SMART WASTE MONITORING AND MANAGEMENT SYSTEM

by

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BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

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A project
submitted as partial fulfilment of the requirement for the degree of

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

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MAY 2018

CERTIFICATE OF APPROVAL

The project entitled as "**Smart waste monitoring and management system**" submitted by **Md. Sayed Imam**, bearing Matric No. **ET-141038** and **Md. Hossain Azad** bearing Matric No. **ET-141016** of session **Spring 2014** to the department of Electrical & Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory for the partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on **18th May, 2018**

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DECLARATION

It is hereby declared that the work presented in this project report is done by us under the supervision of Dr. Sikder Sunbeam Islam, Associate Professor, Dept. of EEE, International Islamic University Chittagong. I also declare that, no portion of the work contained in this thesis has been submitted in support of any application for any other degree or qualification of this or any other university or institute of learning.

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Md. Sayed Imam

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Md. Hossain Azad

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Authors

ABSTRACT

To keep our surrounding environment clean and healthy only two things are needed, the first one is the awareness of people and the other one is proper monitoring and management system of corresponding authority. In developed countries, their garbage system is very much efficient and strong. But in our country, due to lack of public awareness and proper management from authority, environment is becoming polluted day by day. A vast implementation of technology has appeared in waste management system in developed countries so that they can handle this huge work very easily. The authority of our country uses out-dated technology, for that reason their process cannot adapt with our ever-increasing population and problems. To make our existing waste management system efficient and effective, we have proposed a viable solution named Smart Waste Monitoring and Management System based on socio-economic status of Bangladesh. The proposed project is a website based dustbin and air quality regulation system which can be used in order to establish an efficient and smart garbage management protocol. The proposed website contains real time data visualization of the garbage level inside and the irritating gas level around the dustbin. Sulphureted Hydrogen (H_2S), Ammonia (NH_3), NO_x, Alcohol (C_2H_5OH), Benzene (C_6H_6), Smoke, CO_2 etc. are some of the unhealthy gases usually found around dustbins. For this purpose different gas detector sensors named MQ-135, MQ-136 and MQ-137 are used to detect toxic and uncomfortable gas level of the polluted area. To detect garbage level of the dustbins, we have used ultrasonic sensor. By tracking the position of garbage bin using GPS (Global Positioning System) system of Google, dustbin monitoring operator can inform the nearest waste collector if the waste level crosses its predefined mark or the toxic and unhealthy gas level increases over its tolerable limit. An effective and strong waste management system can increase awareness of public about cleanliness. Our proposed system is a solution which has a perfect collaboration of manpower and effective technology. If the authority decides to implement this system, it is likely to bring about a revolutionary improvement in this sector in Bangladesh.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1. Introduction

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Here we have designed a website based waste monitoring management system using the sense of IoT (Internet of Things). Our hardware circuitry send real time data from dustbin to webserver through popular wireless networking technology WiFi.

1.2. Motivation

Every single day in our city the common scenario is that garbage bins or dustbins placed at road side or near to locality are overloaded. The maintenance of those dustbins are inadequate and most of the people of our country both educated and uneducated are not conscious about cleanliness of their surroundings, almost people through their wastes at the wrong place most of the time out of the dustbin and waste collectors collect wastes from the dustbin at their fixed time such as morning or afternoon. Proper monitoring and management system can create a better environment and increase the awareness of people. A website based monitoring system is the easiest way of surveillance and creates the opportunity of accountability in both side.

1.3. Objectives

The objectives of the project is to construct a hardware circuitry and webpage which will have the following properties-

i. Sensing information form dustbin using different sensor.
ii. Detecting the position of different waste collectors from the dustbin.
iii. Send the information using WiFi to the web server
iv. Making a real time visualization of dustbin level and present gas property of dustbin surrounding in the website.

1.4. Chapter outline

Six chapters are covered in the course of design and development of this project. The chapters and their contents are as follows:

1. Chapter one is the introductory chapter that gives the objectives and motivation.
2. Chapter two is literature review. All previous work related of this project and comparison with our project discussed in this chapter.
3. Chapter three is hardware description. In this chapter all the main components used in this project are described elaborately.
4. Chapter four is system design of the project. In this chapter block diagram, internet linking, flow chart, circuit simulation and description are elaborately described.
5. Chapter five describes field survey, cost analysis, system implementation, results and business model. This chapter also describes about upgradability of system.
6. Chapter six is conclusion. Advantage and future work and limitations of this system are described in this chapter.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

In this chapter, the previous project done by other researchers will be discussed. Also it will give a basic idea about the IoT based waste monitoring and management.

2.2 Previous Work

Previous works of this project are described as follows

2.2.1 Intelligent Garbage Monitoring System using Internet of Things

A smart garbage monitoring system allows the municipal corporation to observe the quantity of the garbage present inside the garbage bins thus taking immediate action. The garbage bin 200 mentioned above has a laser level sensor 202 that works in a similar way as a SONAR functions, the difference lies in the usage of laser instead of sound. The garbage bin is shown in **Fig. 2.1** a GSM module (not shown in the figure) is connected with the level sensor that transmits the intended message to the corporation. The status regarding the quantity of garbage present in the bin is indicted on the display screen 100 of the corporation as shown in **Fig. 2.2** In the figure only one bin 101 has been showed for illustrative purpose. The status 102 is displayed using four sets of color namely green, yellow, red and violet. [1]

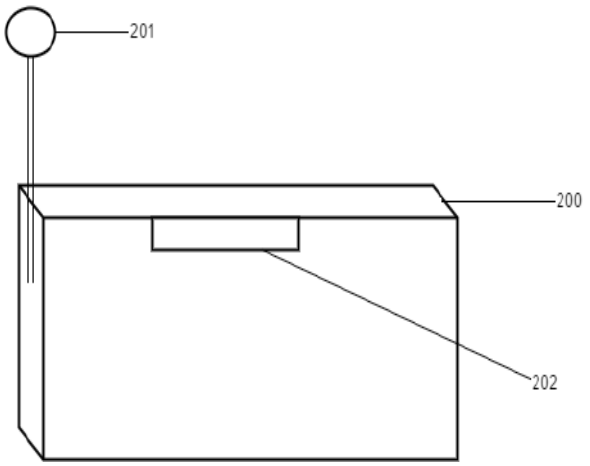


Fig. 2.1 Garbage Bin.[1]

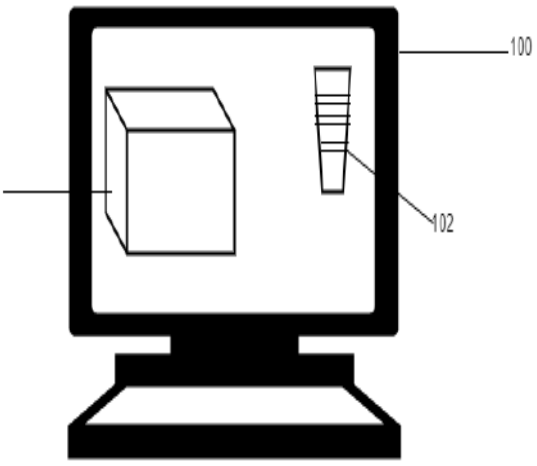


Fig. 2.2 Display screen of the Municipal Corporation.[1]

The garbage bin located in multiples places in a locality has a small camera that is connected with bin. If any person is found littering around the garbage bin is identified by

using the camera 201.The camera 201 is used to monitor the activities of the people in the vicinity of the garbage bin. The data generated during such continuous monitoring is stored in the servers of the municipal corporation. The camera system that is used to monitor the activities of individuals in the vicinity of the garbage, the camera is located at an elevated position to cover the area in the vicinity of the garbage bin. Inside the locality, if any individual is found littering around the garbage bin or throwing the garbage not inside the bin, such an activity is being monitored by the camera, the data of which is telecasted at the municipal corporation.

2.2.2 IoT Based Smart Garbage and Waste Collection Bin

This project work is the implementation of smart garbage management system using IR sensor, microcontroller and Wi-Fi module. This system assures the cleaning of dustbins soon when the garbage level reaches its maximum.

Smart collection bin works in the similar manner with the combination of sensors namely weight sensor and IR sensor that indicates its weight and different levels respectively. The IR sensors will show us the various levels of garbage in the dustbins and also the weight sensor gets activated to send its output ahead when its threshold level is crossed.[2]

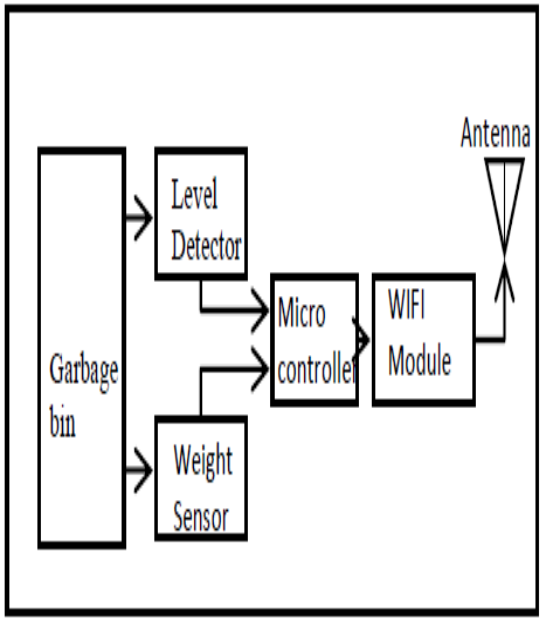


Fig. 2.3 Transmitter [2]

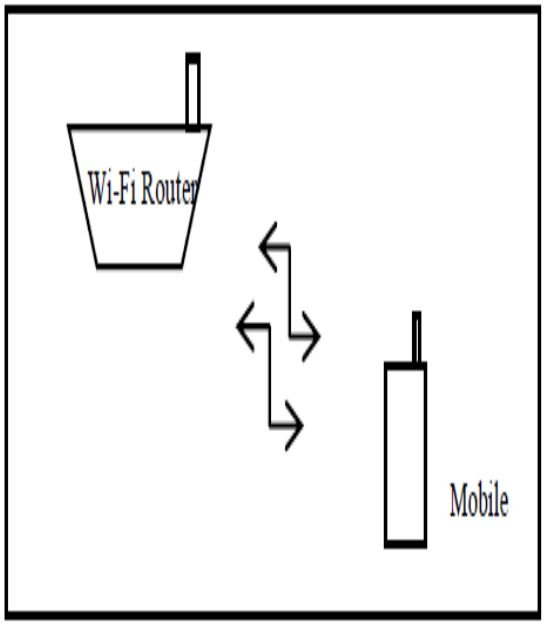


Fig. 2.4 Receiver [2]

This details are further given of the microcontroller (ARM LPC2148) and the controller gives the details to the transmitter module (Wi-Fi module) **Fig. 2.3.** At the receiver section

Fig. 2.4 a mobile handset is needed to be connected to the Wi-Fi router so the details of the garbage bin is displayed onto the HTML page in web browser of our mobile handset

2.2.3 Smart cities: A case study in waste monitoring and management

This paper presented a smart monitoring system for public trash cans. The user-centered design approach was used to understand the needs of the users derive the requirements and develop the system.

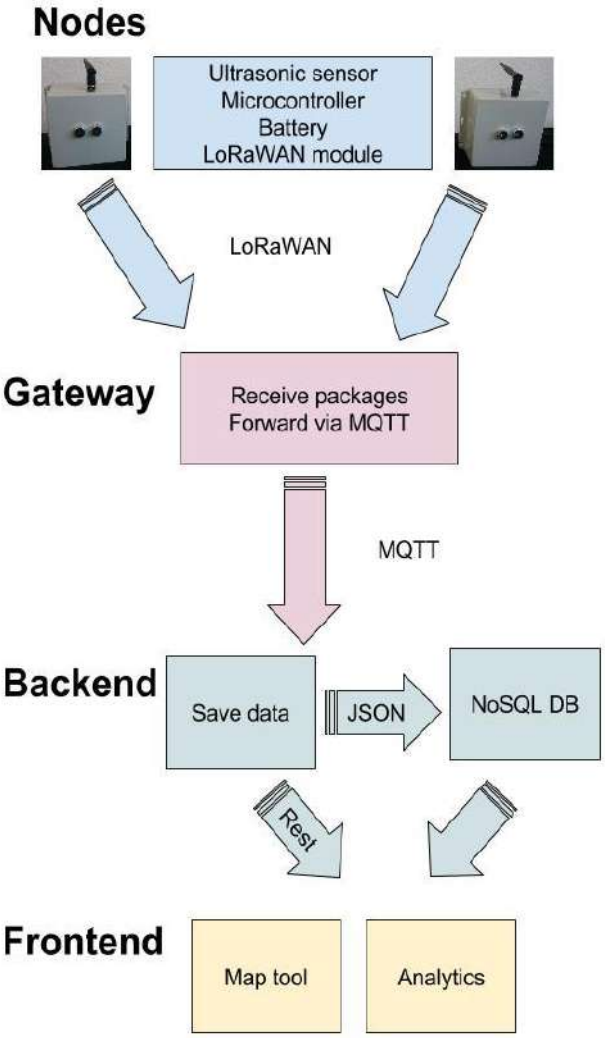


Fig. 2.5 System architecture[3]

Fig. 2.6 Map view provides shows the location and the current state (percent full) of the bins[3]

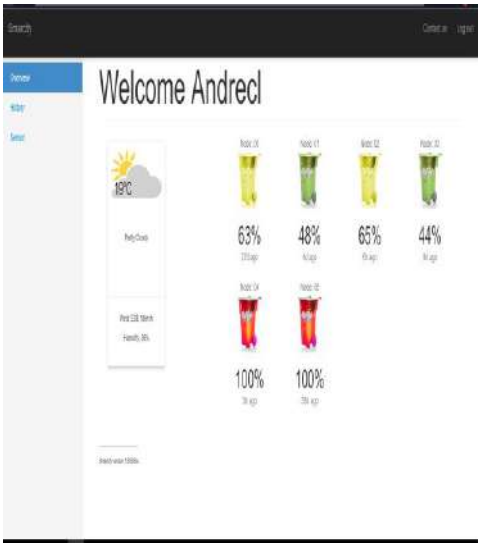


Fig. 2.7 Overview screen provides a quick visualization all bins[3]

The system was evaluated by combining quantitative data, that is collected from the wireless sensor network and the qualitative data that is based on observations and interviews One of the main requirements for the design was setting $100 as the maximum price per sensor/bin; making cost as the key challenge for a smart trash collection solution. This price limit was respected throughout the study, such a system should not replace the knowledge that collectors have of an area, but instead build on top of it, allowing them to

better assess situations. Both municipalities and private contractors that do trash collection work towards one goal: Improving the quality of experience of users in the area. It is highlighted that, implementing a smart trash monitoring system will require commitment and financial investment, and the feasibility of the solutions depend on how much user satisfaction is worth to these parties.[3]

2.3 Comparison with our project

In perspective of our country cost efficient and effectiveness of waste monitoring system is important. The WiFi communication module is cheaper than GSM module. Even WiFi module more reliable and long lasting than GSM module. Our project combines both monitoring and management so that it is very much cost efficient and user friendly. It creates a great opportunity of employment.

