

# **EMBEDDED SYSTEM AND IOT**

## **A PROJECT REPORT**

*Submitted by*

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*In partial fulfillment for the award of the degree of*

**BACHELOR OF ENGINEERING**

*in*

**Electronics and Communication**

**Vishwakarma Government Engineering College, Chandkheda**

**Team ID - 444225**



**Gujarat Technological University, Ahmedabad**  
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## DECLARATION

I hereby declare that the project report submitted along with the Internship entitled **Embedded System and IOT** submitted in partial fulfillment for the degree of Bachelor of Engineering in Electronics and Communication to Gujarat Technological University, Ahmedabad, is a bonafide record of original project work carried out by me at Vishwakarma Government Engineering College under the supervision of Prof. Rahul M. Patel and that no part of this report has been directly copied from any without providing due reference.

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### **CERTIFICATE OF COMPLETION OF INTERNSHIP**

This is to certify that Mr. TIRTH PARMAR (Reg. No. 200170111040) student of 8<sup>th</sup> semester Bachelor of Engineering in Electronics and Communication, Gujarat Technological University, Ahmedabad, has interned with ECOPARADIGM from 15<sup>th</sup> January 2024 to 28<sup>th</sup> April 2024.

He has successfully completed his internship in Embedded System and IOT & in the fields as mentioned below

1. ESP32-based system integrates.
2. GPS tracking, NFC tag detection, and weight.
3. The system utilizes an ESP32 microcontroller, TFT display, GPS module, NFC reader, and HX711 load cell amplifier.
4. Wi-Fi connection for data transmission.

I found his responsible and efficient and his conduct during the internship was satisfactory.

For Paradigm Environmental Strategies Pvt Ltd

A handwritten signature in black ink that appears to read "Padma Rao".

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Thus, in the conclusion to the above said, I once again thank the faculties and members of Vishwakarma Government Engineering College for their valuable support in completion of my internship.

Thanking you

Tirth Parmar

## ABSTRACT

This ESP32-based system integrates various sensors and modules to facilitate waste collection management. It includes functionalities such as GPS tracking, NFC tag detection, and weight measurement using load cells. The system utilizes an ESP32 microcontroller, TFT display, GPS module, NFC reader, and HX711 load cell amplifier. Upon initialization, the TFT display showcases a user interface representing the system's identity and status. The system then proceeds to establish a Wi-Fi connection for data transmission.

During operation, the system continuously reads GPS coordinates and NFC tags. Detected GPS coordinates and NFC tag IDs are utilized to identify collection locations and vehicles respectively. Weight measurements from the load cells determine the quantity of mixed waste collected. Collected data, including driver information, vehicle details, GPS coordinates, and waste weights, are formatted into an HTTP request. This request is sent to a Google Sheets API endpoint for storage and further processing.

Overall, this system provides an efficient and automated solution for waste collection monitoring, offering real-time insights into collection activities and waste quantities.

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## **About company**

Ecoparadigm is a leading company specialised in implementing sustainable and eco-friendly development projects. With a unique mix of knowledge and experience, we work in close collaboration with the public and private sectors.

Since the conception of this company, we have gained extensive experience in capacity development, policy building, awareness raising, project implementation and consulting in the field of sustainable water and sanitation management.

The main motto of the company is to help customers on ways to optimise their utilisation of resources and conserve the environment.

## Introduction

### Objectives:

- **Collection Details Display:** The project aims to display collection details, likely related to waste management or some similar field. This includes information such as driver name, vehicle number, and weight of different types of waste collected.
- **GPS Tracking:** The project incorporates GPS functionality to track the location of the device, presumably the location where waste is being collected. It sends latitude and longitude coordinates as part of the data payload.
- **NFC Integration:** NFC (Near Field Communication) is used to identify objects or bins related to waste collection. The code reads NFC tags and performs actions based on the tag information. It seems to use NFC to trigger a buzzer as well.
- **HTTP Communication:** The project communicates with a web server using HTTP GET requests. It sends data such as driver name, vehicle number, GPS coordinates, and waste weights to the server, likely for monitoring or logging purposes.
- **User Interface:** The project includes a simple user interface displayed on a TFT screen, providing visual feedback to the user. This includes loading indicators and text displays for various information.
- **Weight Measurement:** The project measures the weight of different types of waste using load cells. It calculates the weight of dry waste, wet waste, and mixed waste, and sends this information to the server.
- **Wireless Connectivity:** It connects to a Wi-Fi network (SSID and password are provided) to enable communication with the server and possibly to receive commands or updates remotely.

Overall, the project appears to be aimed at developing a system for tracking and managing waste collection, with features for location tracking, waste weight measurement, NFC tagging, and data communication with a server.

## Description of each component

### ESP32

#### ESP32 DEV KIT V1 PINOUT

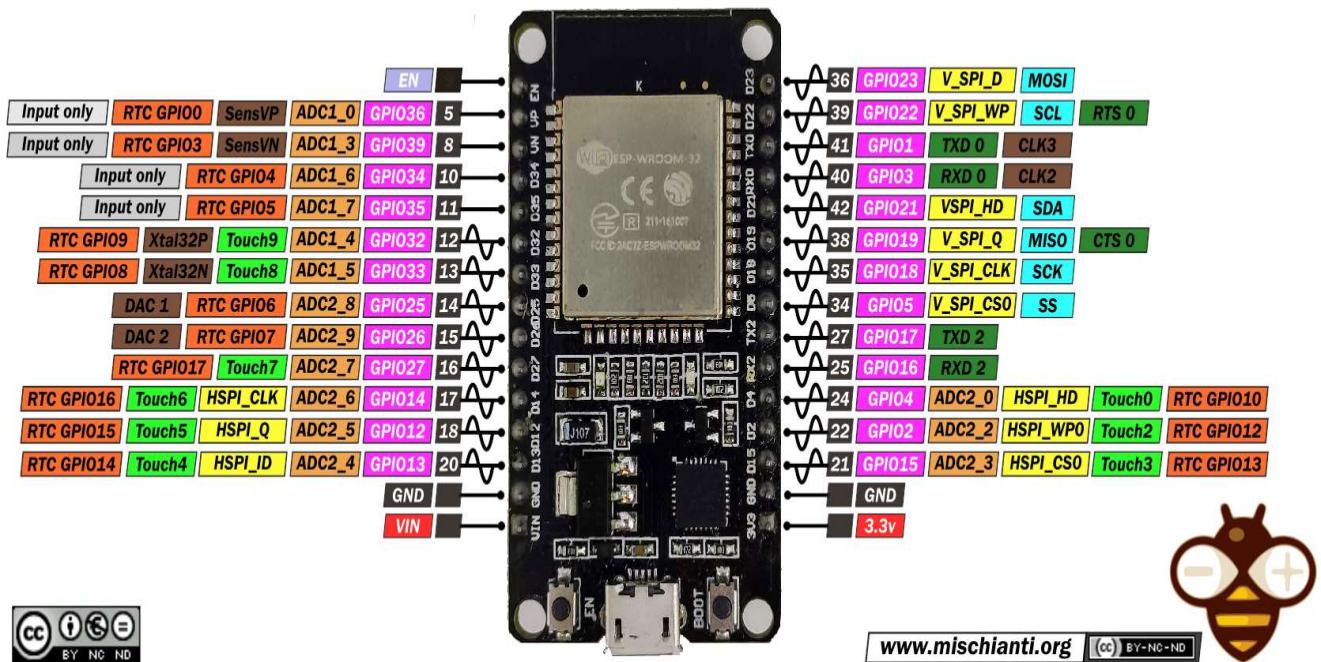


Figure 10:ESP32 Pinout [1]

The ESP32 is a powerful microcontroller board developed by Espressif Systems, a company based in Shanghai, China. It's part of the ESP family of microcontrollers, which gained immense popularity due to their low cost, versatility, and robust features. The ESP32 board is a versatile microcontroller platform that combines powerful processing capabilities with built-in wireless connectivity, making it an excellent choice for a wide range of IoT and embedded projects. Its rich feature set, extensive peripheral support, and compatibility with popular development tools make it a preferred platform for both beginners and experienced developers alike.

Here's a detailed breakdown of the ESP32 board:

**Microcontroller:** The ESP32 board is built around the ESP32 microcontroller, which is a dual-core Xtensa 32-bit LX6 microprocessor. It operates at clock speeds of up to 240 MHz, providing significant processing power for various applications.

**Wireless Connectivity:** One of the standout features of the ESP32 is its built-in Wi-Fi and Bluetooth capabilities. It supports both 2.4 GHz Wi-Fi (802.11 b/g/n) and Bluetooth 4.2 and BLE (Bluetooth Low Energy), making it ideal for IoT (Internet of Things) applications that require wireless communication.

**Peripheral Interfaces:** The ESP32 board is equipped with a wide range of peripheral interfaces, including SPI (Serial Peripheral Interface), I2C (Inter-Integrated Circuit), UART (Universal Asynchronous Receiver-Transmitter), ADC (Analog-to-Digital Converter), DAC (Digital-to-Analog Converter), PWM (Pulse Width Modulation), and more. These interfaces enable seamless integration with various sensors, actuators, displays, and other external devices.

**Applications:** The ESP32 board finds applications across various domains, including IoT, home automation, robotics, wearables, smart agriculture, industrial automation, and more. Its low power consumption, compact form factor, and wireless connectivity make it particularly well-suited for battery-powered and remote monitoring applications.

**Prototyping and Production:** The ESP32 is popular among both hobbyists and professional developers for prototyping and production alike. Its affordability, ease of use, and robust features make it an attractive choice for rapidly iterating on ideas and deploying scalable solutions.

## GPS Modules

### NEO-6M Module



Figure 11: NEO 6-M Module [2]

This is a GPS receiver module manufactured by u-blox, a Swiss company specializing in GPS technology.

#### Features:

- GPS Receiver: The NEO-6M module is equipped with a GPS receiver chip capable of receiving signals from GPS satellites.
- UART Interface: It communicates with the host microcontroller or computer via UART (Universal Asynchronous Receiver-Transmitter) interface, which is a common serial communication protocol.
- Compact Size: It comes in a small form factor, making it suitable for integration into various devices.
- Low Power Consumption: Designed for low power consumption, which is crucial for battery-powered applications.

- Built-in Antenna: Some versions of the NEO-6M module come with a built-in ceramic patch antenna, simplifying the hardware setup.
- High Accuracy: Provides accurate positioning information with typical accuracy down to a few meters.

### **Working Principle:**

The NEO-6M module receives signals broadcasted by GPS satellites orbiting the Earth. It calculates its position by triangulating the signals from multiple satellites. This process involves determining the distance to each satellite based on the time it takes for the signals to reach the receiver. Once it has received signals from enough satellites (usually at least four), it can accurately determine its position in terms of latitude, longitude, and altitude.

### **Applications:**

- Navigation Systems: Used in various navigation systems such as car navigation, marine navigation, and aviation navigation.
- Location-based Services: Provides location information for applications such as fleet management, asset tracking, and geotagging of photos.
- Outdoor Activities: Used in outdoor activities such as hiking, camping, and geocaching for accurate positioning and tracking.
- Time Synchronization: Utilized for time synchronization in applications where precise timing is crucial, such as telecommunications and scientific experiments.
- Environmental Monitoring: Integrated into environmental monitoring systems for tracking the movement of wildlife, studying weather patterns, and monitoring environmental changes.

