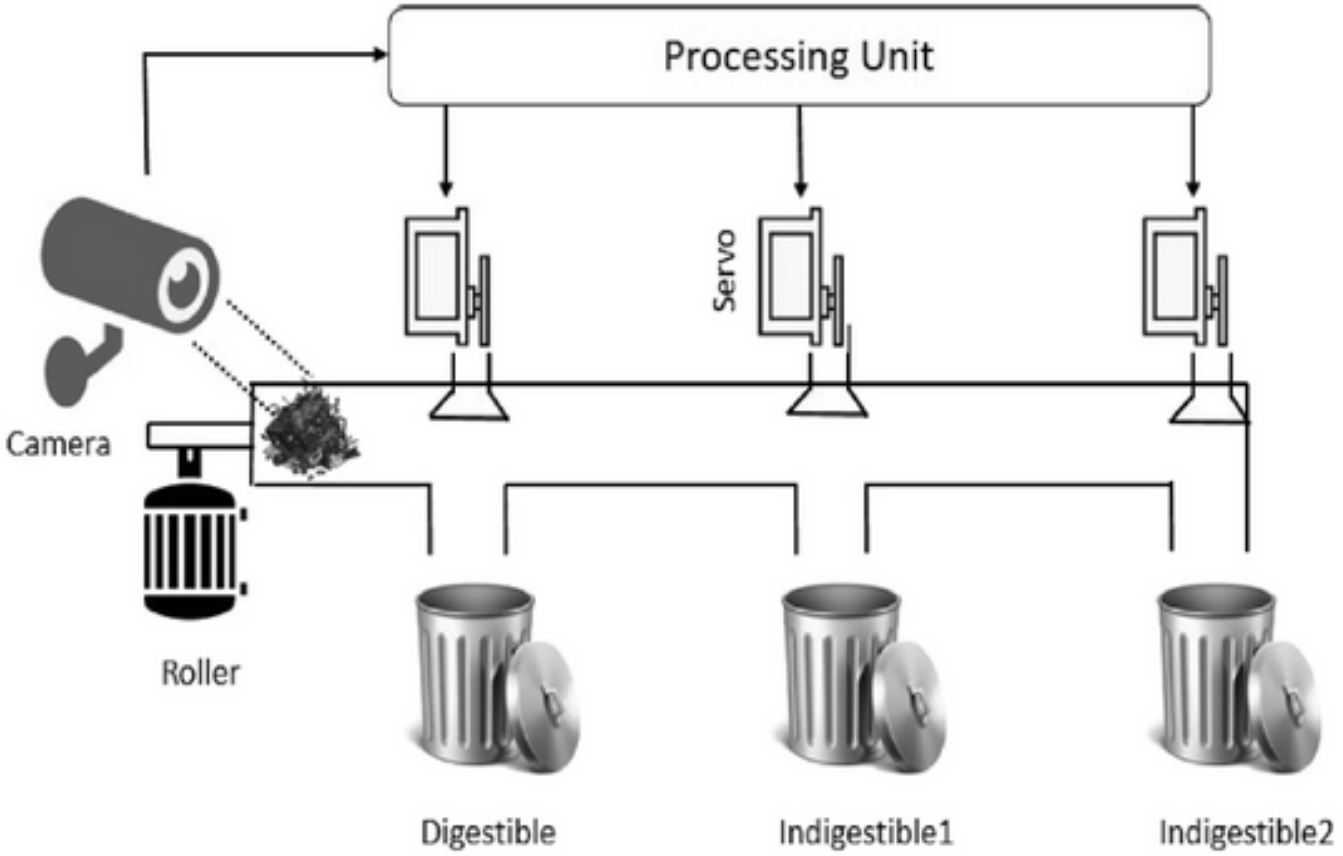


Figure 3.1: Block Diagram of the Proposed Smart Waste Bin System (Source: Encyclopedia)

## 3.2**ANALYSIS OF THE EXISTING SYSTEM**

The current waste management system lacks efficiency and smart features. Traditional waste bins are passive and do not provide real-time information or smart functionalities. Users often face challenges in knowing the fill level of the bins, leading to inefficient waste collection processes. Additionally, there is no systematic way to handle different types of waste, and alarms are not integrated to notify authorities or waste management teams when a bin needs attention. Inefficiencies plague the waste collection process due to the absence of real-time monitoring. Traditional bins do not promote or facilitate the sorting of recyclables, compostables, and general waste, impeding recycling efforts. Users lack information about the fill levels of bins, resulting in overflowing containers, unpleasant surroundings, and unhygienic conditions. The reactive nature of the system means that maintenance teams only identify issues during physical inspections, leading to delayed responses and increased operational costs.