CHAPTER 3
COMPONENTS

3.1 Introduction

In this chapter main components of this project will be discussed. Pin description, pin diagram and feature of components will be discussed.

3.2 List of Components

- WeMos D1 R1
- ADS1115
- Ultrasonic Sensor
- Gas Sensor MQ-135
- Gas Sensor MQ-136
- Gas Sensor MQ-137

3.3 Description of Components

Description of required components is given below

3.3.1 WeMos D1 R1

An Arduino UNO compatible wifi board based on ESP8266EX, therefore it can be programmed using Arduino or its own Lua compiler. It also supports both serial and OTA programming.

(a) Front view (b) Back view

Fig. 3.1 WeMos D1 R1 (a) front view and (b) back view [4]

WeMos D1 R1 series are one of the products developed by the company to enable wireless connectivity, simple data traffic and electronic controlling to electronic projects at the same time.

3.3.1.1 Features of WeMos D1 R1 [5]

- Operating Voltage: 3.3V
- 11 digital input/output pins, all pins have interrupt/pwm/1^2C/one-wire supported (except for D0)
- 1 analog input (3.2V max input)
- Micro USB connection
- Power jack, 9-24V power input.
- Compatible with Arduino
- Compatible with nodemcu
- Clock Speed: 80MHz/160MHz
- Flash Memory: 4M bytes
- Length: 68.6 mm
- Width: 53.4 mm
- Weight:25 g

Fig. 3.2 bellow describes the pin diagram of the WeMos D1 R1. Here the pin diagram is for this WeMos D1 R1.

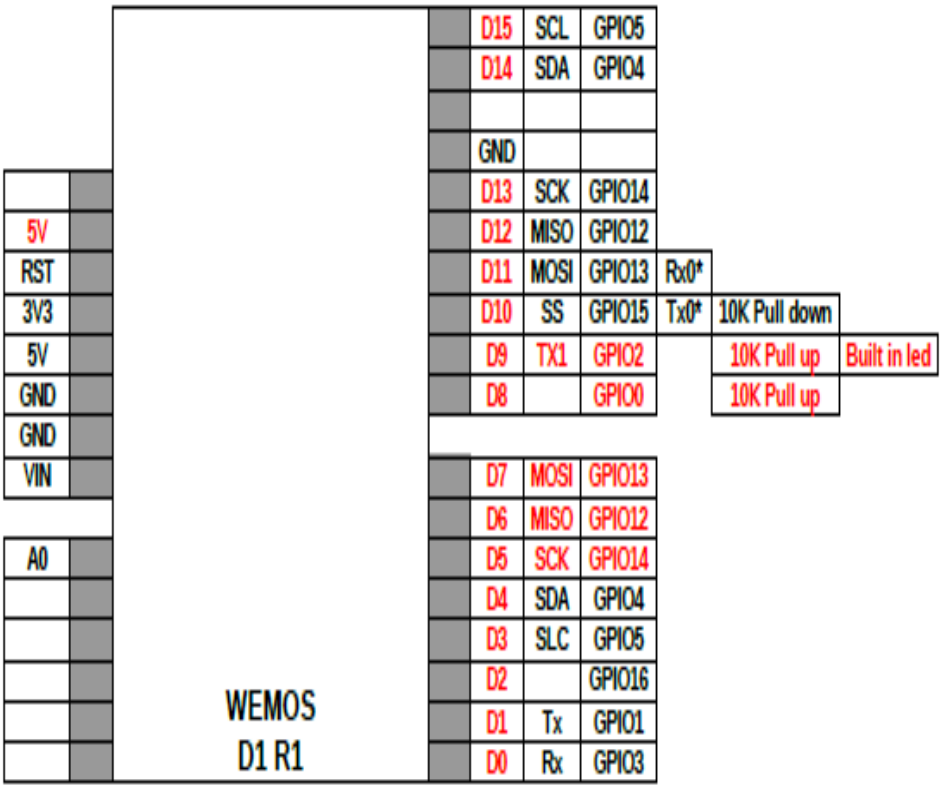


Fig. 3.2 Pin diagram of the WeMos D1 R1 [6]

3.3.1.2 WeMos D1 R1 pin function

Table: 3.1 bellow shows the pin function of WeMos D1 R1

Table: 3.1 Pin function of WeMos D1 R1 [5]

Board Pin	**Function**	**ESP8266 Pin**
TX	TXD	TXD
EX	RDX	RDX
A0	Analog input, max 3.3V input	A0
D0	I/O	GPIO16
D1	I/O, SCL	GPIO5
D2	I/O, SDA	GPIO4
D3	I/O, 10k pull-up	GPIO0
D4	I/O, 10k pull-up, BUILTIN_LED	GPIO2
D5	I/O, SCK	GPIO14
D6	I/O, MOSO	GPIO12
D7	I/O, MOSI	GPIO13
D8	I/O, 10k pull-down, SS	GPIO15
GND	Ground	GND
5V	5V	
3V3	3.3V	3.3V
RST	Reset	RST

3.3.2 ADS1115

The ADS1115 device is precision, low-power, 16-bit, I2Ccompatible, analog-to-digital converters (ADCs) offered in an ultra-small, leadless, X2QFN-10 package, and a VSSOP-10 package. The ADS1115 devices incorporate a low-drift voltage reference and an oscillator. **Fig. 3.3** bellow describes the simplified block diagram for ADS1115

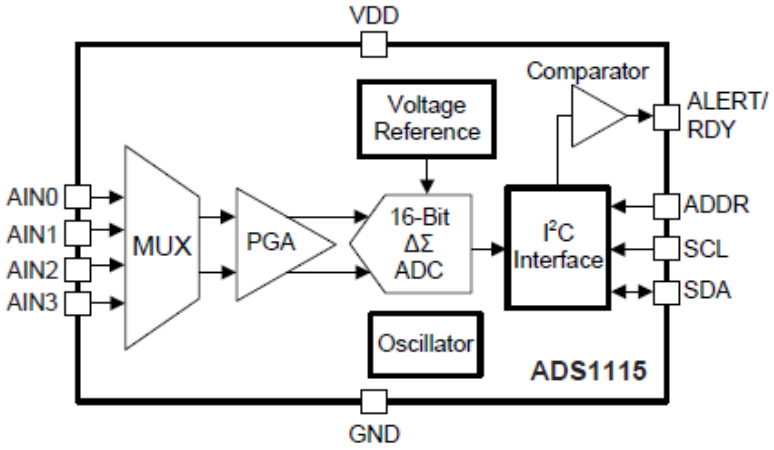


Fig. 3.3 Simplified block diagram for ADS1115 [7]

The ADS1115 also incorporate a programmable gain amplifier (PGA) and a digital

comparator. The features along with a wide operating supply range make the ADS1115 well suited for power- and space-constrained, sensor measurement applications.

3.3.2.1 Feature of ADS1115 [7]

- Ultra-Small X2QFN Package: 2 mm × 1.5 mm × 0.4 mm
- Wide Supply Range: 2.0 V to 5.5 V
- Low Current Consumption: 150 μA (Continuous-Conversion Mode)
- Programmable Data Rate: 8 SPS to 860 SPS
- Single-Cycle Settling
- Internal Low-Drift Voltage Reference
- Internal Oscillator
- I^2C Interface: Four Pin-Selectable Addresses
- Four Single-Ended or Two Differential Inputs (ADS1115)
- Programmable Comparator (ADS1114 and ADS1115)
- Operating Temperature Range: –40°C to +125°C

3.3.2.2 Pin Configuration of ADS1115

Fig. 3.4 shows the pin configuration of ADS1115

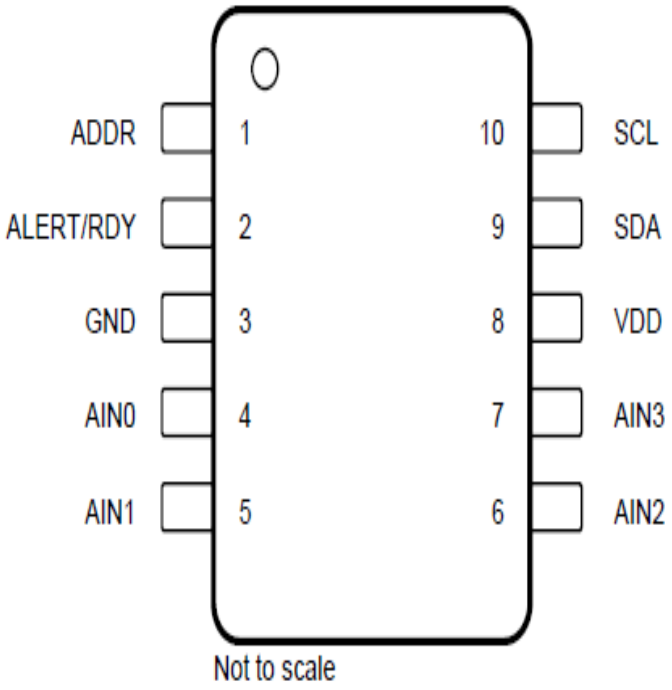


Fig. 3.4 Pin configuration of ADS1115[7]

3.3.2.3 Pin Function

Table: 3.2 bellow shows the pin function of ADS1115

Table: 3.2 Pin function of ADS1115 [7]

PIN		Type	Description
Name	ADS1115		
ADDR	1	Digital input	I^2C slave address select
AINO	4	Analog input	Analog input 0
AIN1	5	Analog input	Analog input 1
AIN2	6	Analog input	Analog input 2 (ADS1115 only)
AIN3	7	Analog input	Analog input 3 (ADS1115 only)
ALERT/RDY	2	Digital input	Comparator output or conversion ready (ADS1114 and ADS1115 only)
GND	3	Analog	Ground
NC	_	_	Not connected
SCL	10	Digital input	Serial clock input. locks data on SDA
SDA	9	Digital I/O	Serial data. Transmits and receives data
VDD	8	Analog	Power supply. Connect a 0.1-μF, power-supply decoupling capacitor to GND.

3.3.3 Ultrasonic Sensor

The ultrasonic sonar sensor has four pins Vcc, Trigger, Echo and Ground. When a low to high pulse is applied to the trigger pin, an ultrasonic sound is transmitted from the transmitter.

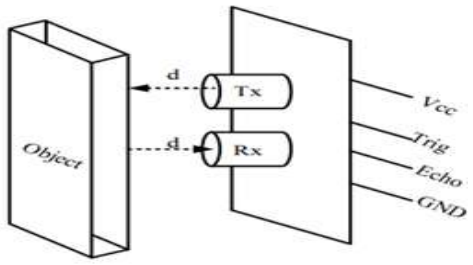


Fig. 3.5 Ultrasonic sensor and its pic configuration [8]

If there exist an obstacle in its range, the sound must be reflected and will be received by receiver. When the reflected sound is received the echo pin becomes

high. The difference between times of transmitting sound (t_1) and receiving sound (t_2) depends on distance of object. If the time difference between time is $t=t_2-t_1$, we can write, $2d = V \times t \gg d = V \times t /2$.

3.3.4 Gas Sensor

In current technology scenario, monitoring of gases produced is very important. From home appliances such as air conditioners to electric chimneys and safety systems at industries monitoring of gases is very crucial. Gas sensors are very important part of such systems. Small like a nose, gas sensors spontaneously react to the gas present, thus keeping the system updated about any alterations that occur in the concentration of molecules at gaseous state.

3.3.4.1 MQ-135

MQ-135 gas sensor applies SnO_2 which has a lower conductivity in the clear air as a gas-sensing material. In an atmosphere where there may be polluting gas, the conductivity of the gas sensor raises along with the concentration of the polluting gas increases.

Fig. 3.6 Gas sensor MQ-135 [9]

MQ-135 performs a good detection to smoke and other harmful gas, especially sensitive to ammonia, sulfide and benzene steam. Its ability to detect various harmful gas and lower cost makeMQ-135 an ideal choice of different applications of gas detection.

3.3.4.1.1 Features of MQ-135 [10]

- Sensitive gas : Ammonia, nitrogen, oxide, alcohols, aromatic compounds, sulfide and smoke
- Operating voltage : 2.5V-5.0 V
- Dimensions : 40.0 mm*21.0 mm
- Fixing hole size : 2.0 mm
- Boost converter chip : PT1301

3.3.4.1.2 Interface

Table: 3.3 bellow shows the pin interface of MQ-135

Table: 3.3 Pin interface of MQ-135[10]

Pin No.	Symbol	Description
1	DOUT	Digital Output
2	AOUT	Analog Output
3	GND	Power ground
4	VCC	Positive power supply (2.5 V-5.0 V)

3.3.4.2 MQ-136

Sensitive material of MQ136 gas sensor is SnO_2, which with lower conductivity in clean air. When the target H_2S gas exists, the sensor's conductivity is higher along with the gas concentration rising.MQ136 gas sensor has high sensitivity to H_2S.