### **Benefits:**

- Accurate Positioning: Provides accurate positioning information, essential for various applications requiring precise location data.
- Compact and Low Power: Its compact size and low power consumption make it suitable for integration into battery-powered devices.
- Cost-effective: Offers a cost-effective solution for adding GPS functionality to devices without the need for complex hardware design.
- Easy Integration: Interfaces with microcontrollers and computers via a simple UART interface, making it easy to integrate into existing projects.

**Limitations:**

- Signal Reception: Signal reception may be affected by obstacles such as tall buildings, trees, or atmospheric conditions.
- Indoor Use: Typically not suitable for indoor use due to difficulties in receiving GPS signals indoors.

**L89/L86 Module**

Figure 12: L89 Module [3]

The L89 is a GPS module, specifically the Quectel L89-M2. It's a compact and highly integrated GPS receiver module that combines GPS, GLONASS, BeiDou, Galileo, and QZSS (Quasi-Zenith Satellite System) systems for accurate positioning. Here's a detailed breakdown of its features, applications, and benefits:

**Features:**

- Multi-GNSS Support: It supports multiple global navigation satellite systems (GNSS) including GPS, GLONASS, BeiDou, Galileo, and QZSS. This ensures better

positioning accuracy and reliability, especially in challenging environments where signals from one system might be obstructed.

- High Sensitivity: The module features high sensitivity for fast and accurate positioning even in urban canyons and dense foliage environments.
- Compact Size: Its compact size makes it suitable for integration into various devices and applications without occupying much space.
- Low Power Consumption: Designed with low power consumption in mind, it's suitable for battery-powered devices where power efficiency is crucial.
- UART Interface: The module typically communicates with the host microcontroller or system via a UART (Universal Asynchronous Receiver-Transmitter) interface, making it easy to interface with a wide range of microcontrollers and systems.

### **Applications:**

- Automotive Navigation: The L89 module is commonly used in automotive navigation systems for providing accurate positioning and navigation assistance to drivers.
- Asset Tracking: It's utilized in asset tracking systems where the real-time location of assets such as vehicles, containers, or packages needs to be monitored.
- Fleet Management: Fleet management systems utilize GPS modules like the L89 to track and manage vehicles, optimize routes, and improve operational efficiency.
- Personal Navigation Devices: It's also found in personal navigation devices such as handheld GPS units used for hiking, biking, or outdoor activities.
- IoT Devices: With its compact size and low power consumption, the L89 is suitable for integration into various Internet of Things (IoT) devices such as wearable fitness trackers, smartwatches, or asset tags.

### **Benefits:**

- Accurate Positioning: By leveraging multiple GNSS systems, the L89 provides accurate positioning even in challenging environments, ensuring reliable navigation and tracking.
- Versatility: Its support for multiple GNSS systems and compact form factor make it versatile for use in various applications across different industries.
- Power Efficiency: The module's low power consumption is beneficial for battery-powered devices, extending battery life and reducing the need for frequent recharging or replacement.

- Easy Integration: With its UART interface and compact size, the L89 module is relatively easy to integrate into existing designs or develop new products around.

## TFT LCD Display

### ILI9488 / ILI9341

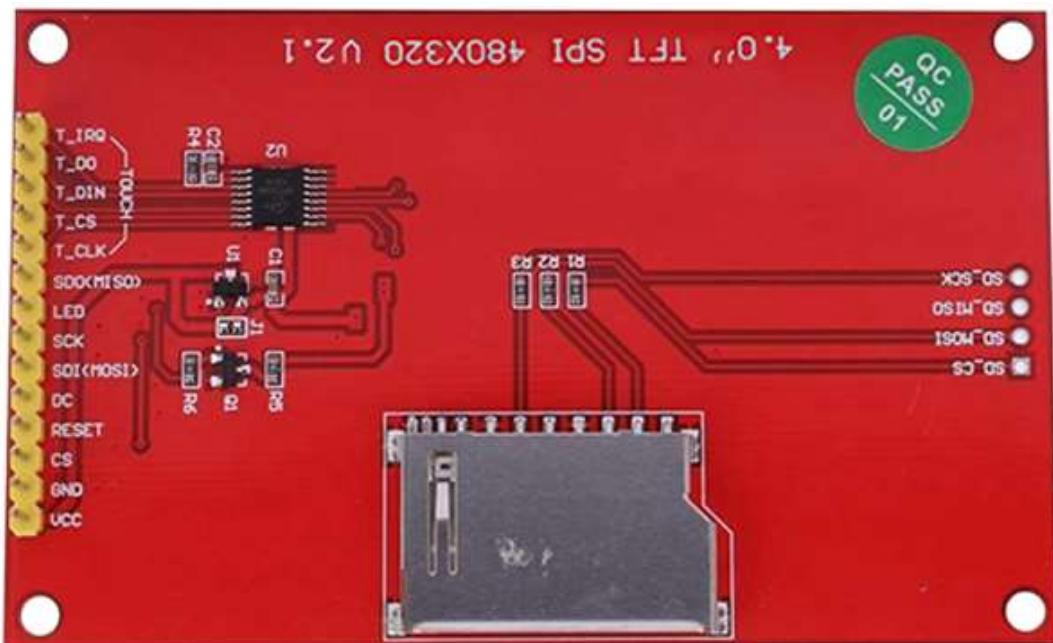


Figure 13: TFT SPI LCD ILI9488 Display [4]

The ILI9488 TFT LCD Display is a type of thin-film transistor (TFT) liquid crystal display (LCD) that utilizes the ILI9488 display controller. Here are some detailed insights:

#### Technical Specifications:

- Controller: ILI9488
- Display Type: TFT LCD
- Resolution: Typically, 320x480 pixels
- Color Depth: 16-bit color (65,536 colors)
- Interface: Usually supports SPI (Serial Peripheral Interface) or MCU (Microcontroller Unit) interface
- Size: Various sizes available, commonly 3.5 inches

**Features:**

- High Resolution: Offers relatively high resolution for a TFT display, making it suitable for displaying detailed graphics and text.
- Colorful Display: Supports 16-bit color depth, providing vibrant and rich colors.
- Versatile Interface: Supports SPI and MCU interfaces, offering flexibility in connection to microcontrollers or other devices.
- Wide Viewing Angle: Typically offers a wide viewing angle, ensuring good visibility from various perspectives.
- Integrated Controller: The ILI9488 controller simplifies the interface between the display and the microcontroller, reducing the complexity of programming.

**Applications:**

- Embedded Systems: Used in various embedded systems where a graphical user interface (GUI) is required, such as industrial control panels, medical devices, and IoT (Internet of Things) devices.
- Consumer Electronics: Found in products like handheld gaming devices, portable multimedia players, and digital cameras for displaying images and user interfaces.
- Information Displays: Utilized in information kiosks, vending machines, and other public displays for presenting information in a visually appealing manner.
- DIY Electronics Projects: Popular among hobbyists and DIY enthusiasts for projects involving graphical displays, such as Arduino-based projects and Raspberry Pi projects.

**Benefits:**

- Enhanced User Experience: Provides a visually pleasing and interactive interface for users, enhancing the overall user experience.
- Easy Integration: With its integrated controller and versatile interface options, it can be easily integrated into various electronic devices and projects.
- Cost-Effective: Offers a balance between cost and performance, making it suitable for a wide range of applications without significantly increasing the overall product cost.
- Customization: Allows for customization of graphical interfaces to suit specific application requirements, enabling developers to create unique and tailored user experiences.

## Considerations:

- Power Consumption: TFT displays, including the ILI9488, can consume significant power, especially when displaying bright colors or animations. Power management strategies may be necessary to optimize battery life in portable devices.
- Driver Compatibility: Ensure compatibility with the microcontroller or driver board being used, as some displays may require specific drivers or libraries to function properly.
- Physical Size and Mounting: Consider the physical dimensions and mounting requirements of the display to ensure it fits within the intended device or enclosure.

## HX711 IC

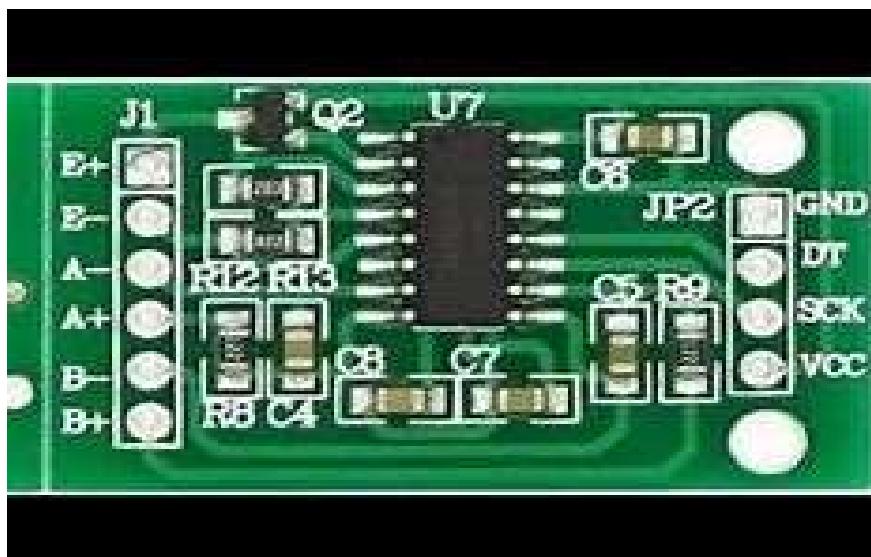


Figure 14: HX711 IC [5]

The HX711 is a precision 24-bit analog-to-digital converter (ADC) designed for weigh scales and industrial control applications to interface directly with a bridge sensor. Here are the details broken down:

**1. Purpose:** The primary purpose of the HX711 is to convert analog sensor signals into digital data that can be processed by a microcontroller or other digital system. It's commonly used in weigh scales and load cells due to its high precision and ability to accurately measure small changes in weight.

**2. Functionality:** The HX711 consists of a programmable gain amplifier (PGA) and a precision delta-sigma ADC. It is specifically designed to interface directly with bridge sensors (such as strain gauges) commonly used in load cells. The PGA allows for selectable gain levels, which enables the HX711 to amplify small sensor signals while maintaining high resolution.

### 3. Features:

- High-resolution ADC: The HX711 has a 24-bit ADC, which provides high-resolution measurements. This means it can detect very small changes in input voltage.
- Selectable Gain: The PGA of the HX711 allows users to select from multiple gain levels, typically 32, 64, or 128, to amplify the input signal. This flexibility enables the HX711 to accommodate sensors with different output voltage ranges.
- On-chip Voltage Regulator: The HX711 includes an on-chip voltage regulator, which simplifies the power supply requirements and improves noise performance.
- Serial Interface: Communication with the HX711 is done via a simple serial interface, typically using protocols like SPI or I2C, making it easy to interface with a wide range of microcontrollers and digital systems.
- Low Noise: The HX711 is designed to minimize noise, ensuring accurate and stable measurements even in noisy environments.

### 4. Applications:

- Weigh Scales: The HX711 is widely used in digital weigh scales for applications ranging from kitchen scales to industrial weighing systems.
- Industrial Automation: It is used in various industrial control applications where precise measurement of force or weight is required, such as in material handling systems, packaging machinery, and process control.
- Smart Agriculture: In agriculture, the HX711 can be utilized in systems for monitoring the weight of produce, livestock, or agricultural equipment.
- Medical Devices: It can also be found in medical devices where precise measurement of weight or pressure is necessary, such as patient monitoring systems or infusion pumps.