## 3.3**PROBLEMS OF THE EXISTING PROBLEM**

Traditional bins do not promote or facilitate the sorting of recyclables, compostables, and general waste, impeding recycling efforts. Users lack information about the fill levels of bins, resulting in overflowing containers, unpleasant. The following are problems of the existing system:

i. Inefficient Waste Collection: The lack of real-time monitoring results in inefficient waste collection routes, leading to unnecessary fuel consumption and increased carbon footprint.
ii. Ineffective Sorting: Traditional bins do not encourage or facilitate the sorting of recyclables, compostables, and general waste. This hinders recycling efforts and contributes to environmental pollution.
iii. Limited User Awareness: Without a feedback mechanism, users are unaware of the current fill level of the bins. This leads to overflowing bins, unsightly surroundings, and unhygienic conditions.
iv. Delayed Maintenance: The absence of an automated notification system means that waste management teams often discover issues only when they physically inspect the bins. This results in delayed maintenance and increased operational costs.

## 3.4**DESCRIPTION OF THE PROPOSED SYSTEM**

The envisioned smart waste bin system aims to overcome existing limitations through innovative features, real-time monitoring is enabled by smart sensors in each bin, offering up-to-date information about fill levels. This data is transmitted to a central server, empowering waste management teams to optimize collection routes. A shuffle refuse mechanism is integrated into the bin, automatically sorting recyclables, compostables, and general waste, thereby promoting efficient waste management and boosting recycling efforts. An alarm system sends automatic notifications to waste management teams when bins reach predefined fill levels, ensuring timely collections and mitigating the risk of overflow. Users can access a mobile app or web portal to check nearby bin fill levels, encouraging responsible waste disposal.

The proposed smart waste bin system incorporates several advanced features to address the limitations of the existing system:

i. Real-Time Monitoring: Smart sensors are installed in each bin to provide real-time information about the fill level. This data is transmitted to a central server, allowing

waste management teams to optimize collection routes.

ii. Shuffle Refuse System: The bin is equipped with a shuffle refuse mechanism that automatically sorts recyclables, compostables, and general waste. This promotes efficient waste management and enhances recycling efforts.

iii. Alarm Notification System: An integrated alarm system sends automatic notifications to waste management teams when a bin reaches a predefined fill level. This ensures timely collections and reduces the risk of overflowing bins.

## 3.5 ADVANTAGES OF THE PROPOSED SYSTEM

The shuffle refuse system enhances waste sorting, leading to increased recycling rates and a reduction in landfill contributions. The following are advantages of the proposed system:

i. Optimized Collection Routes: Real-time monitoring enables waste management teams to optimize collection routes, reducing fuel consumption and environmental impact.

ii. Improved Recycling Rates: The shuffle refuse system encourages proper waste sorting, leading to increased recycling rates and a decrease in landfill contributions.

iii. Timely Maintenance: The alarm notification system ensures that maintenance teams are alerted promptly, reducing response times and minimizing operational costs.

iv. Enhanced User Awareness: Users are informed about the status of nearby bins, fostering a sense of responsibility and contributing to cleaner and more hygienic public spaces.

v. Data-Driven Decision Making: The system generates valuable data that can be analyzed to identify trends, optimize waste management strategies, and make informed decisions for future improvements.

# CHAPTER FOUR

# DESIGN, IMPLEMENTATION AND DOCUMENTATION OF THE SYSTEM

## 4.1 DESIGN OF THE SYSTEM

This is the computation of the particulars of a new system and the determination of what the new system would be and the function it is to perform. This may involve changing from one system to another or modifying the existing system operation.