Fig. 3.7 Gas sensor MQ-136 [11]

Also MQ-136 could be used to detect other vapor which contains Sulfur. It has low sensitivity to normal combustible gases, which is with low cost and suitable for different application.

3.3.4.2.1 Features of MQ-136 [12]

- Good sensitivity to H_2S
- Long life and low cost
- Simple drive circuit

3.3.4.2.2 Interface

Table: 3.4 bellow shows the pin interface of MQ-136

Table: 3.4 Pin interface of MQ-136[12]

Pin No.	Symbol	Description
1	DOUT	Digital Output
2	AOUT	Analog Output
3	GND	Power ground
4	VCC	Positive power supply (2.5 V-5.0 V)

3.3.4.3 MQ-137

Sensitive material of MQ137 gas sensor is SnO_2, which with lower conductivity in clean air. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising.

Fig. 3.8 Gas sensor MQ-137 [13]

MQ137 gas sensor has high sensitivity to Ammonia, also to other organic amine. The sensor could be used to detect different gas which contains Ammonia (NH_3), it is with low cost and suitable for different application.

3.3.4.3.1Features of MQ-137 [14]

- Good sensitivity to Ammonia
- Long life and low cost
- Simple drive circuit

3.3.4.3.2 Interface

Table: 3.5 bellow shows the pin interface of MQ-137

Table: 3.5 Pin interface of MQ-137 [14]

Pin No.	Symbol	Description
1	DOUT	Digital Output
2	AOUT	Analog Output
3	GND	Power ground
4	VCC	Positive power supply (2.5 V-5.0 V)

CHAPTER 4
SYSTEM DESIGN

4.1 Introduction

Design procedure is the most important part of a project. In this chapter operating principle, interfacing different devices with WeMos D1 R1, designing the block diagram, circuit diagram, internet linking and flow chart will be described.

4.2 Operating Principle

In this proposed system, WeMos D1 R1 is the main junction of all these peripheral devices and sensors. ADS1115 is a peripheral device which is used to make a link between WeMos and gas sensors. The gas sensors have used for sensing gas from the surroundings of dustbin. In this project analog output of gas sensors have used because analog data give the actual curve contingent on time. Ultrasonic sensor has used for detecting the level of dustbin waste. The Wemos D1 has been connected with internet through coding and its using communication protocol is WiFi.

ThingSpeak is an IOT based web developing site, where we have created a personal account and this account gives us an opportunity to create a channel. In ThingSpeak channel we have created five different fields three for showing gas level of dustbin, one field for showing the status of waste level of the dustbin and last one is dedicated for showing the position of waste collectors. The ThingSpeak channel provides an API Key, using this API Key we can send our measured data in ThigSpeak server through ESP8266 of WeMos D1.

In our ThingSpeak channel field have individual web sharing key using those key we have developed a website where all fields activities of ThingSpeak channel can be displayed.

4.3 System Architecture

Fig. 4.1shows a simple model of data collection from dustbin and sending those data using WiFi to ThingSpeak server to visualize. The basic system consists of three different parts which are data collection from dustbin, data sending in ThingSpeak

server and data visualization.

Fig. 4.1 shows the system architecture of this project

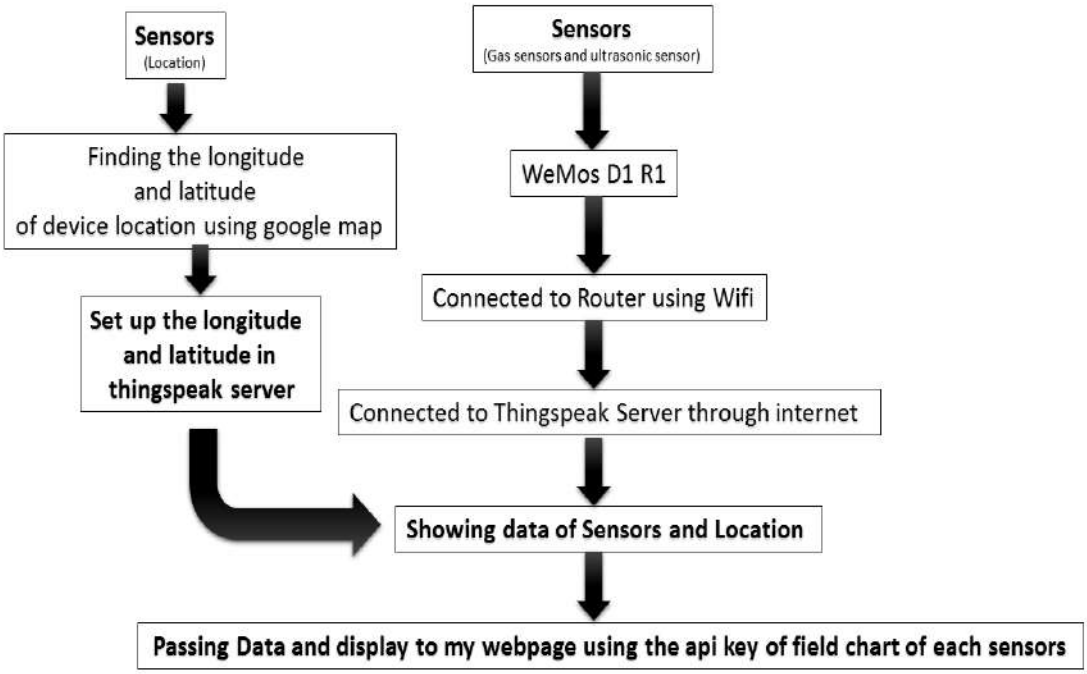


Fig. 4.1 System Architecture

4.4 ThingSpeak Personal Channel Allocation

Fig. 4.2 shows the account creation in ThingSpeak and data visualization from the dustbin through the circuitry

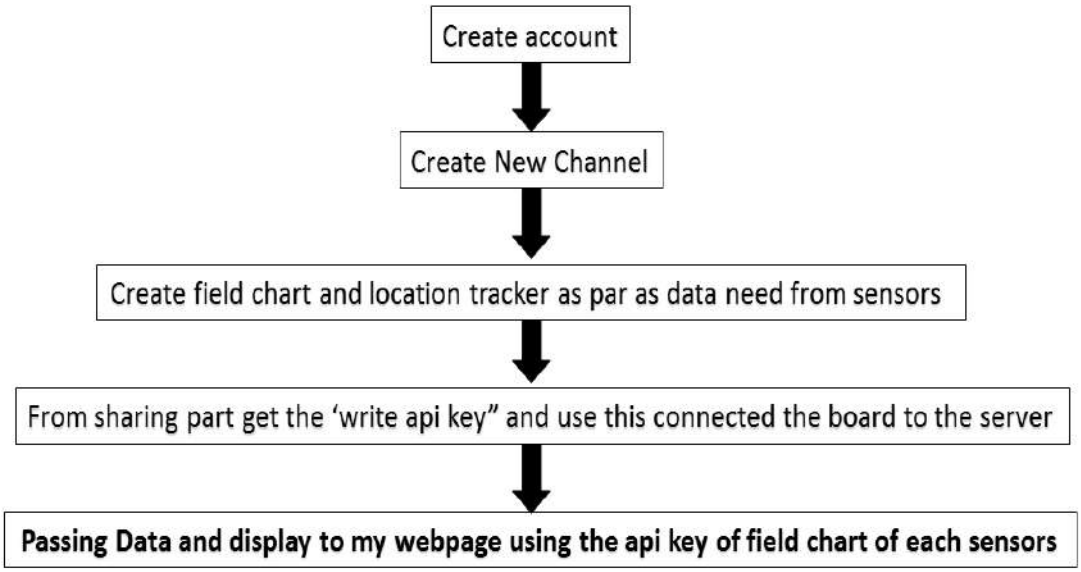


Fig. 4.2 Web page creation architecture

4.5 Interfacing Different Devices with WeMos D1 R1

Fig. 4.3 shows the sensors interface with the WeMos D1 where ADS1115 is a peripheral device

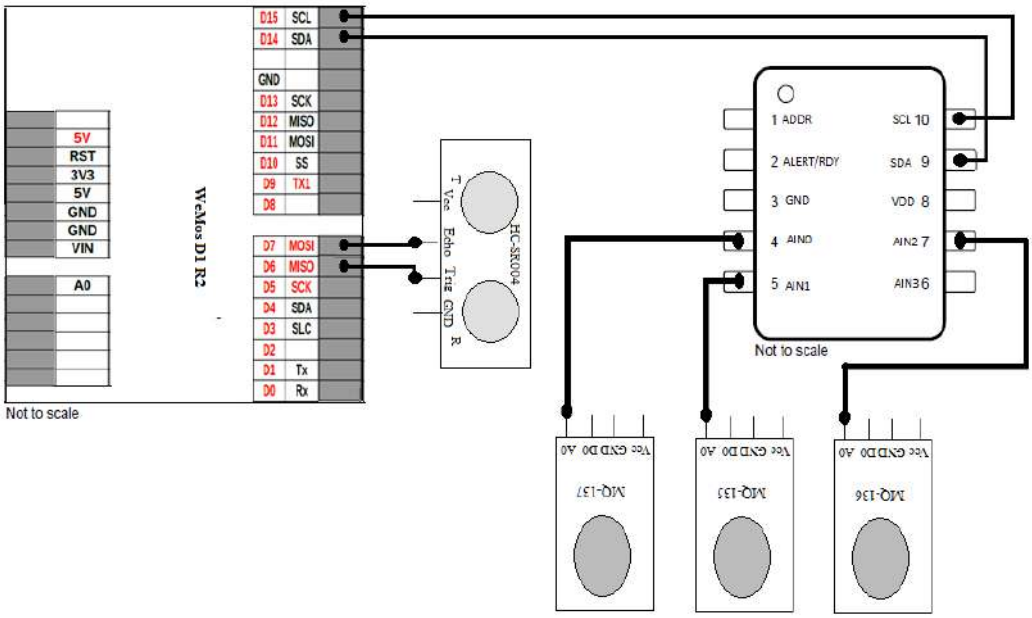


Fig. 4.3 Sensor interface with WeMos D1 R1

4.6 Power Connection of Total Circuit

In **Fig. 4.4** shows the power connection of the circuit, here we have used a power supply module which is more reliable and cost efficient than handmade power supply (elaborately explained in Article-5.2.1)

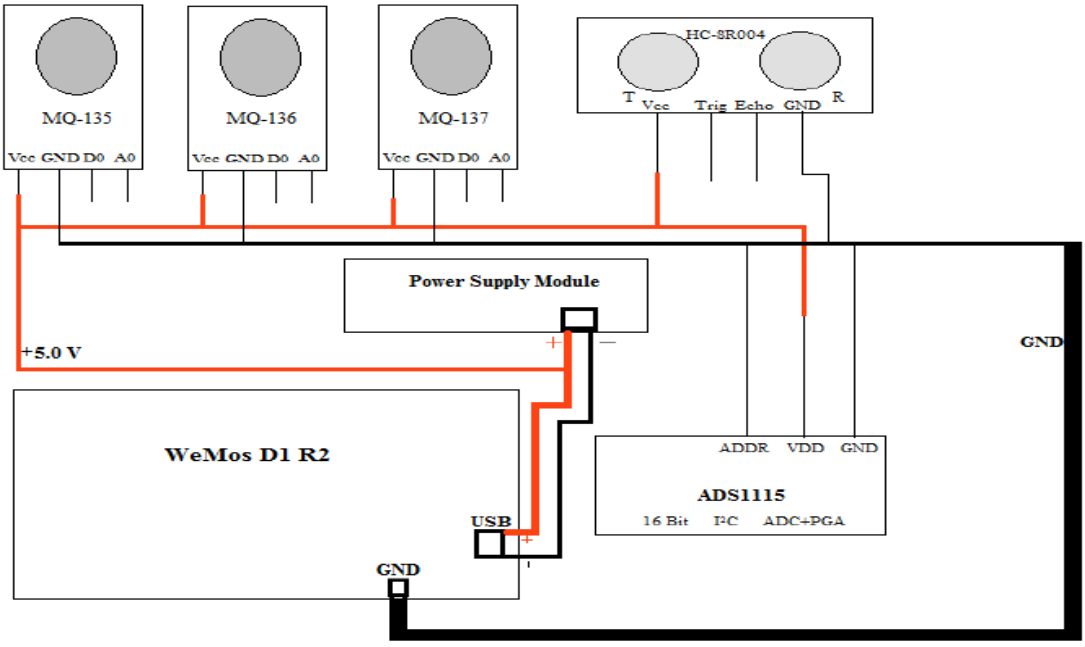


Fig. 4.4 Power connection of whole circuit

4.7 Circuit Diagram

As WeMos D1 R1 is a latest version of embedded system based of ESP8266, we don't find any package of WeMos D1 in Proteus or PSPICE. We have used an online circuit simulator named by "Easy.EDA"

Fig. 4.5 shows the complete circuit diagram drawn in "Easy.EDA"