### 5. Advantages:

- High Precision: The 24-bit ADC provides high-resolution measurements, allowing for precise and accurate readings.

- Versatility: The selectable gain and serial interface make the HX711 versatile and suitable for a wide range of sensor types and applications.
- Easy Integration: Its simple serial interface and availability of libraries and code examples make it easy to integrate into projects using popular microcontrollers like Arduino or Raspberry Pi.

## Loadcells



Figure 15 : Loadcell [6]

Load cells are transducers that convert force or weight into an electrical signal. They are commonly used in various industries and applications where accurate measurement of force or weight is required. Here's a detailed breakdown:

**1. Purpose:** Load cells are used to measure force or weight in a wide range of applications, from industrial weighing systems to laboratory experiments. They are designed to provide accurate and reliable measurements of the force applied to them.

**2. Functionality:** Load cells typically consist of a metal structure (such as aluminum or stainless steel) with strain gauges bonded to it. When a force is applied to the load cell, it deforms slightly, causing a change in the resistance of the strain gauges. This change in resistance is proportional to the applied force and is measured using Wheatstone bridge circuitry.

### **3. Types of Load Cells:**

- **Compression Load Cells:** These load cells are designed to measure compressive forces. They are often used in applications where the force is applied vertically, such as in platform scales or industrial weighing systems.
- **Tension Load Cells:** These load cells measure tensile forces and are commonly used in applications where the force is applied horizontally, such as in crane scales or tension measurement systems.
- **Bending Beam Load Cells:** These load cells measure both compression and tension forces and are often used in applications where space is limited or where the force may be applied in different directions.

### **4. Features:**

- **Accuracy:** Load cells are designed to provide precise and accurate measurements of force or weight, making them suitable for applications where high precision is required.
- **Reliability:** When properly installed and calibrated, load cells offer reliable and consistent performance over time.
- **Durability:** Load cells are often built to withstand harsh environments, with features such as corrosion-resistant materials and rugged construction.
- **Range:** Load cells are available in a wide range of capacities, from a few grams to several tons, allowing them to be used in various applications.

### **5. Applications:**

- **Industrial Weighing Systems:** Load cells are widely used in industrial scales for weighing materials, products, and vehicles. They are commonly found in platform scales, conveyor belt scales, and truck scales.
- **Process Control:** Load cells are used in various industrial processes to monitor and control the application of force or weight, such as in packaging machinery, material handling systems, and assembly lines.

- Medical Devices: Load cells are used in medical devices for applications such as patient weighing scales, infusion pumps, and physical therapy equipment.
- Agricultural Equipment: Load cells are used in agricultural machinery for tasks such as measuring the weight of harvested crops, monitoring the load on agricultural equipment, and controlling irrigation systems.

## 6. Advantages:

- Precision: Load cells offer high precision and accuracy in measuring force or weight.
- Versatility: Load cells can be adapted to various applications and environments, thanks to their different designs and capacities.
- Real-Time Monitoring: Load cells provide real-time data on force or weight, allowing for immediate feedback and control in automated systems.
- Non-Intrusive Measurement: Load cells offer non-intrusive measurement of force or weight, making them suitable for applications where direct contact with the object being measured is not desired.

## NFC Module

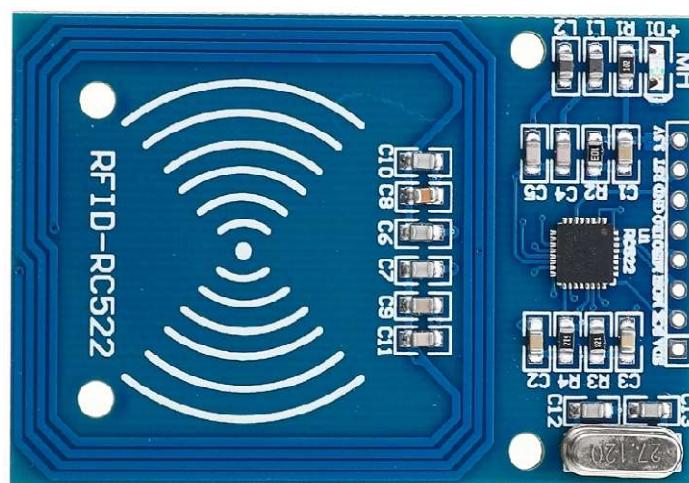


Figure 16: NFC Module [7]

Near Field Communication (NFC) tags, also known as RFID (Radio Frequency Identification) modules, are small electronic devices that can store and transmit data wirelessly using radio frequency signals. Here's a detailed breakdown:

**1. Purpose:** NFC tags serve various purposes, including identification, tracking, authentication, and data exchange. They enable communication between electronic devices when they are brought into close proximity (typically within a few centimeters), making them suitable for a wide range of applications.

**2. Functionality:** NFC tags consist of an integrated circuit (IC) and an antenna, typically encased in a small, passive package. The IC contains memory where data can be stored, and the antenna allows the tag to communicate wirelessly with NFC-enabled devices.

When an NFC-enabled device, such as a smartphone or tablet, is brought near an NFC tag, it generates a magnetic field that powers the tag. The tag then uses this energy to transmit data back to the device, which can read the information stored on the tag.

### **3. Features:**

- Data Storage: NFC tags can store various types of data, including text, URLs, contact information, and commands.
- Security: Some NFC tags support encryption and authentication mechanisms to ensure data security and prevent unauthorized access.
- Ease of Use: NFC tags are easy to use and require no physical contact or pairing process. Users can simply tap their NFC-enabled device against the tag to initiate communication.
- Compatibility: NFC technology is widely supported by smartphones, tablets, and other consumer electronics, making NFC tags compatible with a broad range of devices.

### **4. Applications:**

- Access Control: NFC tags are used in access control systems for building entry, parking facilities, public transportation, and event ticketing.
- Payment Systems: NFC tags enable contactless payment systems, allowing users to make payments using their smartphones or contactless payment cards.
- Inventory Management: NFC tags are used in inventory and asset tracking systems to monitor the movement and status of items in warehouses, stores, and logistics operations.

- Marketing and Advertising: NFC tags are used in marketing campaigns to deliver promotional content, product information, and interactive experiences to consumers.
- Authentication and Security: NFC tags are used for product authentication, anti-counterfeiting measures, and secure access to sensitive information or restricted areas.

## 5. Advantages:

- Convenience: NFC tags enable quick and effortless communication between devices with a simple tap or proximity.
- Versatility: NFC tags can be used in a wide range of applications, from access control to payment systems to marketing campaigns.
- Cost-Effectiveness: NFC tags are relatively inexpensive and offer a cost-effective solution for implementing wireless communication and data exchange.
- Interoperability: NFC technology is standardized, ensuring interoperability between different devices and systems.

## Buzzer



Figure 17 : Buzzer [8]

A buzzer is an electronic device that produces sound when an electrical current is passed through it. It's commonly used to generate audible alerts, notifications, or alarms in various applications.

Buzzers are versatile electronic devices used to produce audible alerts, notifications, and alarms in a wide range of applications, from consumer electronics to industrial machinery to emergency systems. Their simple design, reliability, and effectiveness make them essential components in numerous devices and systems.

**Functionality:** When an electrical current is applied to a buzzer, it energizes the buzzer's internal components, causing them to vibrate at a specific frequency. These vibrations create sound

### **Applications:**

- **Alarms and Notifications:** One of the primary applications of buzzers is to provide audible alerts and notifications in various devices and systems. For example, buzzers are used in alarm clocks, timers, doorbells, and security systems to alert users of specific events or conditions.
- **Industrial Equipment:** Buzzers are commonly used in industrial machinery and equipment to signal the completion of a process, indicate an error or malfunction, or warn of hazardous conditions.
- **Automotive Systems:** In automobiles, buzzers are used to provide audible warnings for seat belt reminders, door open alerts, low fuel warnings, and other vehicle functions.
- **Consumer Electronics:** Buzzers are found in a wide range of consumer electronics devices, including appliances, gadgets, and toys, to provide user feedback, confirm button presses, or indicate system status.
- **Medical Devices:** In medical equipment and devices, buzzers are used to alert healthcare professionals or patients of critical events, such as low battery warnings, alarm conditions, or medication reminders.
- **Emergency Systems:** Buzzers are integrated into emergency systems such as fire alarms, smoke detectors, and evacuation alarms to alert occupants of buildings or facilities in case of emergencies.

- Educational Kits: Buzzers are often included in educational electronics kits and projects to demonstrate basic principles of electricity, circuits, and sound generation.

## Buck Boost Converter



Figure 18 : Buck Boost Converter [9]

A buck-boost converter is a type of DC-DC converter that can step up (boost) or step down (buck) an input voltage to provide a stable output voltage, regardless of whether the input voltage is higher or lower than the desired output voltage.

Buck-boost converters are essential DC-DC converters used to regulate voltage in various electronic systems and devices. Their ability to step up or step down the input voltage to provide a stable output voltage makes them valuable components in applications ranging from portable electronics to renewable energy systems.

## 1. Principle of Operation:

- Buck Mode: In buck mode, the input voltage is higher than the output voltage. The converter reduces the input voltage to provide a stable lower output voltage. This is achieved by controlling the duty cycle of a switching element (usually a transistor) in the circuit.
- Boost Mode: In boost mode, the input voltage is lower than the output voltage. The converter increases the input voltage to provide a stable higher output voltage. This is accomplished by storing energy in an inductor during the off period of the switching element and releasing it during the on period.
- Automatic Transition: Buck-boost converters can seamlessly transition between buck and boost modes as the input voltage varies, ensuring a continuous and stable output voltage.

## 2. Components of a Buck-Boost Converter:

- Switching Element: Typically a transistor (such as a MOSFET) that controls the flow of current in the circuit.
- Inductor: Stores and releases energy during the switching process, helping to regulate the output voltage.
- Diode: Allows current to flow in only one direction and is used in conjunction with the inductor to control the flow of energy.
- Capacitor: Smoothes out voltage fluctuations and helps stabilize the output voltage.
- Control Circuitry: Monitors the input and output voltages and adjusts the duty cycle of the switching element to maintain a stable output voltage.

## 3. Applications:

- Battery-Powered Devices: Buck-boost converters are commonly used in battery-powered devices, such as smartphones, laptops, and portable electronics, to regulate the voltage supplied to the device's components.
- Solar Power Systems: In solar power systems, buck-boost converters are used to regulate the voltage output from solar panels, which can vary depending on factors such as sunlight intensity and temperature.