The most challenging phase of the system life cycle is the change from manual operation to a faster and more accurate one; system design stage covers the technical specifications that will be employed in the implementation of the new system in order to modify the previous system. Some factors are put in consideration. These factors include input design, output design, definitions file and procedure designs and other documentation.

### 4.1.1 OUTPUT DESIGN

The output design for the smart waste bin system encompasses various visual, auditory, and remote communication methods to relay information effectively to users and administrators. It includes LED indicators for visual cues on system status, an LCD display for real-time feedback on fill levels, and a buzzer or speaker for audible alerts. Additionally, remote output options such as mobile apps and web interfaces enable users to monitor the system remotely and receive notifications on bin status. Notification systems, including SMS alerts and email notifications, further enhance communication by providing timely updates on critical events. Combined, these output mechanisms ensure efficient operation and user awareness, contributing to effective waste management. Things taken into consideration in determining the output are represented below:


*Figure 4.1: Trash can* A trash can, also known as a garbage can, waste bin, or rubbish bin, is a container used to hold refuse until it is collected and disposed of.


*Figure 4.2:* Servomotor

A servomotor is a closed-loop servomechanism that uses position feedback (either linear or rotational position) to control its motion and final position.


Figure 4.3: Arduino Uno

The Arduino Uno is a popular microcontroller board based on the ATmega328P microcontroller. It is widely used for a variety of projects and applications due to its ease of use, versatility, and extensive community support.

### 4.1.2**INPUT DESIGN**

The input design for the smart waste bin system includes various methods to enable user interaction and data entry. It incorporates proximity sensors to automatically detect when users approach, triggering the lid to open. Physical buttons or touch-sensitive panels allow for manual control of the system, such as opening the lid or switching modes. Additionally, ultrasonic and weight sensors monitor the fill level of the bin. Remote input options, such as a mobile app and web interface, provide users with the ability to monitor and control the system from their devices. Advanced input methods like voice and gesture recognition can further enhance user interaction, ensuring a versatile and user-friendly experience.

*Figure 4.4: smart waste bin*

A smart waste bin is an advanced trash receptacle equipped with various technologies to enhance waste management efficiency and user convenience. These bins typically incorporate sensors, connectivity features, and automation to provide a more sustainable and intelligent waste disposal solution.

### 4.1.3PROCEDURE DESIGN

These are the steps involved in unifying the whole process to produce the desired output. It involves computer procedures which start from the original input lessons to the output result file. This allows the processing of User information and result to be possible. Menu is provided to aid User in the processing of the output file.

## 4.2IMPLEMENTATION OF THE SYSTEM

To implement a smart waste bin system, we will integrate an Arduino Uno microcontroller with ultrasonic sensors to monitor fill levels and motion sensors to detect proximity for automatic lid opening. A servo motor will be used to actuate the lid. The system will include wireless connectivity for remote monitoring and alerts, enhancing waste management efficiency and user convenience through real-time data and automated operations.

### 4.2.1CHOICE OF PROGRAMMING LANGUAGE

The choice of programming language for implementing a smart waste bin system with an Arduino Uno is C/C++ due to its compatibility with the Arduino IDE, efficient performance for real-time hardware control, and extensive community support for troubleshooting and resources.

### 4.2.2HARDWARE REQUIREMENT

The hardware requirements for implementing a smart waste bin system are as follows:

i. **Microcontroller**:
   - Arduino Uno: Central unit for controlling sensors and actuators.

ii. **Sensors**:
   - Ultrasonic Sensors: For detecting the fill level of the bin.
   - Motion Sensors: For detecting user proximity to automatically open the lid.

iii. **Actuators**:
   - Servo Motor: For actuating the lid mechanism.

iv. **Power Supply**:
   - 9V Battery or DC Power Adapter: To power the Arduino and connected components.

v. **Connectivity**:
   - Wi-Fi Module (e.g., ESP8266 or ESP32): For wireless communication and remote monitoring.

vi. **Additional Components**:
   - Breadboard and Jumper Wires: For prototyping and connections.
   - Resistors and Capacitors: For circuit stability and sensor interfacing.
   - Enclosure: To house the components securely within the waste bin.