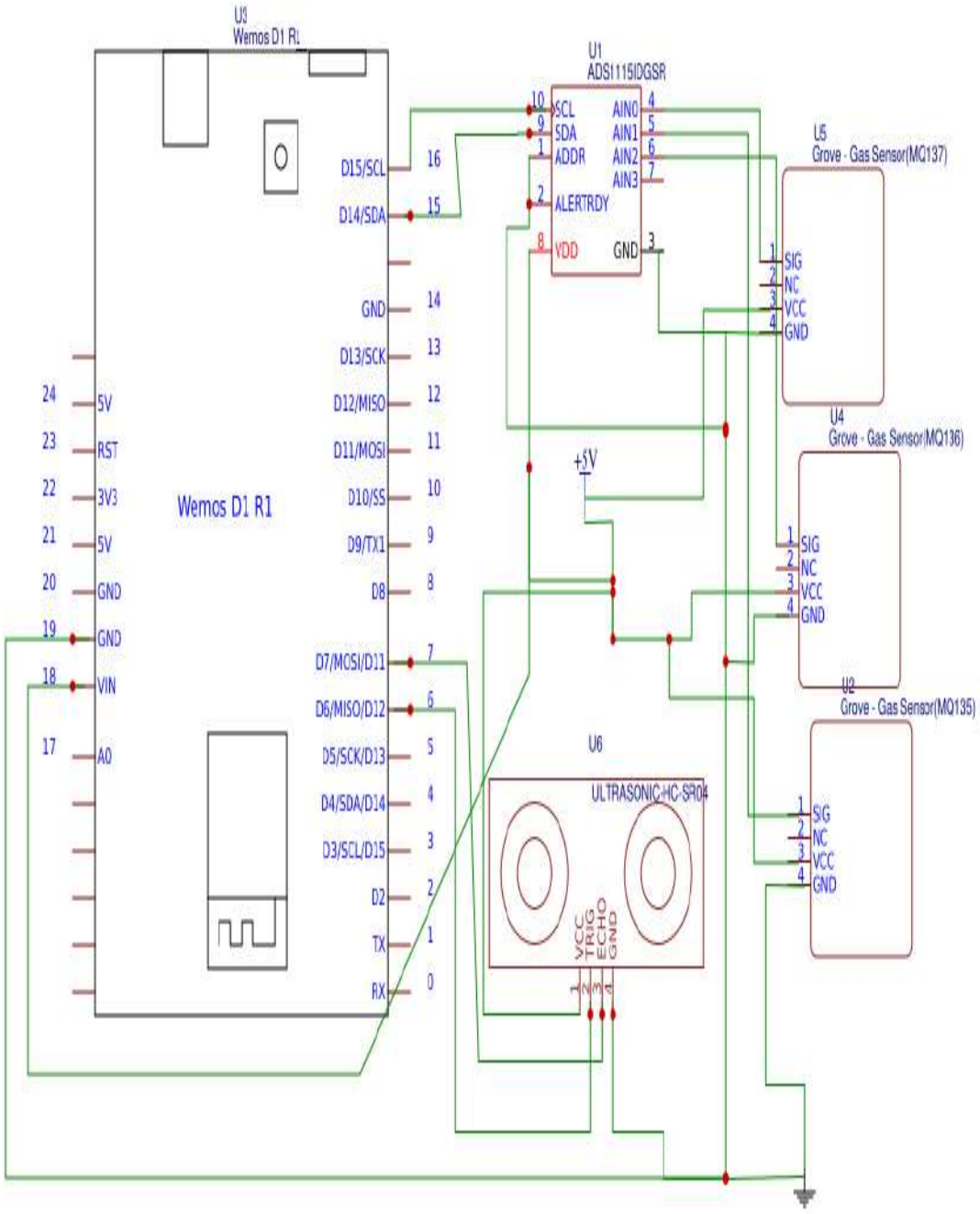


Fig. 4.5 Circuit Diagram

4.8 Flow Chart

Fig. 4.6 shows the overall working process of this project

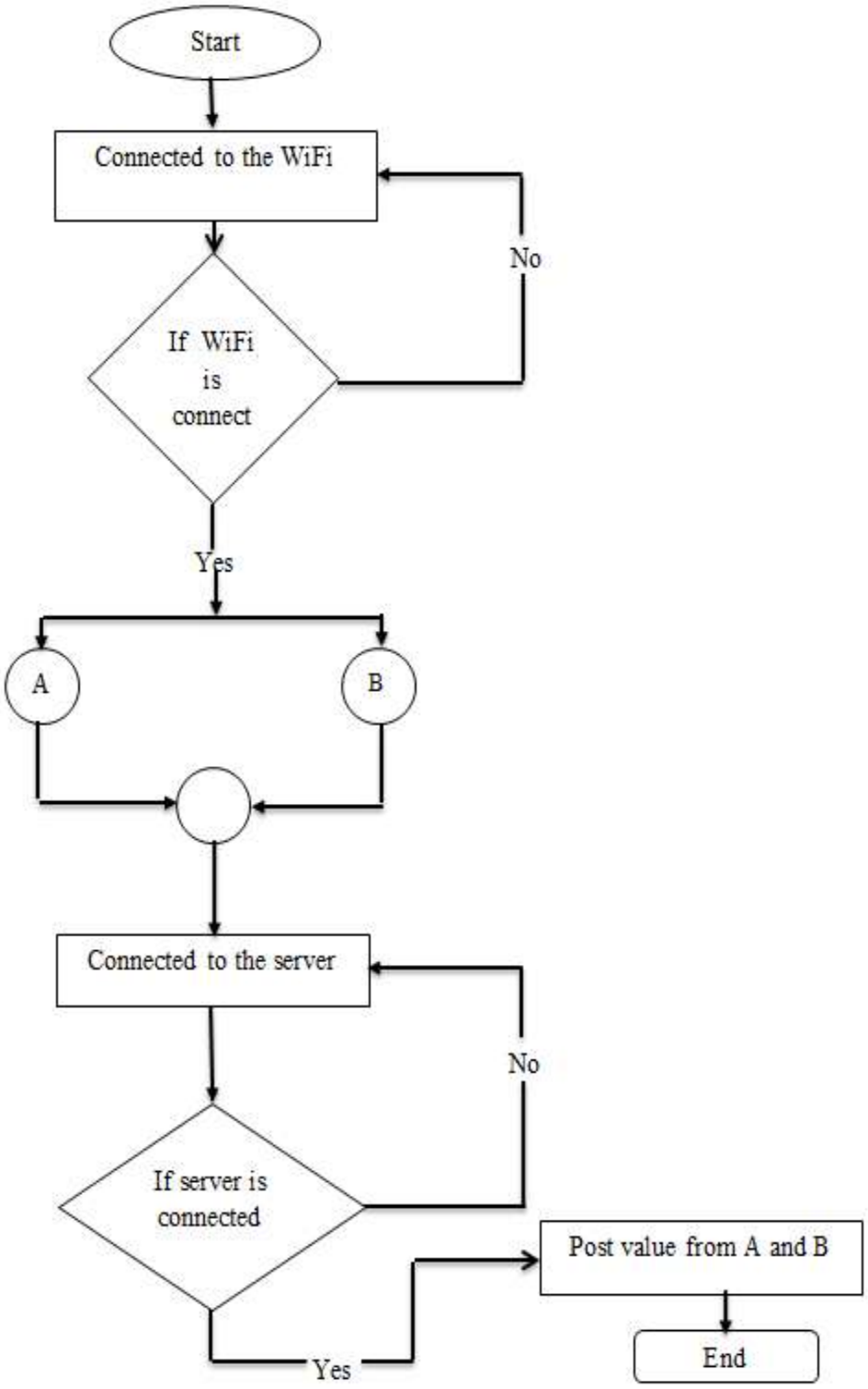


Fig. 4.6 Overall working process of this project

Fig. 4.7 shows gas detecting process and posting those data into the server

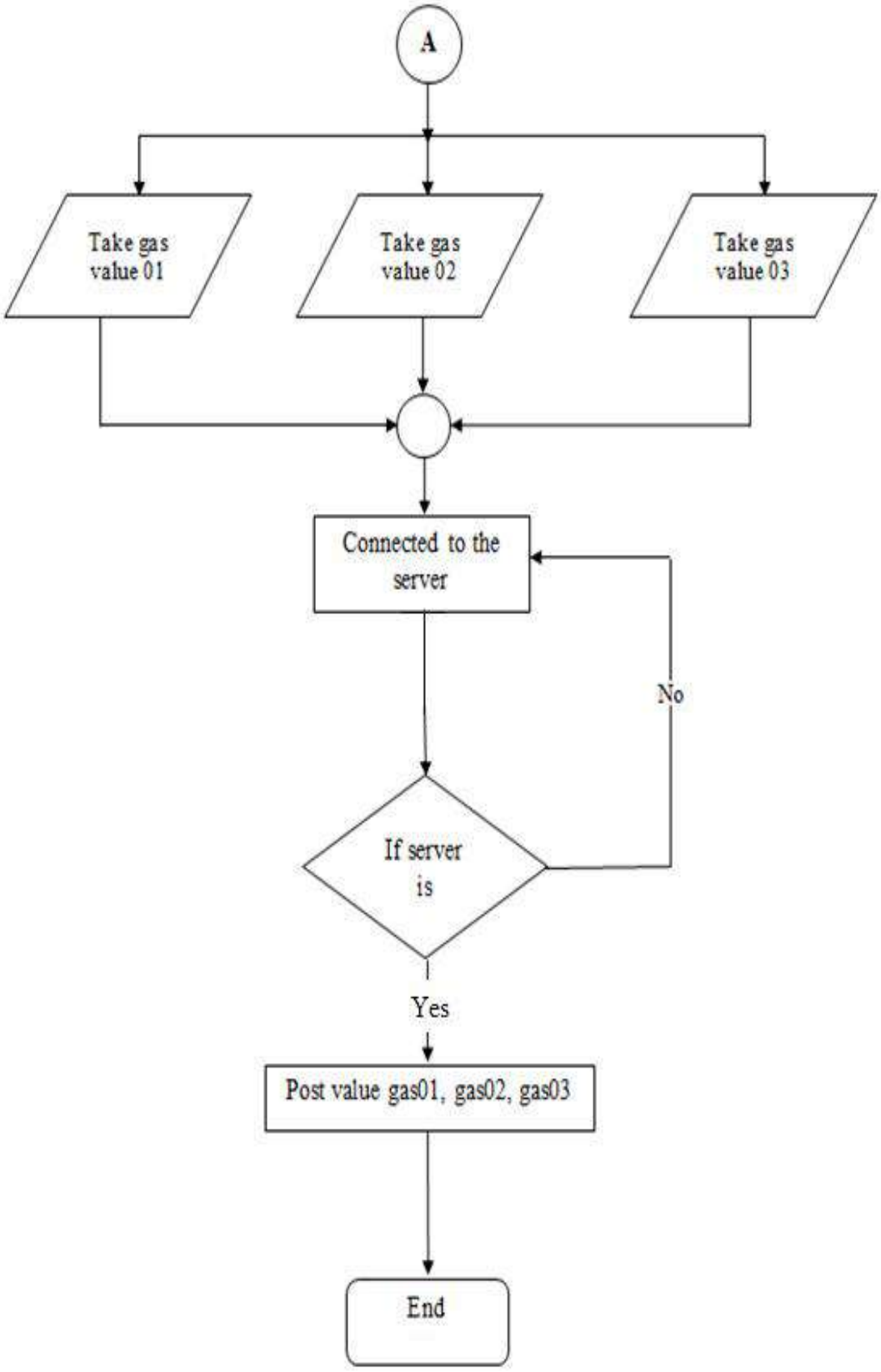


Fig. 4.7 Gas detecting process and posting those data into the server

Fig. 4.8 shows garbage level detection inside the dustbin and post those data into the server

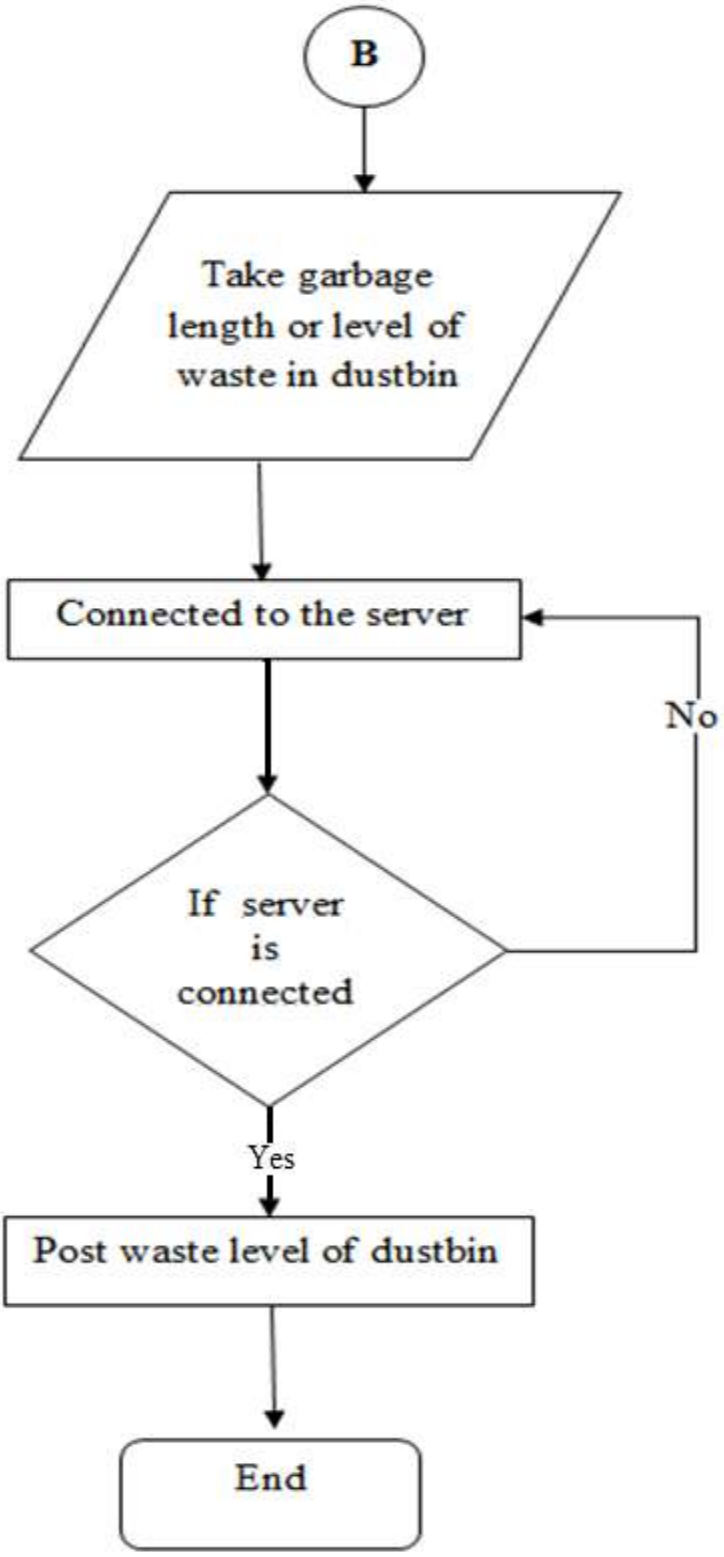


Fig. 4.8 Garbage level detection inside the dustbin and post those data into the serve

CHAPTER 5
SURVEY, IMPLEMENTATION AND RESULTS

5.1 Introduction

This chapter will describe the field research, project acceptability according to public reaction, real time data visualization through website, practical implementation, result and business model. In this section we will discuss about overview for dustbin level and harmful gas monitoring through website and tracking the waste collectors using the same website in order to fulfill our objectives.