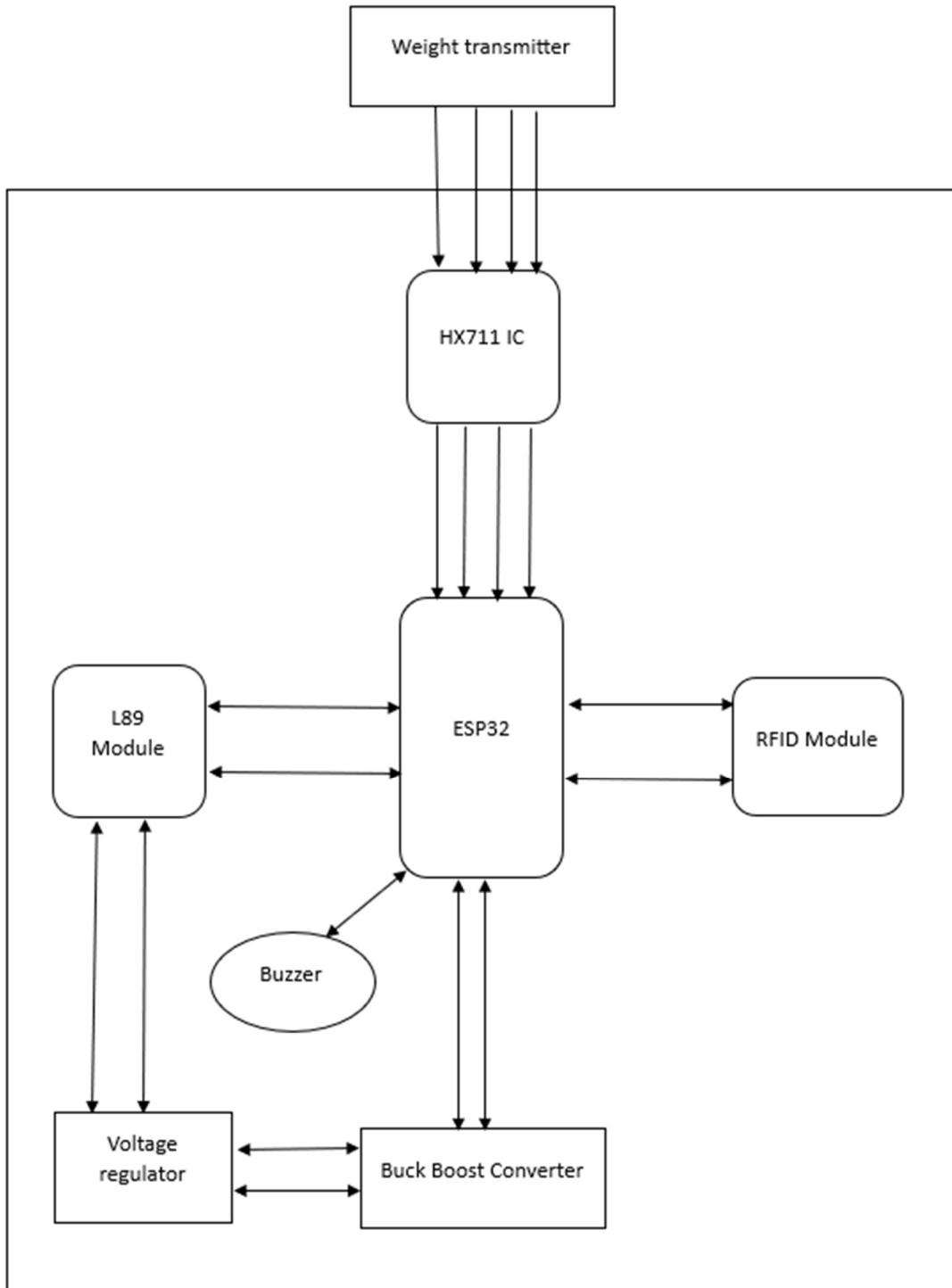
- LED Lighting: Buck-boost converters are used in LED lighting applications to ensure a consistent and stable voltage supply to the LEDs, regardless of fluctuations in the input voltage.
- Automotive Electronics: In automotive systems, buck-boost converters are used to regulate the voltage supplied to various electronic components, such as sensors, actuators, and lighting systems.
- Portable Chargers: Buck-boost converters are used in portable chargers and power banks to regulate the voltage supplied to devices being charged, ensuring compatibility with a wide range of devices.
- IoT Devices: In Internet of Things (IoT) devices, which often operate on low-power and have varying input voltage sources (e.g., batteries, solar panels), buck-boost converters are used to maintain a stable voltage supply to the device's electronics.

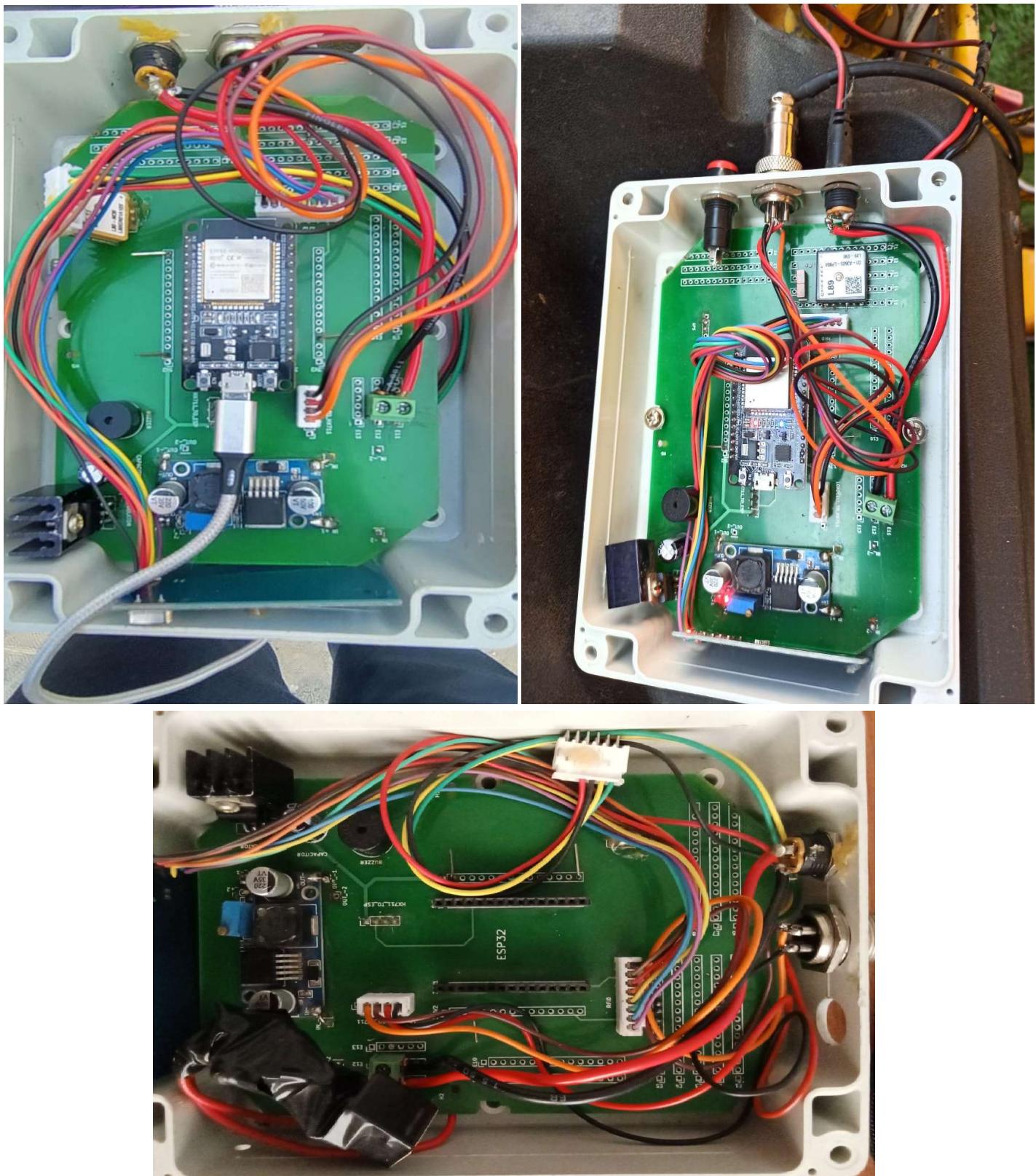
#### **4. Advantages:**

- Flexibility: Buck-boost converters can operate over a wide range of input voltages and provide a stable output voltage, making them versatile for various applications.
- Efficiency: Modern buck-boost converters can achieve high levels of efficiency, minimizing power losses and extending battery life in battery-powered devices.
- Compact Size: Buck-boost converters can be designed to be compact and lightweight, making them suitable for portable and space-constrained applications.
- Regulated Output: Buck-boost converters provide a regulated output voltage, ensuring consistent performance of electronic devices and systems.

## Project details

### Circuit Block Diagram:



**Project board:**

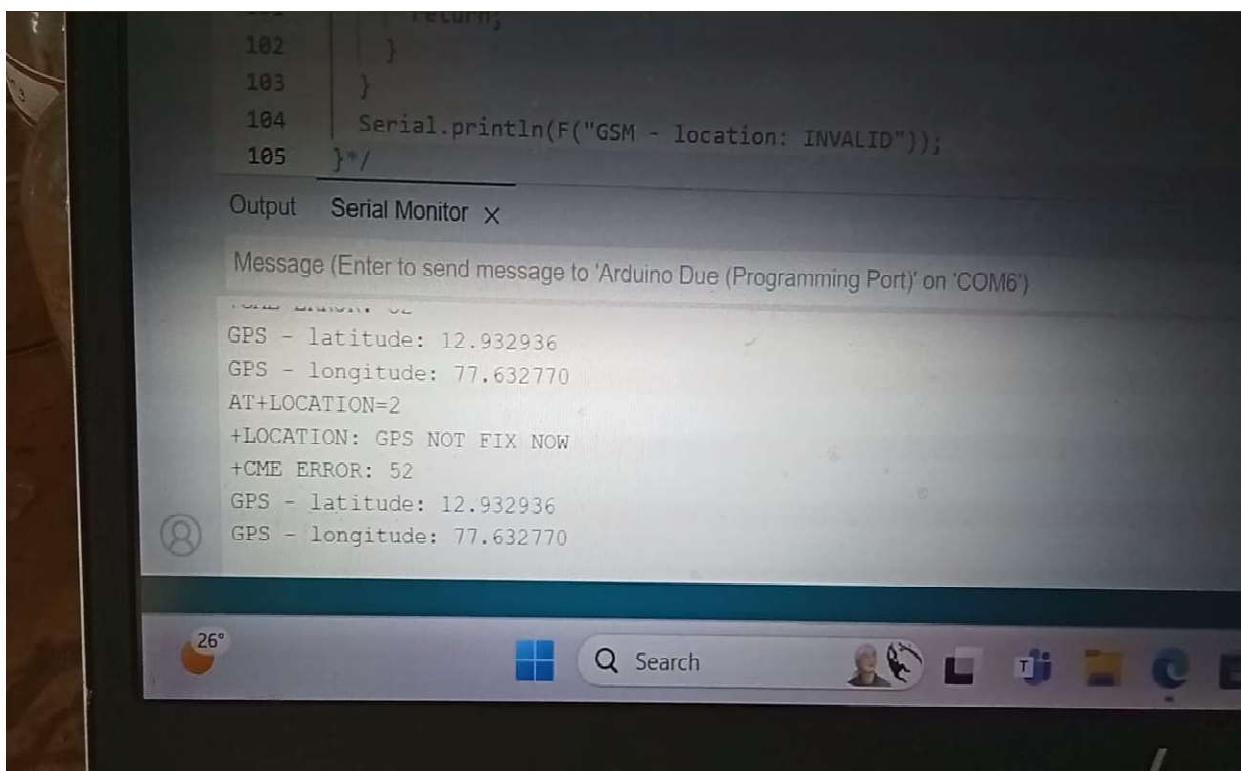
**Explanation :**

This ESP32-based system integrates various sensors and modules to facilitate waste collection management. It includes functionalities such as GPS tracking, NFC tag detection, and weight measurement using load cells. The system utilizes an ESP32 microcontroller, TFT display, GPS module, NFC reader, and HX711 load cell amplifier. Upon initialization, the TFT display showcases a user interface representing the system's identity and status. The system then proceeds to establish a Wi-Fi connection for data transmission.