This hardware setup will enable the smart waste bin to detect fill levels, open the lid automatically, and provide remote monitoring capabilities.

### 4.2.3**SOFTWARE REQUIREMENT**

The software requirements for implementing a smart waste bin system with an Arduino Uno include using the Arduino IDE as the development environment, programming the microcontroller in C/C++, and incorporating necessary libraries such as Servo Library for controlling the lid actuator, NewPing Library for ultrasonic sensor management, and WiFi Library (e.g., ESP8266WiFi) for wireless connectivity if remote monitoring is desired. Additional tools like the Serial Monitor for debugging and network configuration interfaces may be necessary. Optional components include an IoT platform for remote data logging and notifications, along with a mobile app for user interaction and alerts.

## **4.3DOCUMENTATION OF THE SYSTEM**

### 4.3.1**PROGRAM DOCUMENTATION**

The program documentation for the smart waste bin system provides a comprehensive guide to understanding, configuring, and utilizing the software developed for the Arduino Uno. It includes setup instructions for the development environment, details on hardware configuration, an overview of the software structure, explanations of functionality, definitions of configuration parameters, usage instructions, and troubleshooting guidance. This documentation serves as a valuable resource for developers and users, ensuring smooth implementation, operation, and maintenance of the smart waste bin system.

### 4.3.2**MAINTAINING OF THE SYSTEM**

Maintaining the smart waste bin system involves regular checks, updates, and occasional troubleshooting to ensure its continued functionality and efficiency. This entails inspecting

hardware components for wear or damage, updating software to the latest versions, monitoring sensor data for irregularities, and conducting scheduled calibrations and battery replacements as needed. Troubleshooting efforts include diagnostic checks, component replacements, and meticulous documentation of maintenance activities to facilitate seamless operation and timely interventions.

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.1SUMMARY

The introduction of the Smart Waste Bin with Shuffle Refuse and Alarm Notification system marks a transformative advancement in waste management technology. This innovative solution addresses the inherent inefficiencies of traditional waste collection systems by incorporating real-time monitoring, shuffle refuse technology, and an alarm system. These features collectively promise to streamline waste collection processes, encourage responsible waste disposal practices, and significantly contribute to increased recycling rates. The Smart Waste Bin system is poised to revolutionize urban cleanliness, environmental sustainability, and the overall efficiency of waste management operations.

## 5.2CONCLUSION

The smart waste bin system represents a holistic and efficient approach to modernizing waste management practices. By tackling issues such as delayed maintenance, inefficient sorting, and lack of user awareness, this system offers a comprehensive solution. The integration of advanced technologies not only ensures timely and optimized waste collection but also promotes a culture of responsible waste disposal among users. The shuffle refuse mechanism, coupled with the alarm notification system, contributes to a more sustainable and responsive waste management infrastructure, setting the stage for a cleaner and environmentally conscious future.

## 5.3**RECOMMENDATIONS**

Based on the findings of this project, the followings are recommended:

i. Community Engagement: awareness campaigns should be conducted to educate the community about the benefits of the smart waste bin system. Encourage active participation and responsible waste disposal practices among users.
ii. Integration with Municipal Systems: collaboration with municipal authorities to integrate the smart waste bin system into existing waste management infrastructure. This will ensure a seamless transition and facilitate centralized monitoring and control.
iii. Continuous Monitoring and Upgrades: this system should be a continuous monitoring system to track system performance and address any emerging issues promptly. Regular upgrades and software updates should be scheduled to enhance system capabilities and security.
iv. Data Analytics for Optimization: the data collected by the system should be leveraged for in-depth analytics. Analyze trends to optimize waste collection routes, improve sorting algorithms, and make data-driven decisions for ongoing enhancements.
v. Environmental Impact Assessment: Conduct an environmental impact assessment to quantify the positive effects of the system, including reductions in carbon footprint, landfill contributions, and resource utilization. Use this data to showcase the system's contribution to sustainability.

Incorporating these recommendations will not only ensure the successful implementation of the Smart Waste Bin system but also contribute to a more sustainable and efficient waste management ecosystem.

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