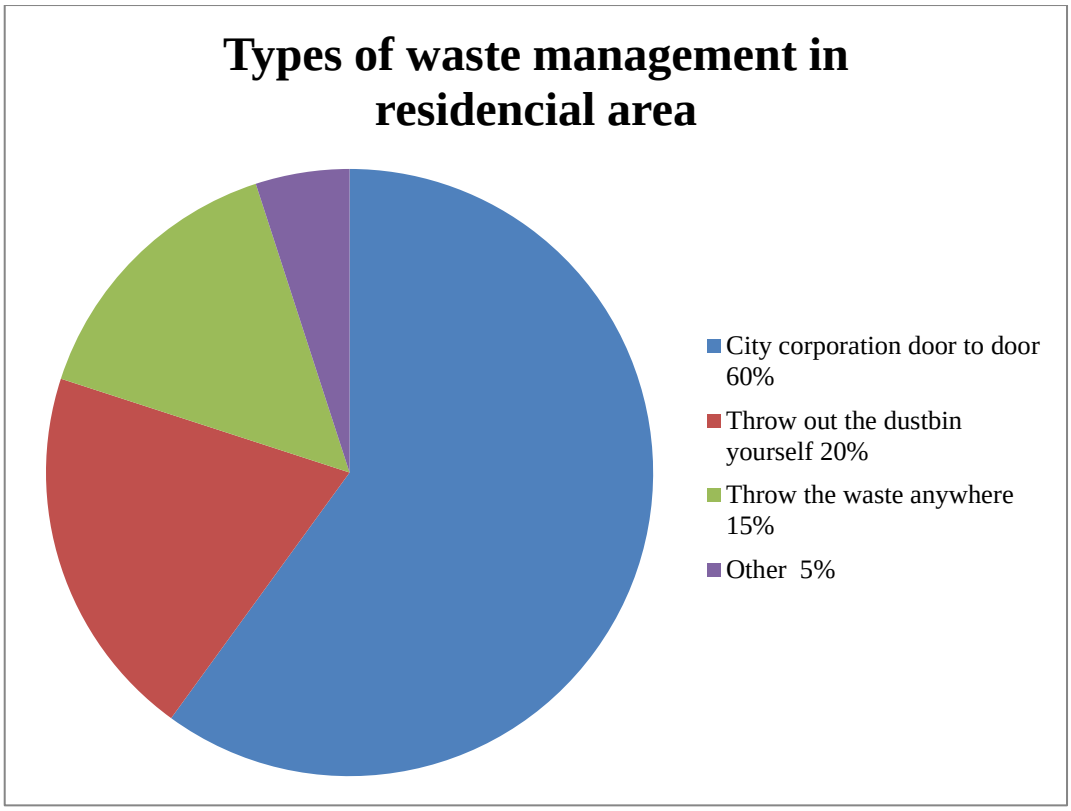
5.2 Field Survey

The main purpose of our project is to make a timely change in our existing waste monitoring and management system so that we can make our city more hygienic and inhabitable keeping the sense of socio-economic status of our country. So that we choose an area under Chittagong City Corporation, those field works results are given bellow

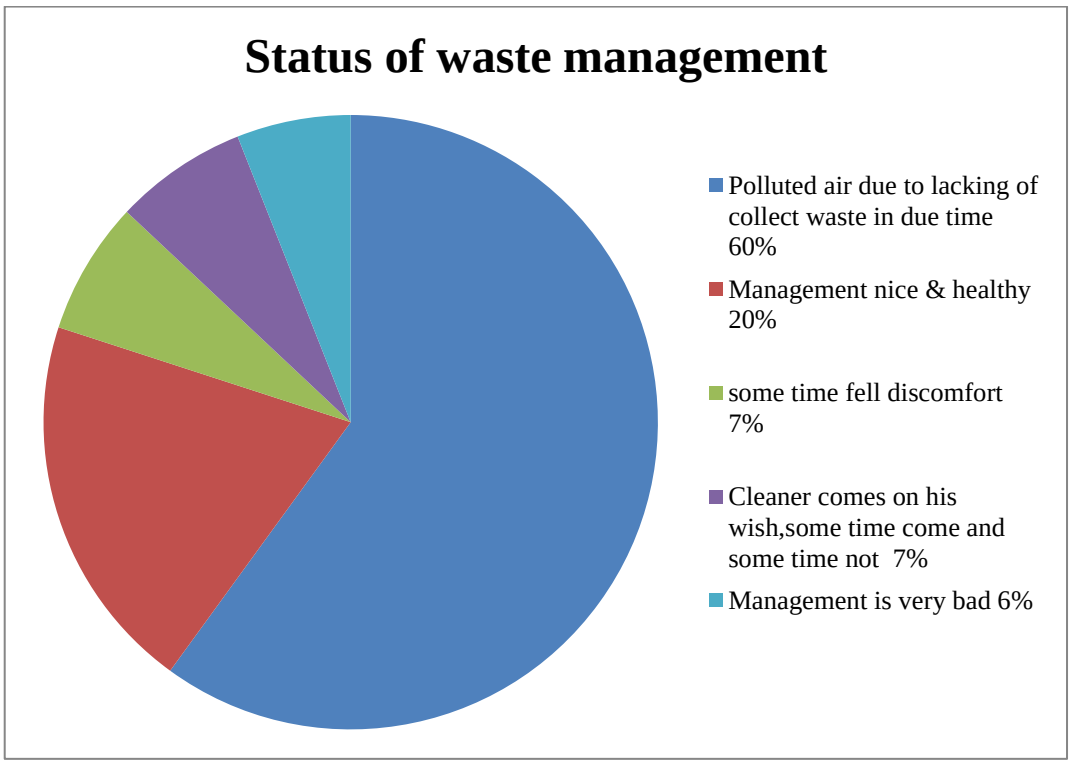
Name of Area: Chandgaon Residence, A-Block
Type: Residential
Town: Chittagong
Country: Bangladesh
Number of residential building: 170
Population: Near about 10000
Number of School: 10
Number of College: 0
Number of Mdrasa: 6
Small office: 10
Waste collection system: Door to Door
Number of big tanker dustbin: 3
Number of waste collector: 6
Number of people appeared in our survey Program: 200

In our survey program we gave a MCQ question paper after describing our website based waste monitoring and management system. According their response we have decided following decisions

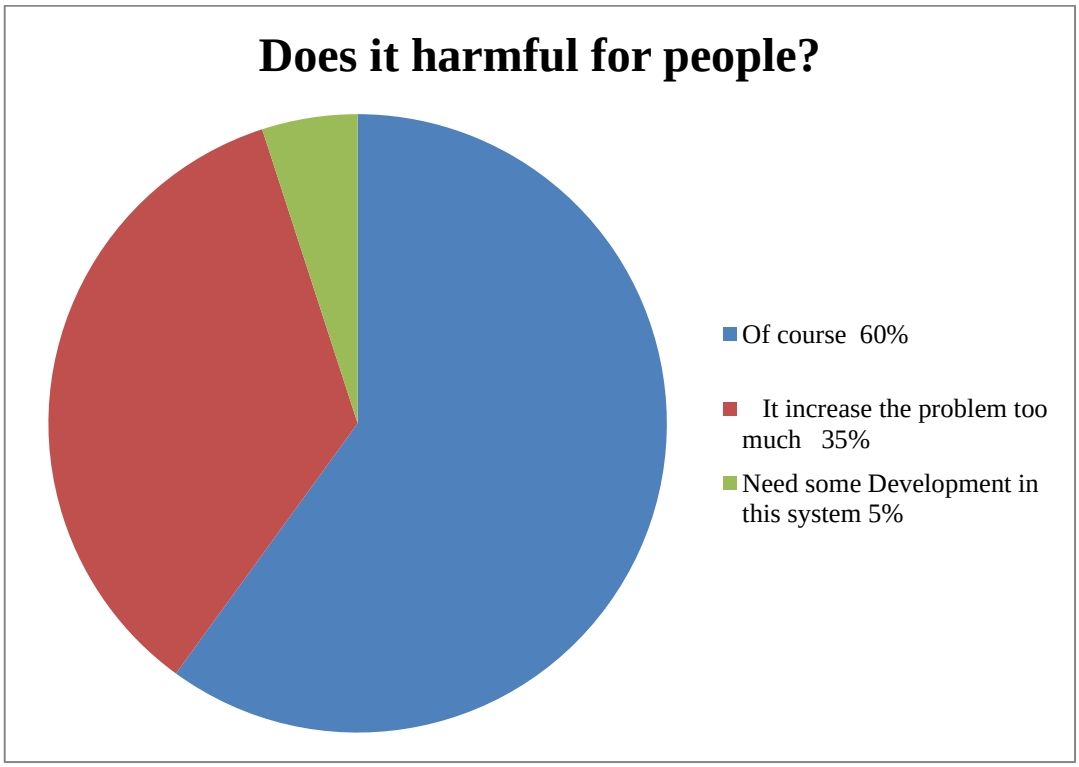
1. Which type of yours Residence Waste management?



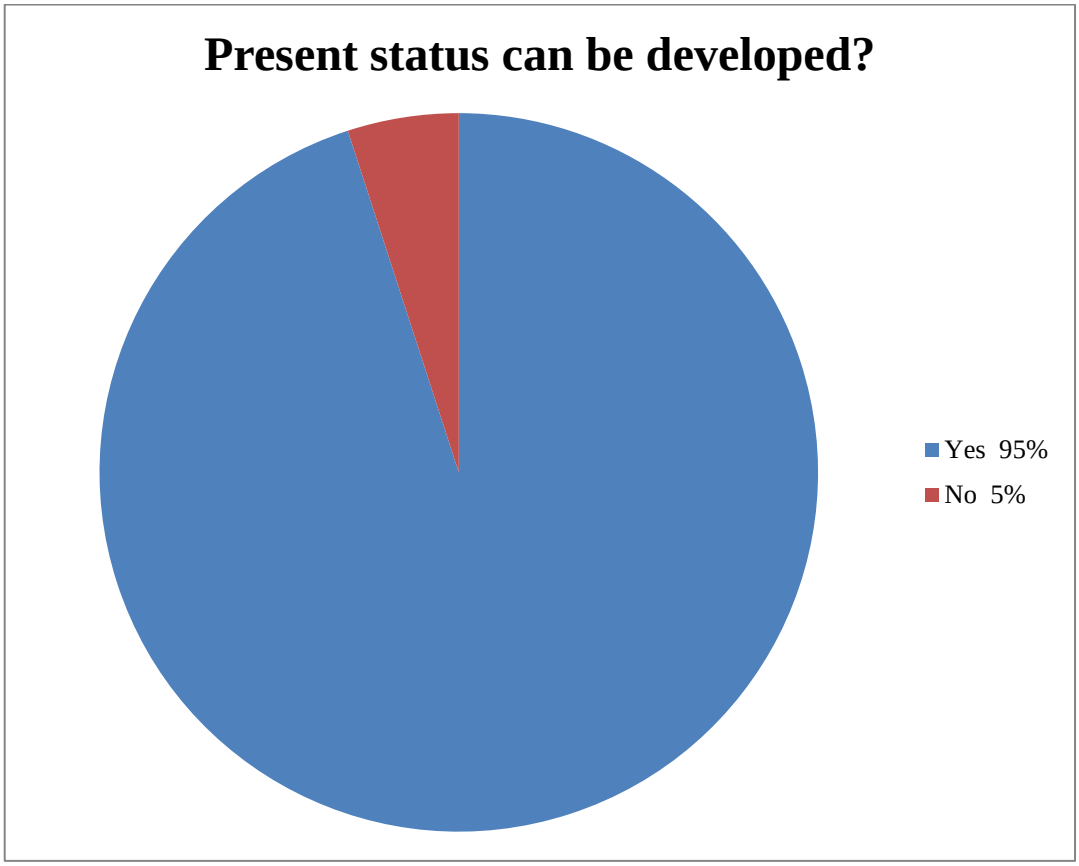
2. Present status of waste management in your Area?