During operation, the system continuously reads GPS coordinates and NFC tags. Detected GPS coordinates and NFC tag IDs are utilized to identify collection locations and vehicles respectively. Weight measurements from the load cells determine the quantity of mixed waste collected. Collected data, including driver information, vehicle details, GPS coordinates, and waste weights, are formatted into an HTTP request. This request is sent to a Google Sheets API endpoint for storage and further processing.

Overall, this system provides an efficient and automated solution for waste collection monitoring, offering real-time insights into collection activities and waste quantities.

## Locations with GPS and GSM:



A screenshot of a computer monitor displaying a terminal window titled "Serial Monitor". The window shows code at the top and a message input field below it. The message field contains the text: "Message (Enter to send message to 'Arduino Due (Programming Port)' on 'COM6')". Below the message field, the terminal output shows several lines of text, including GPS coordinates and AT commands. The Windows taskbar is visible at the bottom of the screen.

```
102 }
103 }
104 Serial.println(F("GSM - location: INVALID"));
105 }*/
```

Output    Serial Monitor X

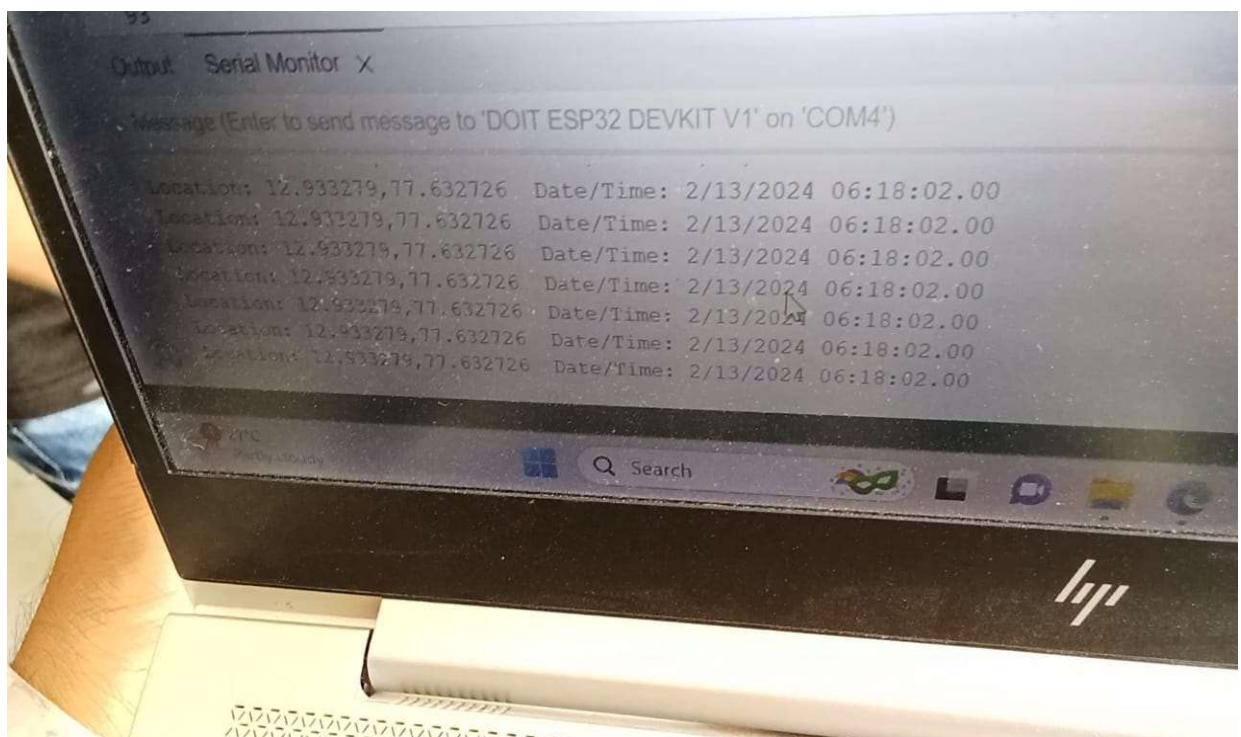
Message (Enter to send message to 'Arduino Due (Programming Port)' on 'COM6')

```
GPS - latitude: 12.932936
GPS - longitude: 77.632770
AT+LOCATION=2
+LOCATION: GPS NOT FIX NOW
+CME ERROR: 52
GPS - latitude: 12.932936
GPS - longitude: 77.632770
```

26°

Search

HP



A screenshot of a computer monitor displaying a terminal window titled "Serial Monitor". The window shows code at the top and a message input field below it. The message field contains the text: "Message (Enter to send message to 'DOIT ESP32 DEVKIT V1' on 'COM4')". Below the message field, the terminal output shows multiple lines of text, all identical, indicating repeated location data. The Windows taskbar is visible at the bottom of the screen.

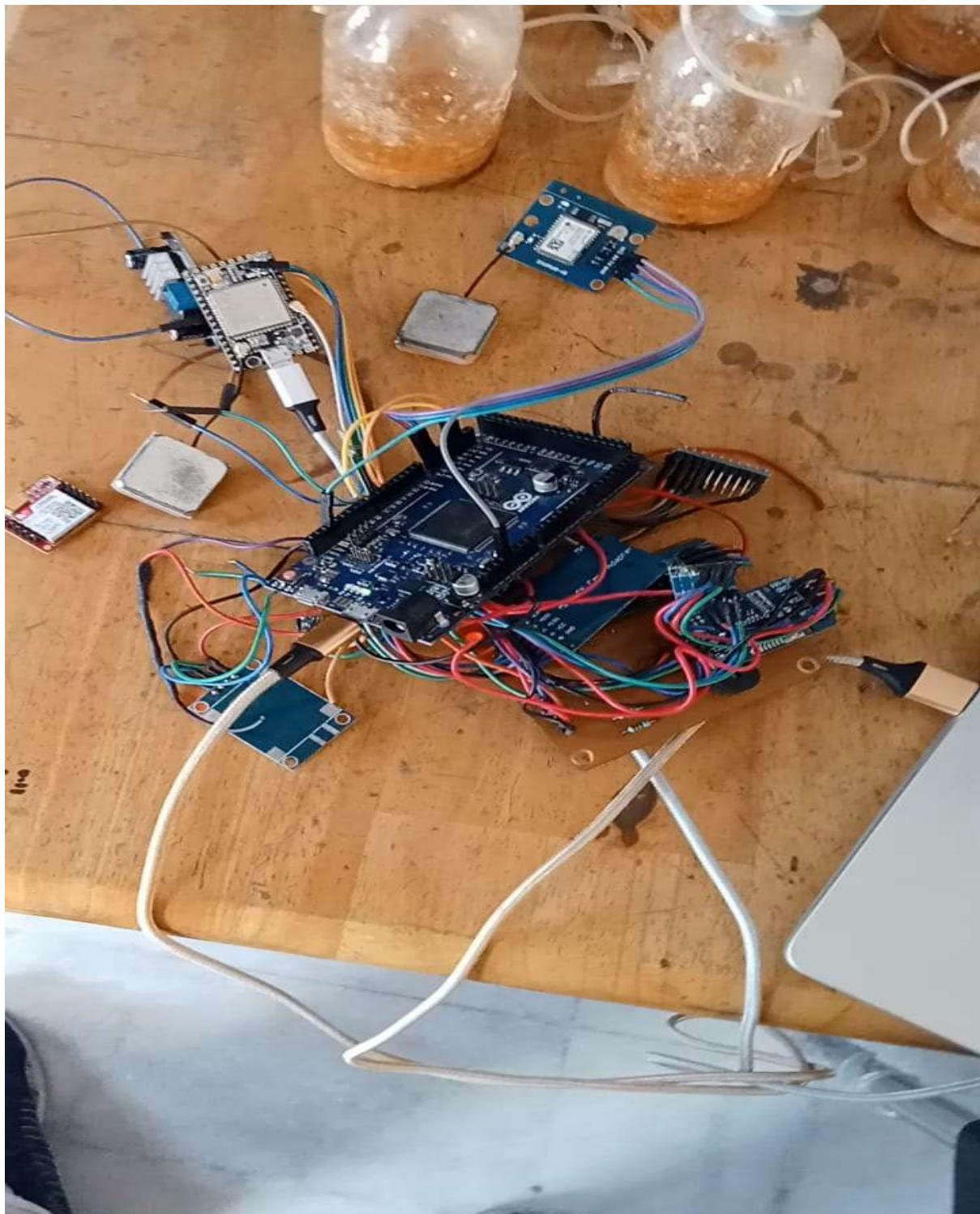
```
Location: 12.933279,77.632726 Date/Time: 2/13/2024 06:18:02.00
```