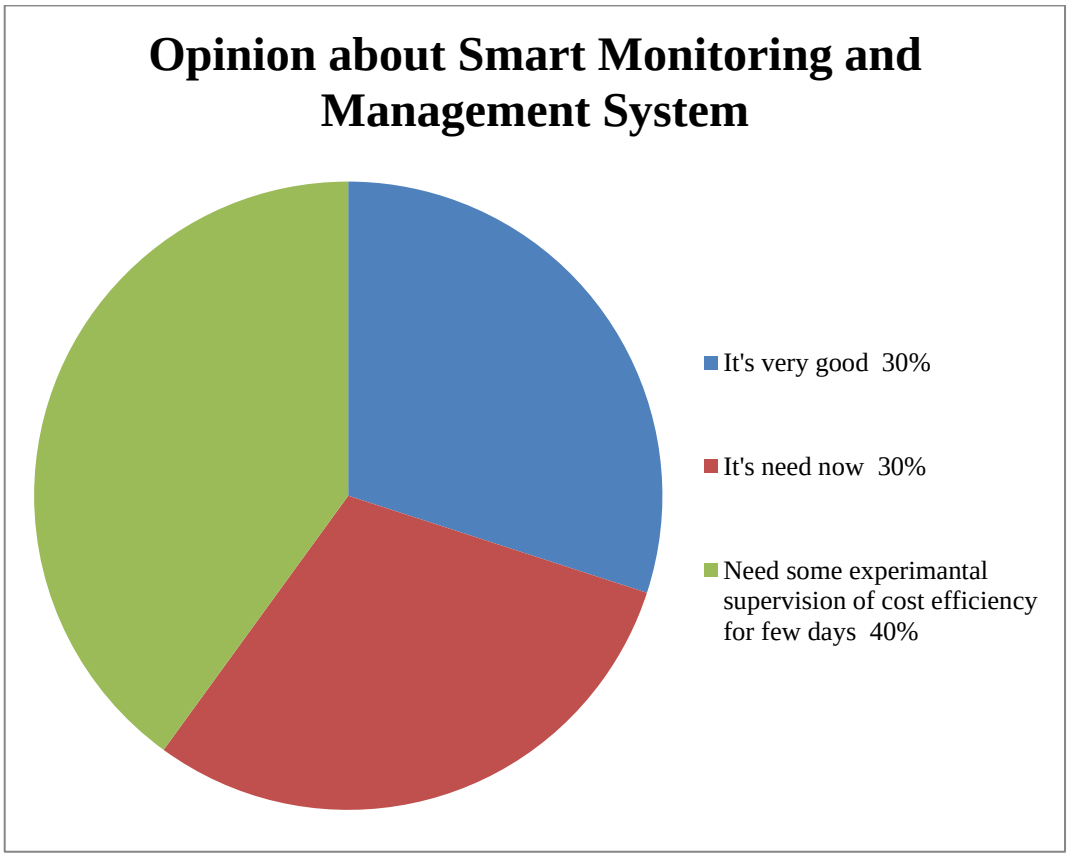
3. Dose the waste make any harm in locality which are gathered in the big waste tank after collecting the wastes from house?



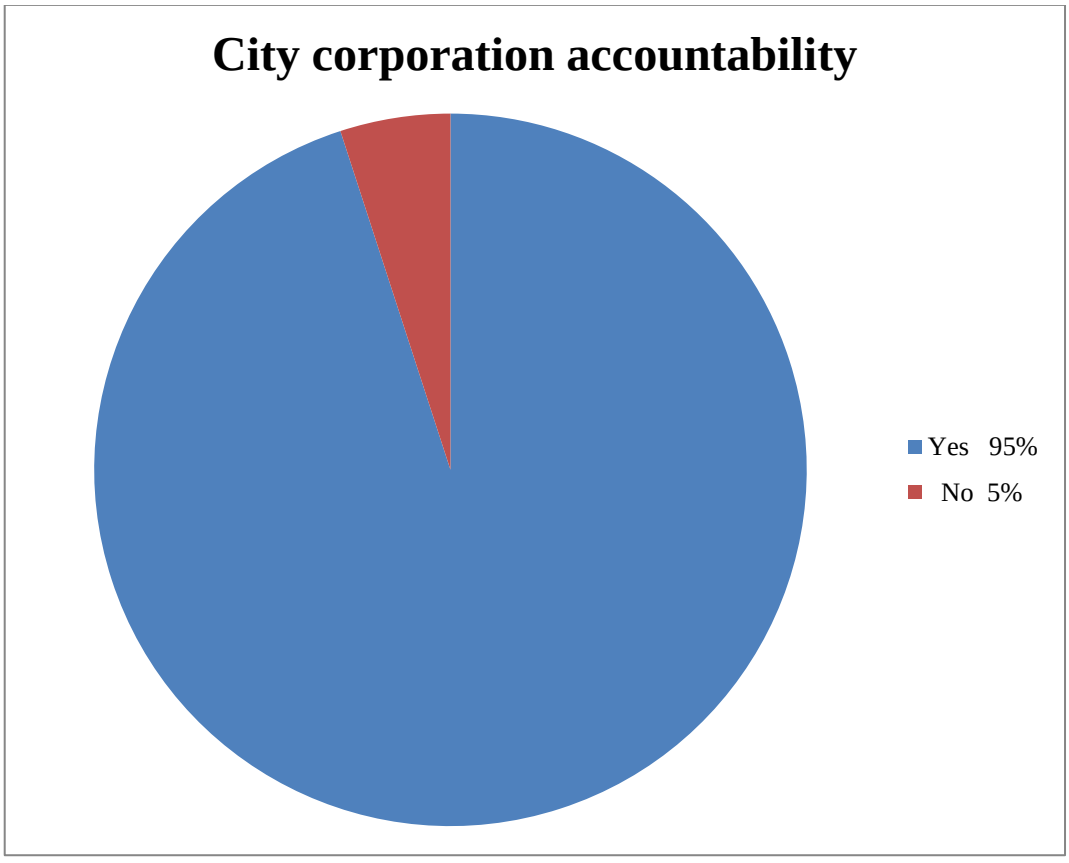
4. If waste management can convert into 24/7 Website monitoring system then present status can be developed?



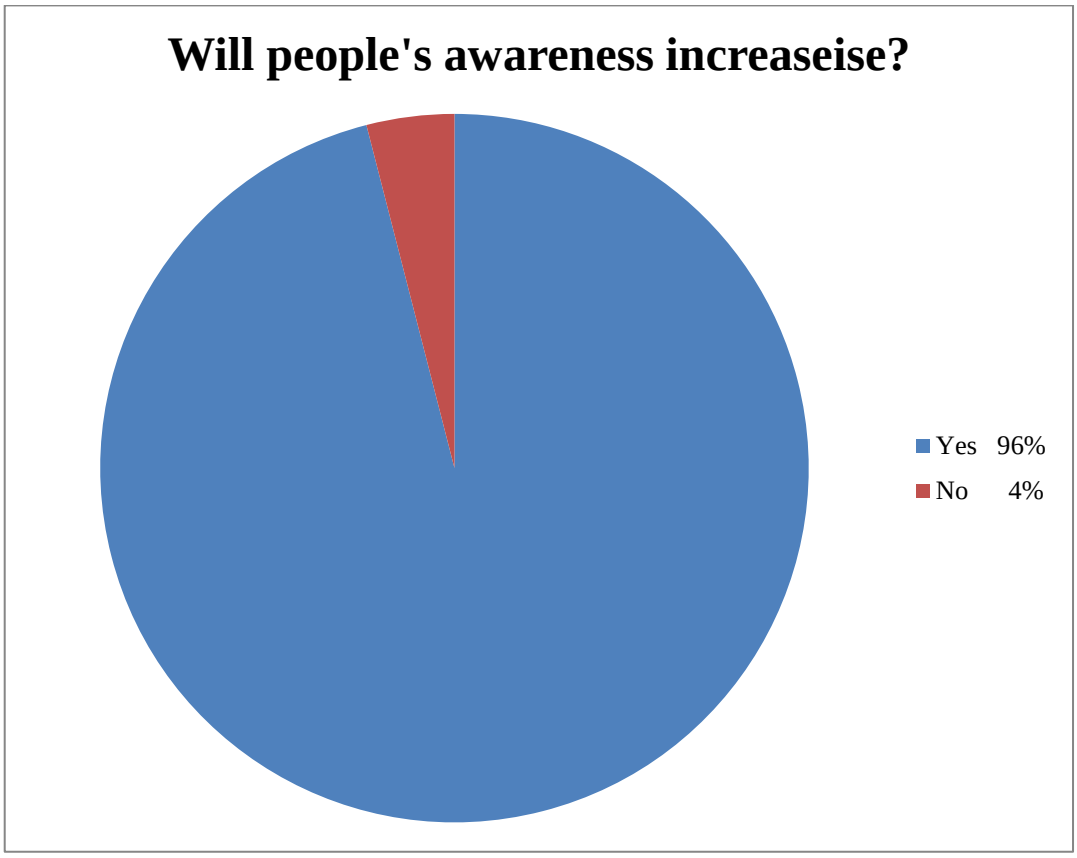
5. What is your opinion about our Smart Monitoring and Management System?



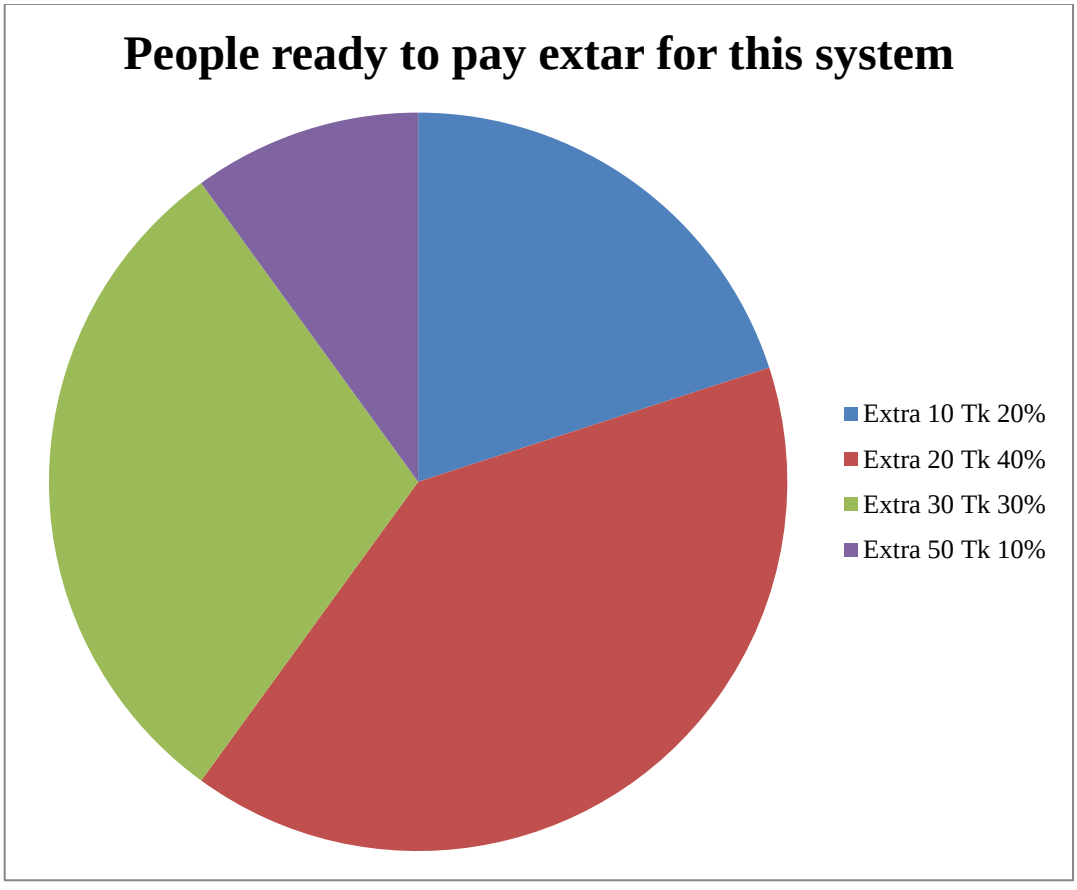
6. Do you Think that it increase the city corporation accountability?



7. If this system can successful partially does people awareness rise?



8. How much amount per people ready to pay extra for this system



Our decision after researching the survey result:

1. The project is actually a crying need.
2. The project must have to be reliable.
3. It has to be cost efficient.
4. Monthly maintenance should be low

5.2.1 Cost Analysis for Our Project

Table: 5.1 below shows the price list of components used in our project

Table: 5.1 Price list of components

Element	Quantity	Cost (Taka)
WeMos D1 R1	1	400
ADS1115	1	450
MQ-135	1	180
MQ-136	1	600
MQ-137	1	700
Ultrasonic sensor	1	80
Power bank	1	1000
Wire		100
Vero bard	1	50
Connector		20
USB cable	1	50
Total		3630

5.2.2 Monthly Revenue vs. Monthly Maintenance Cost of Our Project

Number of house: 170
Number of family (10 apartments per building average): 170×10=1700
Revenue collection per house: 50 Taka
Total revenue: 50×1700=85000 Taka
Number of waste collector: 6
Wages of each waste collector: 8500 Taka
Total wages: 8500×6=51000 Taka
Wages of two offices staff: 8000×2=16000 Taka
In hand: 18000 Taka (This money are used to give occasion bonus of waste collector and staff)

Initial cost of our Project:

Installation Cost: 4000 Taka each

Total installation cost: 4000×3=12000 Taka

WiFi cost: 1000 Taka

Two extra Waste collector's wages: 8500×2= 17000 Taka

Monitoring cell cost: 2000 (For 3 dustbins per month)

Total monthly maintenance cost: 1000+2000+17000= 20000 Taka

∴Installation cost per family (One Time)= 12000÷1700

= 7.06 Taka≈10 Taka

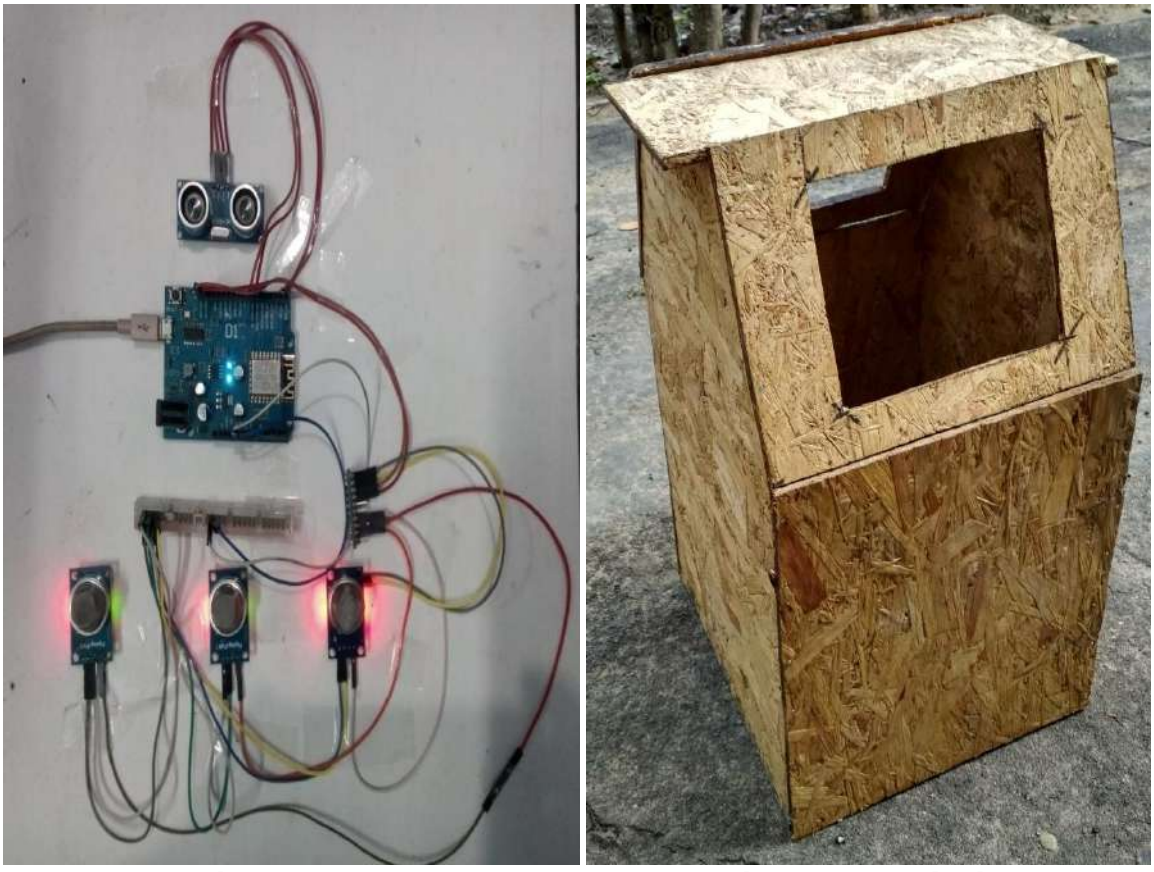
∴Monthly cost per family = 20000÷1700

= 11.76 Taka ≈15 Taka

Decision: Our project is highly cost efficient

5.3 System Implementation

Fig. 5.1 shows complete overview of this project



a. Dustbin monitoring circuit b. Prototype dustbin

Fig. 5.1 Overview of the complete system a. circuitry, b. Prototype dustbin

5.4 Real Time Visualization of Dustbin Through This Project

This article will show the activities of website though which our monitoring system will be completed. The WeMos D1 R1 sends data to the web server using WiFi and a user friendly graphical representation has been shown in our created ThinkSpeak channel.