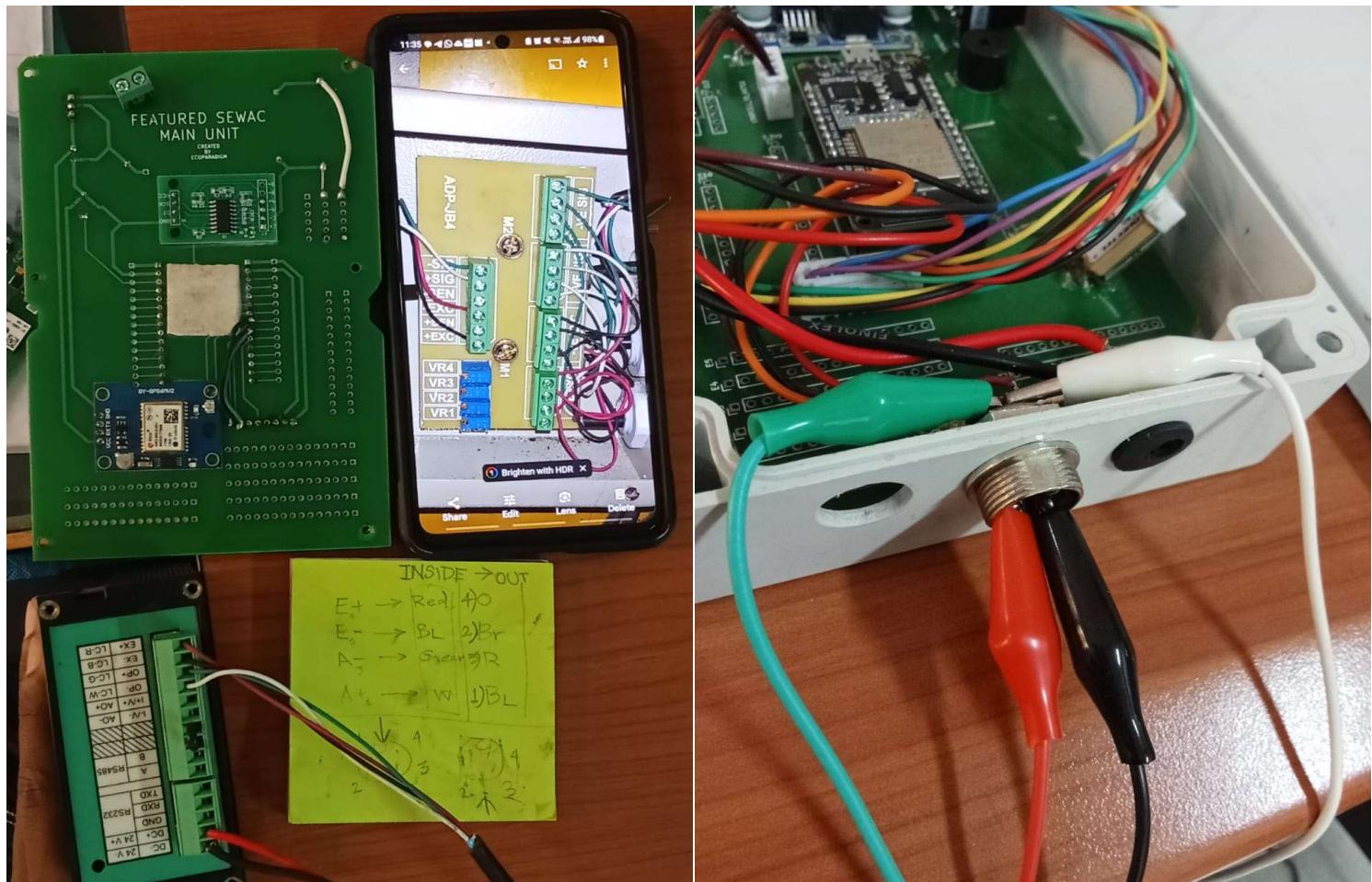
Output    Serial Monitor X

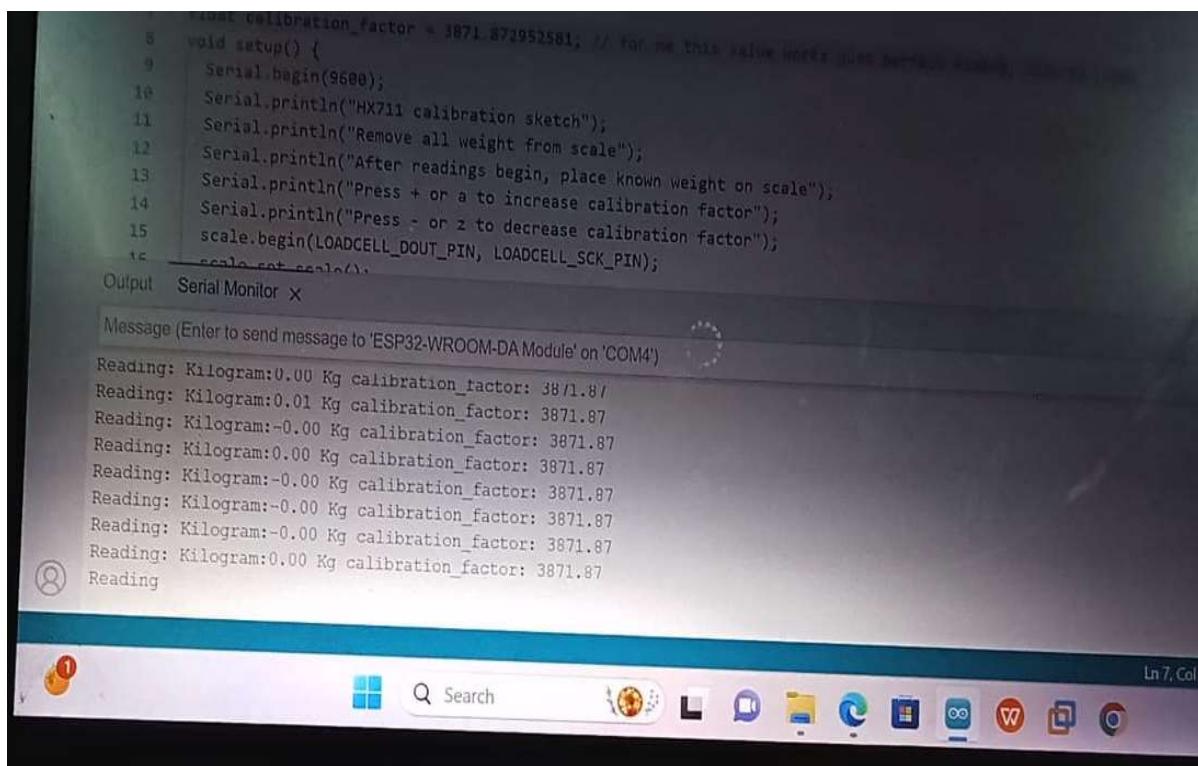
Message (Enter to send message to 'DOIT ESP32 DEVKIT V1' on 'COM4')

Search

HP



**TFT SPI Display working:****Weight Measurement:**



The screenshot shows a computer monitor displaying a serial monitor window and a Windows taskbar.

**Serial Monitor Output:**

```
8 void setup() {  
9     Serial.begin(9600);  
10    Serial.println("HX711 calibration sketch");  
11    Serial.println("Remove all weight from scale");  
12    Serial.println("After readings begin, place known weight on scale");  
13    Serial.println("Press + or a to increase calibration factor");  
14    Serial.println("Press - or z to decrease calibration factor");  
15    scale.begin(LOADCELL_DOUT_PIN, LOADCELL_SCK_PIN);  
16    scale.set_scale();  
17 }  
18  
19 // Main loop:  
20 void loop() {  
21     if (Serial.available() > 0) {  
22         char c = Serial.read();  
23         if (c == '+') {  
24             scale.increase_calibration();  
25         } else if (c == '-') {  
26             scale.decrease_calibration();  
27         } else if (c == 'a') {  
28             scale.increase_calibration();  
29         } else if (c == 'z') {  
30             scale.decrease_calibration();  
31         }  
32     }  
33     scale.read();  
34     scale.print();  
35 }
```

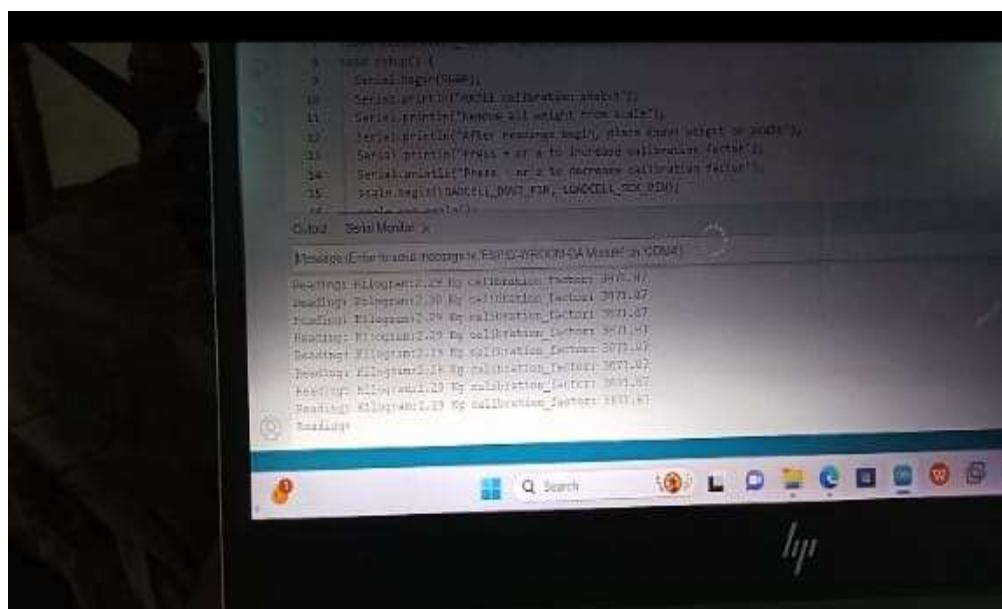
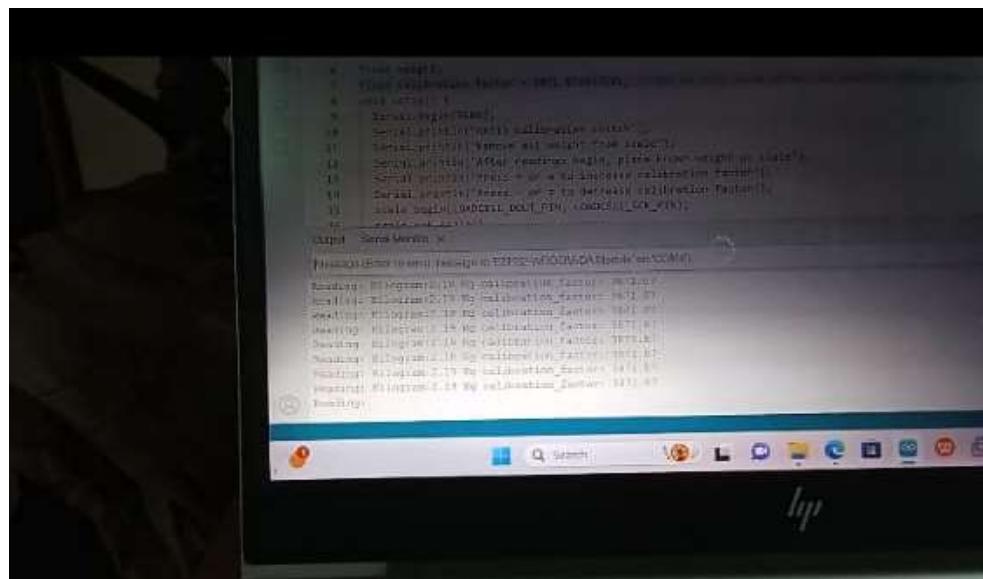
**Message:** (Enter to send message to 'ESP32-WROOM-DA Module' on 'COM4')

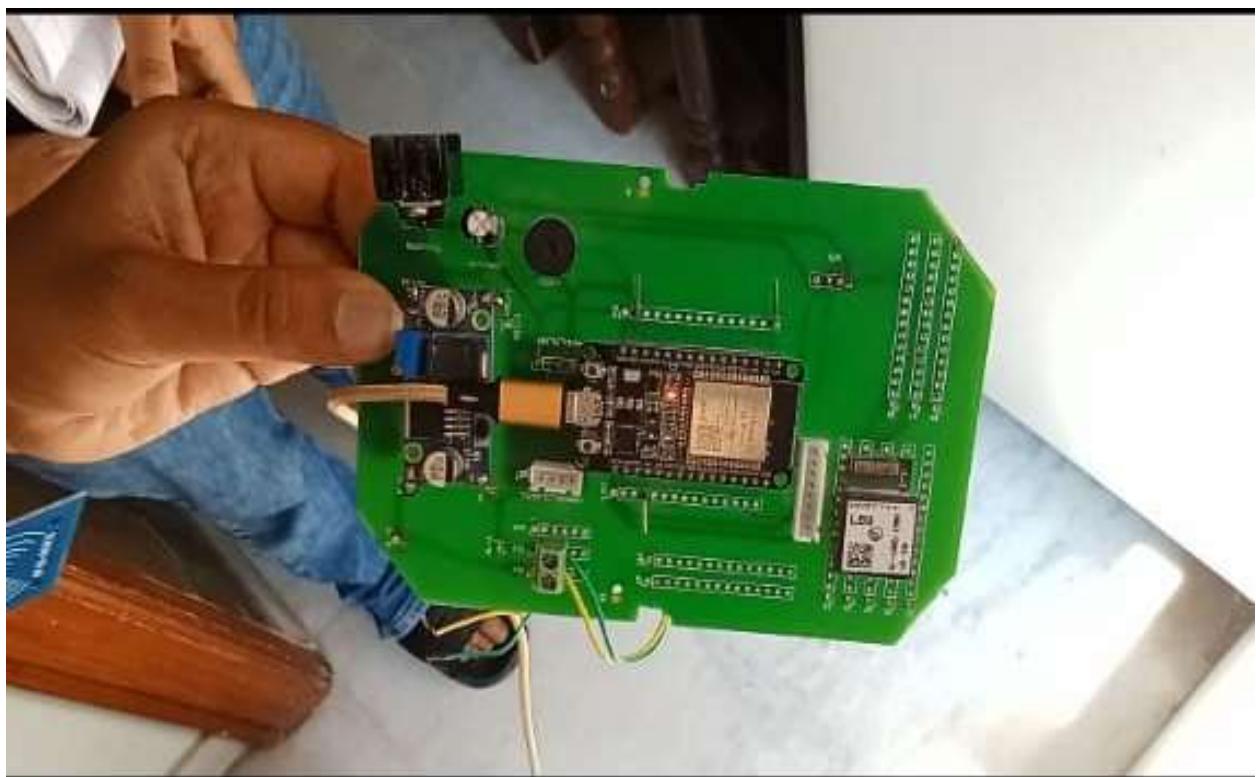
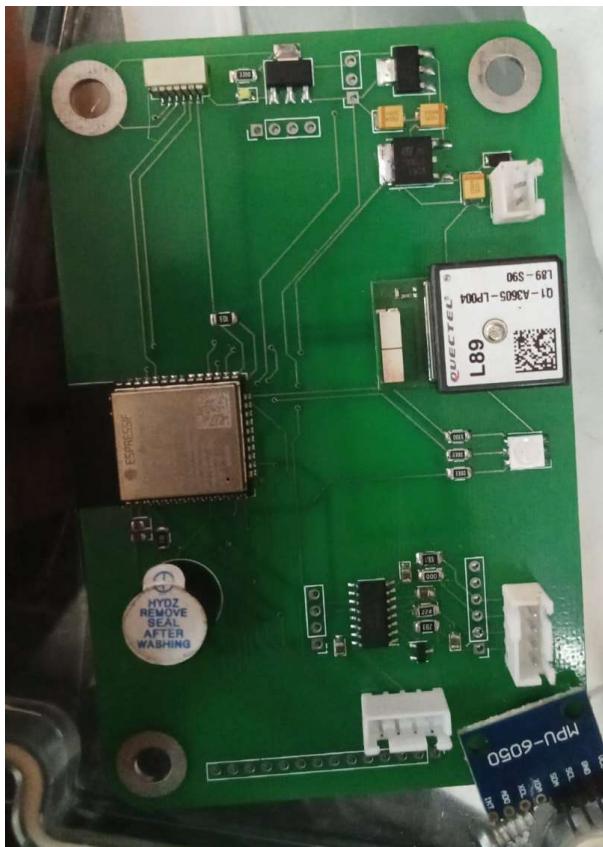
Reading: Kilogram:0.00 Kg calibration\_factor: 3871.87  
Reading: Kilogram:0.01 Kg calibration\_factor: 3871.87  
Reading: Kilogram:-0.00 Kg calibration\_factor: 3871.87  
Reading: Kilogram:0.00 Kg calibration\_factor: 3871.87  
Reading: Kilogram:-0.00 Kg calibration\_factor: 3871.87  
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Reading: Kilogram:0.00 Kg calibration\_factor: 3871.87

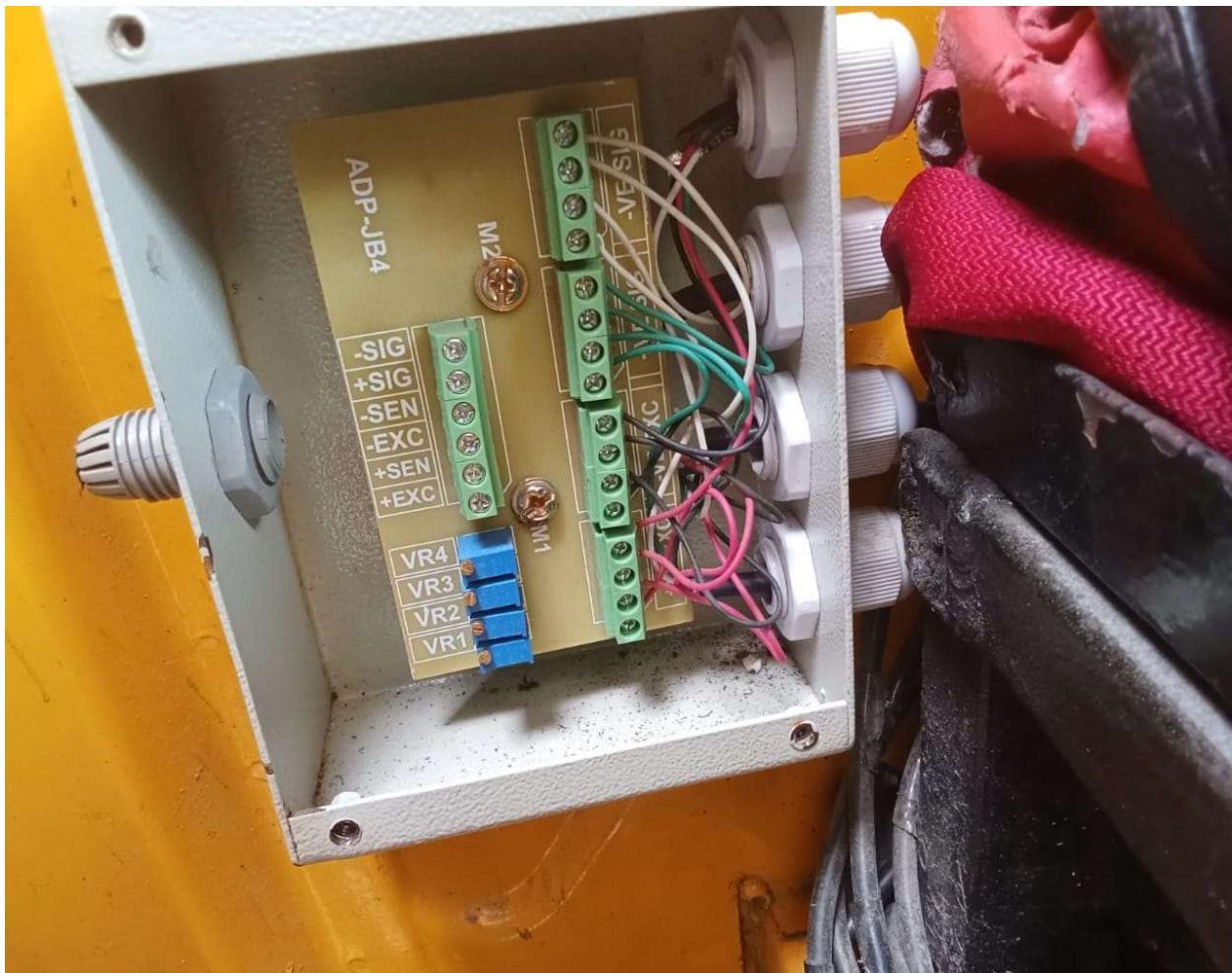
**Windows Taskbar:**

- Search bar
- Icons for File, Copy, Paste, Find, and others
- Taskbar icons for various applications
- Language switcher: English (US)
- Date and time: Fri 10:45 AM
- System tray icons: battery, signal strength, volume, etc.





**Others work:**



## Conclusion

The project aims to create an IoT-based waste management system that tracks waste collection activities, including the types and weights of waste collected at various locations. It provides real-time monitoring and data logging capabilities, allowing for better management and analysis of waste collection operations. Possible future enhancements could include features such as real-time notifications, route optimization based on collected data, and integration with larger waste management systems.

## Advantages

The described ESP32-based waste collection management system offers several advantages:

**Efficiency:** By automating the waste collection process, the system reduces manual effort and potential errors associated with traditional methods. This efficiency translates into cost savings and improved resource utilization.

**Real-time Monitoring:** The integration of GPS tracking enables real-time monitoring of collection activities. Supervisors can track the location of collection vehicles and ensure efficient routing, leading to optimized schedules and reduced fuel consumption.

**Accuracy:** The use of NFC tags and GPS coordinates ensures accurate identification of collection locations and vehicles. This accuracy minimizes the risk of errors in data recording and enhances the reliability of collected information.

**Data Insights:** Collected data, including GPS coordinates, NFC tag IDs, and waste weights, provide valuable insights into waste collection operations. Analyzing this data allows for optimization of collection routes, identification of high-volume collection areas, and better resource allocation.

**Integration with Google Sheets:** Sending data to a Google Sheets API endpoint enables seamless storage and further processing of collected information. This integration simplifies data management and facilitates analysis using familiar spreadsheet tools.

**Scalability:** The modular design of the system allows for easy integration of additional sensors or functionalities to meet evolving requirements. This scalability ensures that the system can adapt to changing needs and accommodate future enhancements.

**Environmental Impact:** By optimizing waste collection routes and improving operational efficiency, the system helps reduce fuel consumption and greenhouse gas emissions associated with waste collection activities. This contributes to environmental sustainability goals.

## Future requirements

**Predictive Analytics:** Implementing predictive analytics algorithms to forecast waste generation patterns based on historical data. This could help optimize collection routes and schedules, reducing costs and improving efficiency.

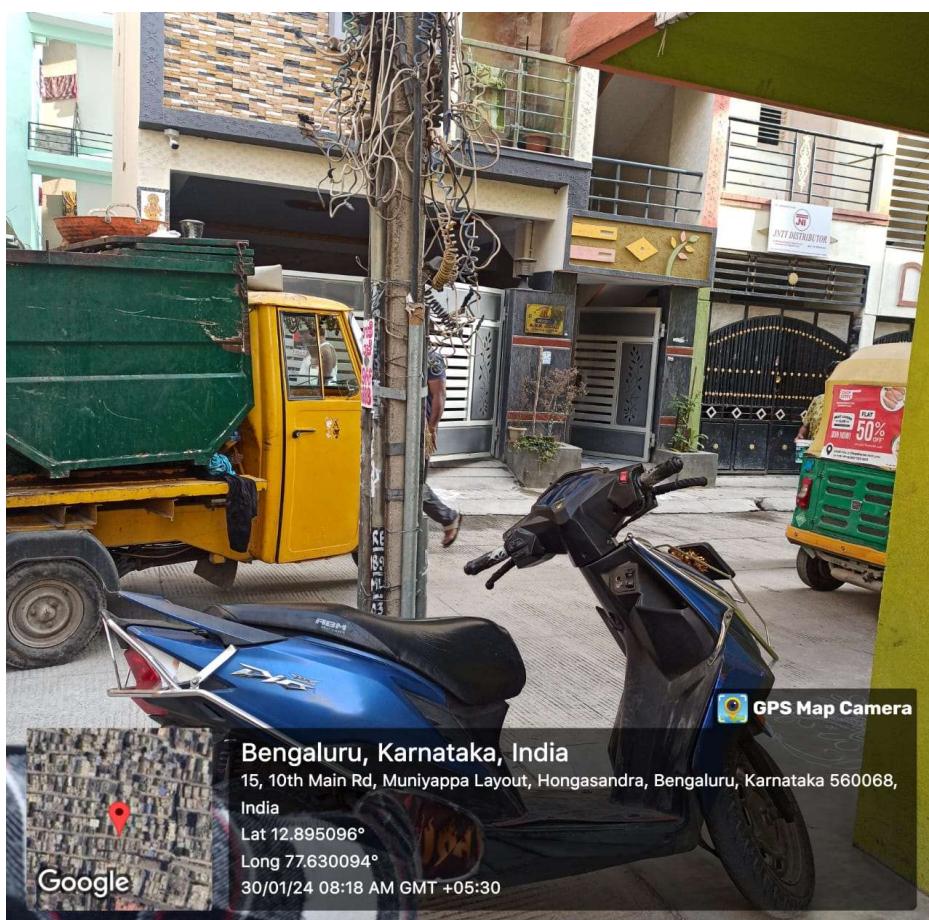
**Fault Detection and Maintenance:** Integrating sensors for detecting system faults or component failures, and implementing remote monitoring capabilities for proactive maintenance. This would help prevent downtime and ensure the system operates smoothly.

**Mobile Application:** Developing a mobile application for waste collection personnel to view route information, update collection statuses, and report issues in real-time. This would improve communication and coordination among team members.

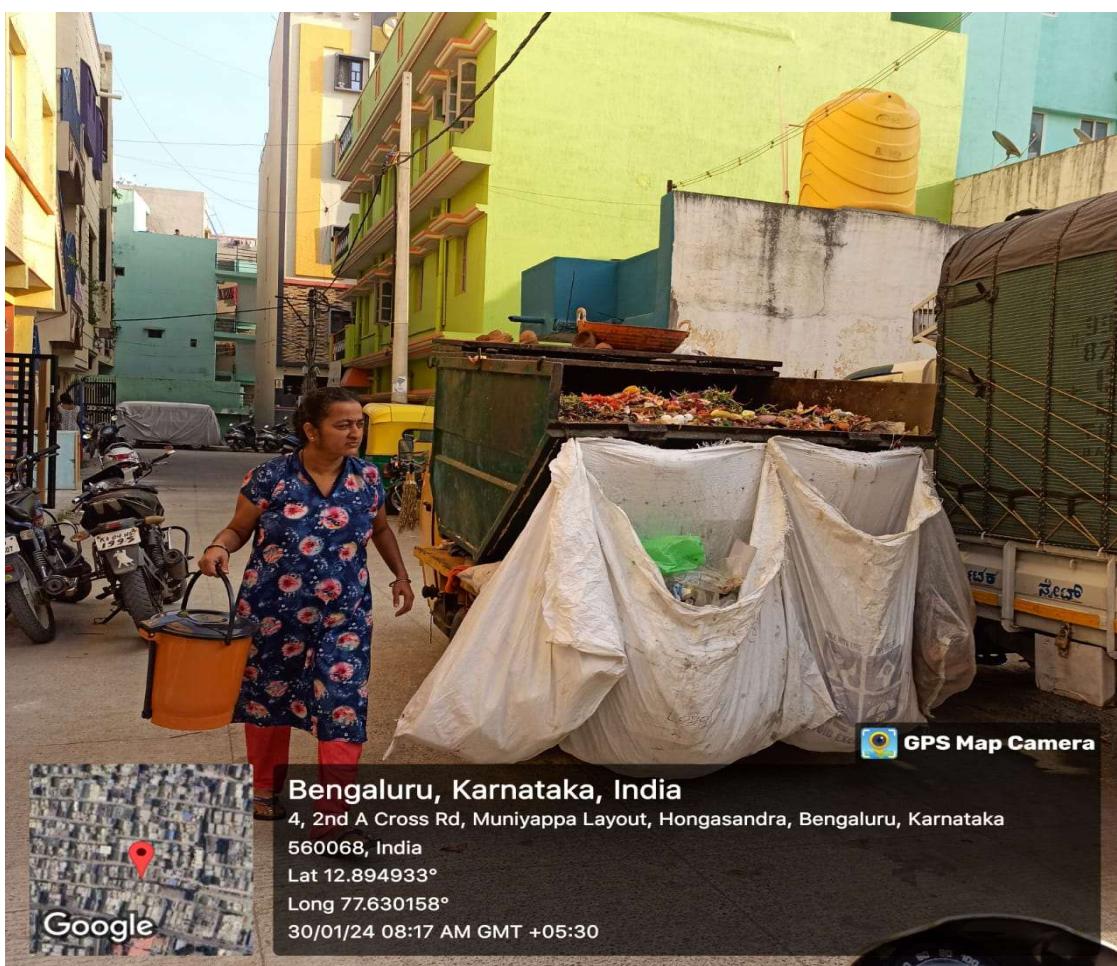
**Environmental Impact Assessment:** Incorporating features to assess the environmental impact of waste collection activities, such as calculating carbon emissions or estimating landfill usage. This could support sustainability initiatives and help reduce the ecological footprint of waste management operations.

**User Feedback and Satisfaction Tracking:** Incorporating mechanisms for collecting feedback from stakeholders, such as residents and waste collection personnel, to monitor satisfaction levels and identify areas for improvement.

## Appendix 1– Hongasandra











Type	Degress	DMS	mist
Latitude	12.89541	12°53'43...	20.0 °C
Longitude	77.62795	77°37'40...	



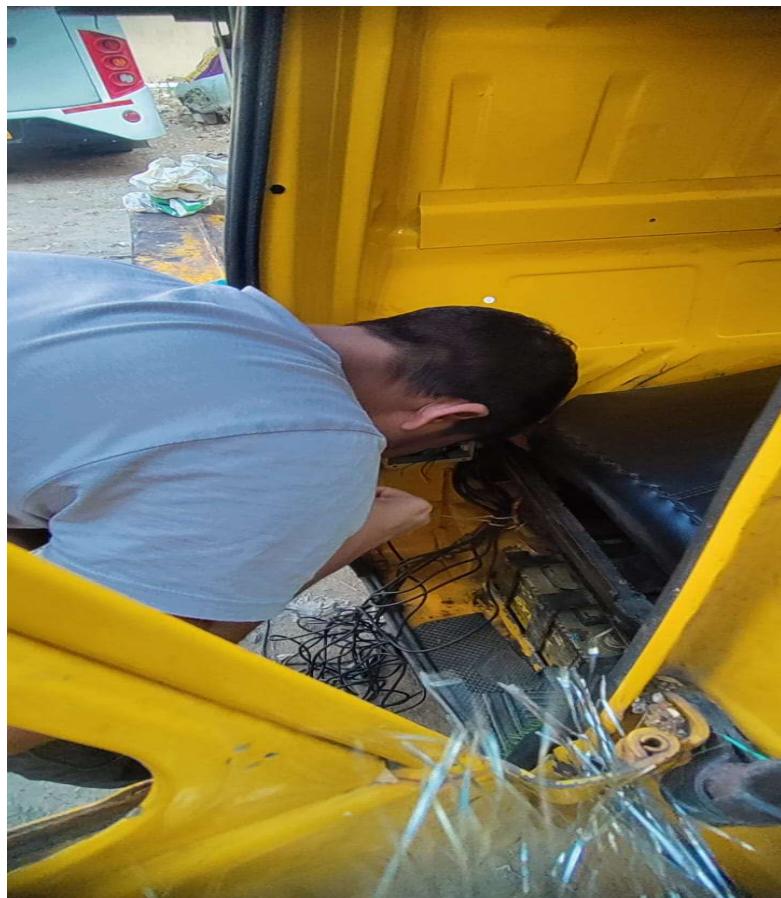
Type	Degress	DMS	mist
Latitude	12.89541	12°53'43...	20.0 °C
Longitude	77.62795	77°37'40...	



Type	Degress	DMS	mist
Latitude	12.89297	12°53'34...	20.0 °C
Longitude	77.61871	77°37'7"...	

## Appendix 2-Vijaynagar





## References

- 1- [www.mischianti.org](http://www.mischianti.org)
- 2- <https://th.bing.com/th/id/OIP.mrSx3OAZEQUXubbxgKOiwQAAAA?rs=1&pid=ImgDetMain>
- 3- <https://www.empowerlaptop.com/wp-content/uploads/2021new/20211117/62445384144-1.jpg>
- 4- <https://i.ibb.co/j3hLg8J/TFT-4-T-SPI-ILI9488-003.jpg>
- 5- [https://th.bing.com/th/id/OIP.4BqWeedutkHrKE\\_3zQKDsAHaHb?w=172&h=180&c=7&r=0&o=5&pid=1.7](https://th.bing.com/th/id/OIP.4BqWeedutkHrKE_3zQKDsAHaHb?w=172&h=180&c=7&r=0&o=5&pid=1.7)
- 6- <https://products.carolinascaling.com/Asset/RL1260-Aluminum-Single-Point-Load-Cells.png>
- 7- <https://imgaz.staticbg.com/images/oaupload/ser1/banggood/images/9A/A1/be97de9b-60df-48e9-9f51-af07a16f7aee.jpg>
- 8- [https://i5.walmartimages.com/asr/9446bf54-ffad-4ac3-a905-f43b60614a3c\\_1.c481cb972065f7989a5f1e43a482a3fe.jpeg](https://i5.walmartimages.com/asr/9446bf54-ffad-4ac3-a905-f43b60614a3c_1.c481cb972065f7989a5f1e43a482a3fe.jpeg)
- 9- <https://cf.shopee.ph/file/cf57f5221f9e6716a180111c6b365573>



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ગુજરાત ટેકનોલોજીકલ યુનિવર્સિટી  
 (ગુજરાત અધિનિયમ ક્રમાંક: ૨૦/૨૦૦૭ દ્વારા સ્થાપિત)

**Annexure 2****Feedback Form by Industry expert**

Student Name: Tirth Parmar

Date: May 1st 2023

Work Supervisor: Prajwal Pravinjith

Title: Project manager

Company/Organization: Ecoparadigm

Enrollment No: 200170111040

Internship Address: 15Q 2nd Main Rd, 4th Block, S.T. Bed, S.T Bed Layout, Koramangala, Bengaluru, Karnataka 560034

Dates of Internship: From 15 January 2023 to 20 April 2023

Please evaluate your intern by indicating the frequency with which you observed the following behaviors:

Parameters	Needs improvement	Satisfactory	Good	Excellent
Shows interest in work and his/her initiatives				✓
Produces high quality work and accepts responsibility				✓
Uses technical knowledge and expertise				✓
Analyzes problems effectively				✓
Communicates well and writes effectively			✓	

Overall performance of student intern: (Needs improvement/ Satisfactory/Good/Excellent):

Tirth is very passionate in his work and to learn new things. His drive to advance his skill and his commitment to work is a much appreciated quality.

Additional comments, if any:

Signature of Industry person with name and Stamp:

Prajwal Pravinjith

  
01/05/23

Signature of the Faculty Mentor