Fig. 5.2 shows the H_2S gas level around the dustbin

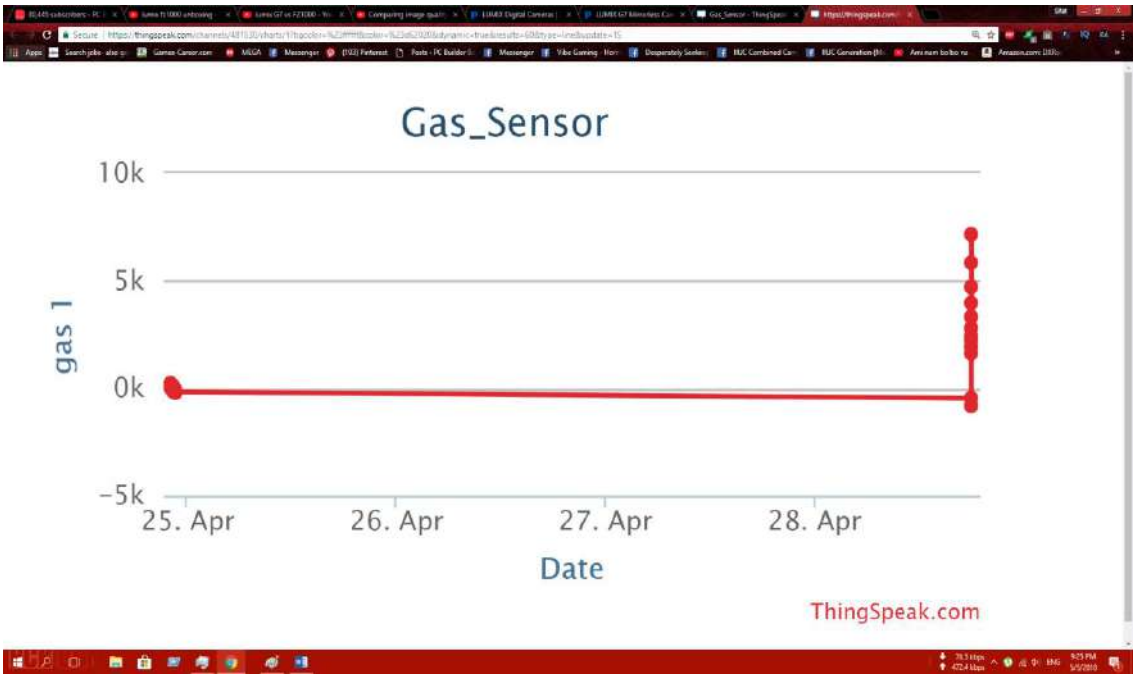


Fig. 5.2 H_2S gas level around the dustbin

Fig. 5.3 shows the air quality level around the dustbin

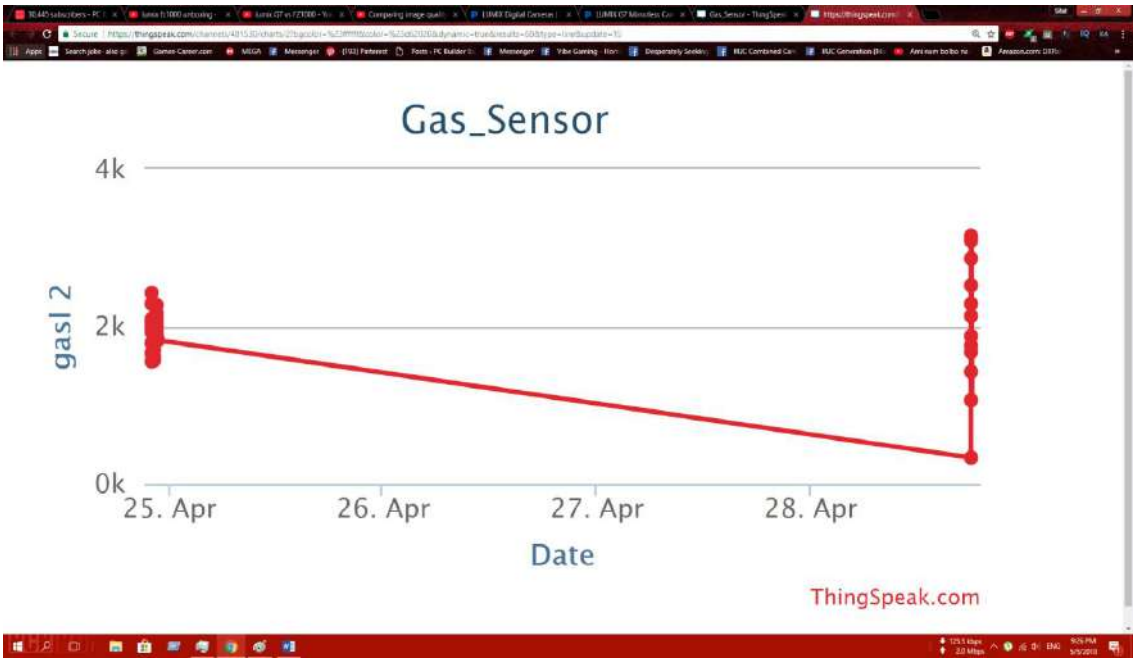


Fig. 5.3 Air qualities around the dustbin

Fig. 5.4 shows the NH_3 gas level around the dustbin

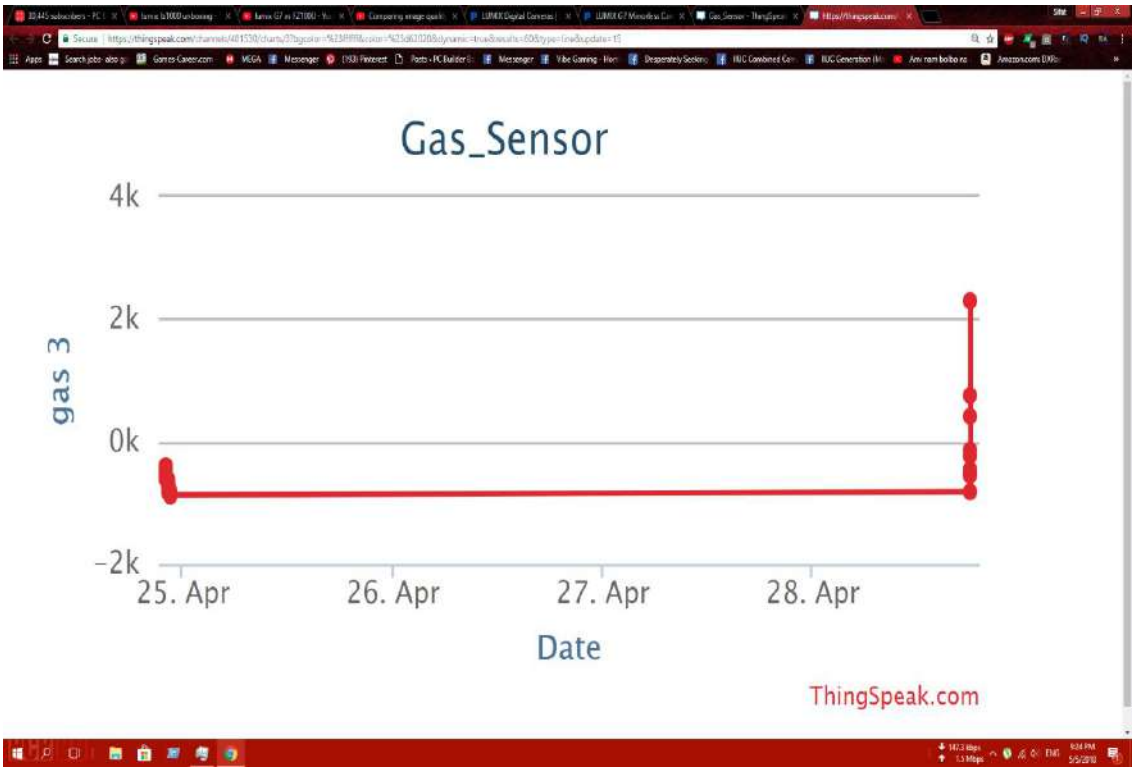


Fig. 5.4 NH_3gas level around the dustbin

Fig. 5.5 shows the garbage level inside the dustbin

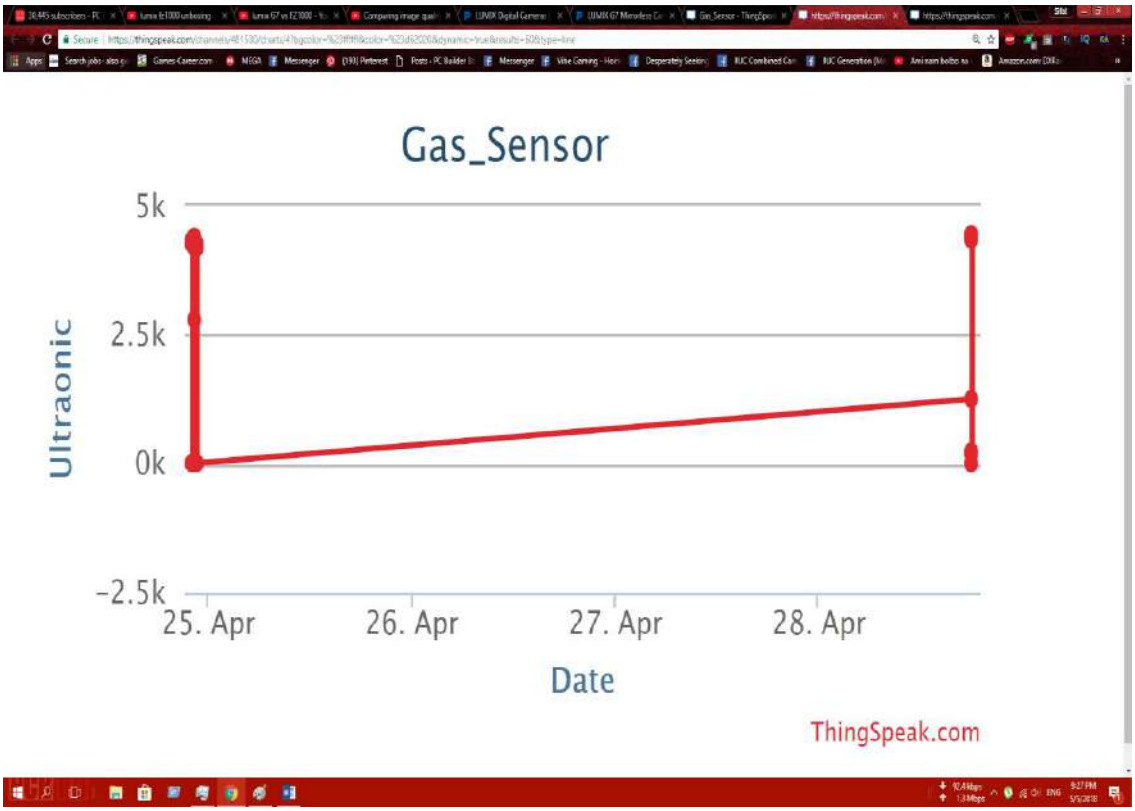
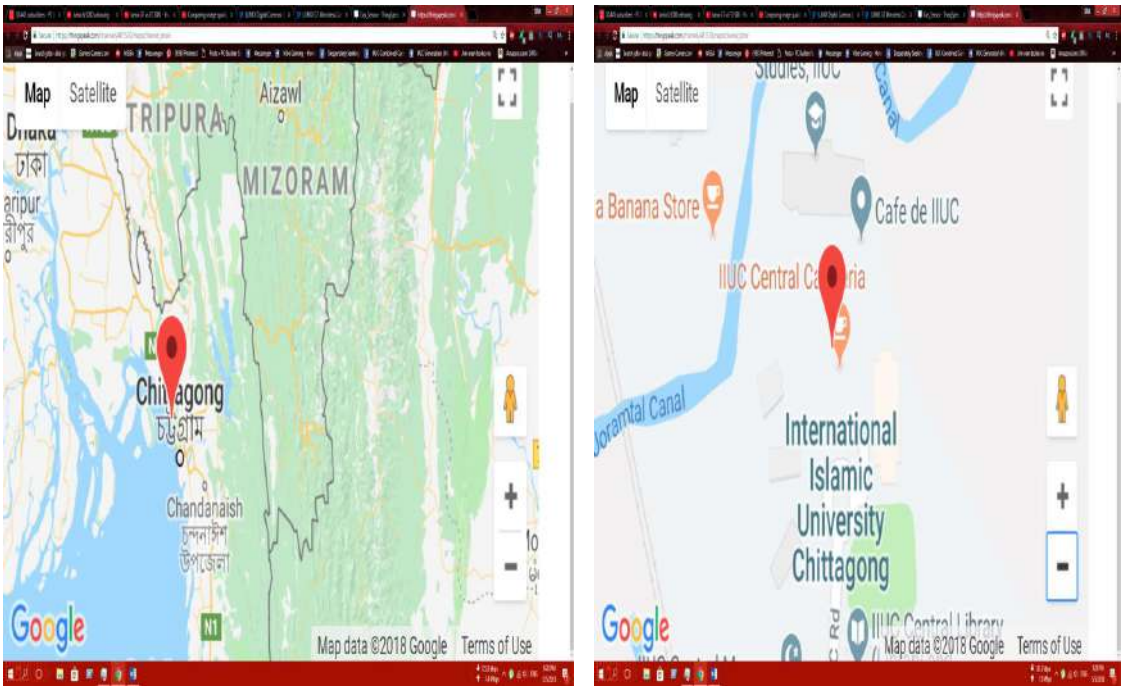


Fig. 5.5 Garbage level inside the dustbin

Fig. 5.6 shows the location of dustbin using Google Map



a. Dustbin location b. Zoom in view

Fig. 5.6 Location of Dustbin Using Google Map a. Dustbin location, b. Zoom in view

5.4.1 Data Analysis for Different Area under Chittagong City Corporation

Table 5.2 bellow shows the different gas level those are detected by our device and shows in web page

Table: 5.2 Gas level measurement in Riaz Uddin Bazar and Noya Bazar

Area	Detected Substance	Measurement (ADC 16 Bit Data)	Date & Time
Riaz Uddin Bazar	Gas 1	9560 (Maximum 10289 or 20 PPM)	14.05.2018, 16.25.42, GMT +0600
	Gas 2	8425 (Maximum 10565 or 25 PPM)	14.05.2018, 16.25.42, GMT +0600
	Gas 3	15559 (Maximum 14248 or 50 PPM)	14.05.2018, 16.25.42, GMT +0600
Noya Bazar	Gas 1	1085 (Maximum 10289 or 20 PPM)	14.05.2018, 17.40.55, GMT +0600
	Gas 2	2094 (Maximum 10565 or 25 PPM)	14.05.2018, 17.40.55, GMT +0600
	Gas 3	4034 (Maximum 14248 or 50 PPM)	14.05.2018, 17.40.55, GMT +0600

5.5 Power Consumption and System Stability

Supply voltage = 5 V

Current consumed by WeMosD1= 0.1 A

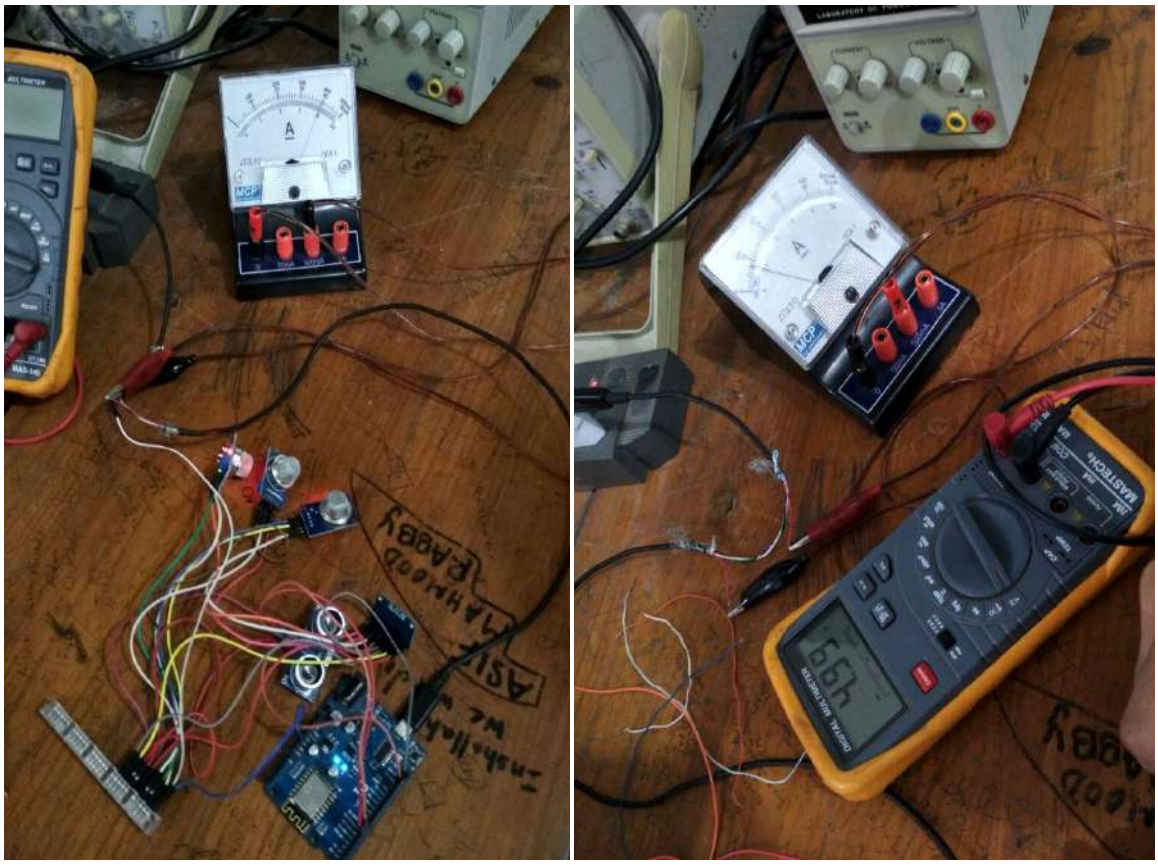
Current consumed by sensors and ADS1115 = 0.3 A

So, total power consumed by the circuit = 5 × (0.1+0.3) Watt

= 2 Watt

So, we can say that a 10000mAh 5V power bank can supply more than 20 Hours.

Fig. 5.7 shows the power consumption by this project



(a) Power consumed by total circuit (b) Power consumed by WeMos D1

Fig. 5.7 Power consumption by Smart Waste Monitoring & Management Project (a) Total Circuit, (b) Only WeMos D1

5.6 Business Model

For Prototype we have used ThingSpeak server for free so that we have faced some restrictions. When this project will be implemented by proper authority a paid server and website must be needed, for that reason maintenance cost will increase. If any private company wants to implement this project widely they can folly our business

plan. Following business plan describes the total system in one graph as well as it shows its importance, project coast, revenue and many activities of this project.

Fig. 5.8 shows the business model of this project

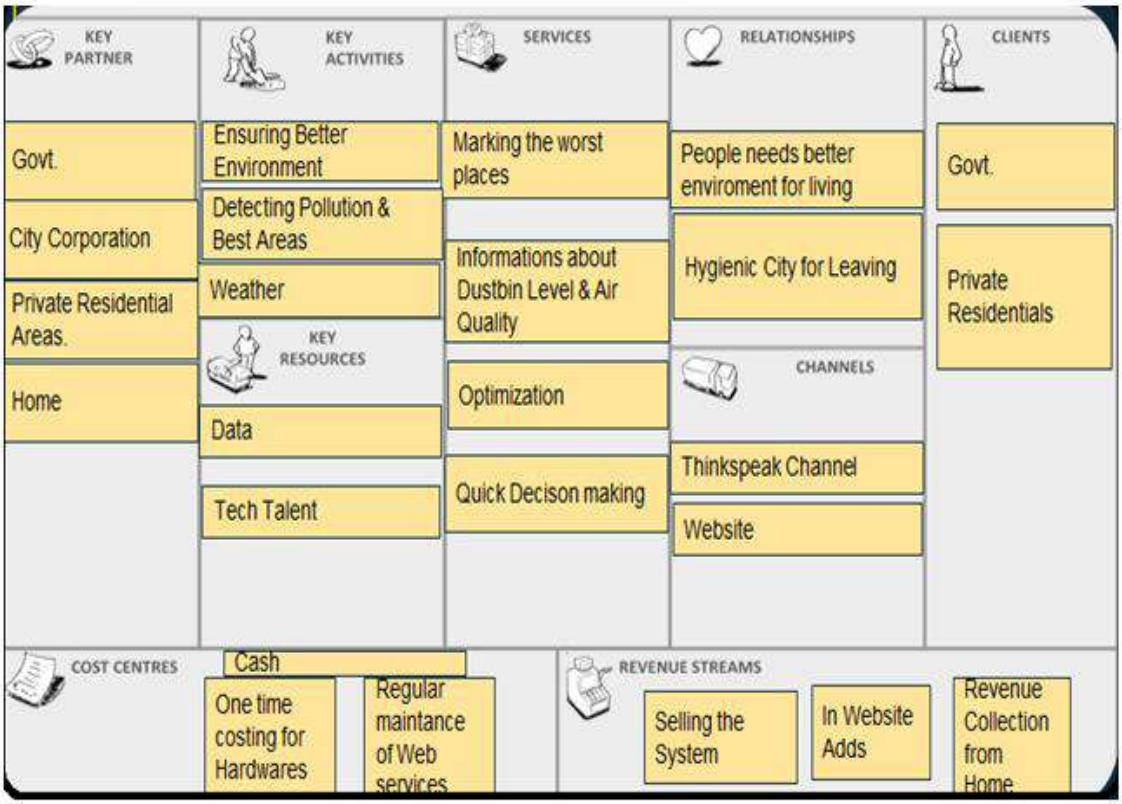


Fig. 5.8 Business model for Smart Waste Management

5.7 Prototype vs. Real

This is made with primarily for research purpose as we design the prototype here in the project. Real system may need some modification to be done. The prototype and the real system are compared bellows:

1. This project only can detect the garbage level inside the dustbin, in future such idea should be invented so that we can detect the level of garbage outside of the dustbin
2. In prototype we have used one ultrasonic sensor for measuring the level of garbage in dustbin but in real situation dustbins are very big like 10 to 15 fit wide and 8-18 fit tall, so we have to use more ultrasonic sensor to realize the actual level of waste. No problem, we have kept this situation under consideration, using this WeMos D1 R1 we can add three more ultrasonic sensors only some modification in program is needed.

3. Though this circuit is not so expensive we should ensure some extra security system like fixed metal case attached with dustbin.
4. As this product will be placed in road side regular maintenance is needed because dust can decrease the sensitivity of gas sensors.
5. In prototype we can use mobile “Personal Hotspot” but in real the needs WiFi router with good bandwidth for 24 hour incessant monitoring.

CHAPTER 6
CONCLUTION AND FUTURE WORK

6.1 Conclusion

According to cost analysis and trustworthiness of this project it is accepted by most of the people of our surveying area near about 95%. Though the present invention is slightly costlier than previous system (only 20 taka), it provides a clean city and better environment for living.

In previous work those systems are beneficial for either monitoring or management of waste and those systems are appropriate for their country but our system is completely appropriate to our country's socio-economic status.

6.2 Future work

The area of "Smart waste monitoring and management system" is very broad. In future, this research based project opens different door of opportunities like

1. In Future it will encourage different IoT based innovative work.
2. Used the same circuit after some modification in programming we can use it for monitoring different places where observing is needed like hospital, convention hall, pharmaceutical industry, heavy industry pollution monitoring etc.
3. This type of IoT based project creates a huge opportunity of employment which decreases the unemployment problem of Bangladesh.
4. As it is our prototype project we have future aim in web developing in such way we can monitor our every dustbin using one website.

6.3 Limitations

In our prototype project have some limitations. Those are discussed below

1. Calibration of gas sensor MQ-135 is very difficult because it is sensitive for various gases.
2. This project only can detect the garbage level inside the dustbin, in future such idea should be invented so that we can detect the level of garbage outside of the dustbin
3. In our Prototype we just used a free ThingSpeak server so it has some limitation of accessing and it has some risk of hacking.

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APPENDIX

Code for WeMos D1 R1

```
#include <ESP8266WiFi.h>
#include <Wire.h>
#include <Adafruit_ADS1015.h>
#define echoPin D7 // Echo Pin
#define trigPin D6 // Trigger Pin
String apiKey = "ZTQM58JT59IY3B8N";   //change
const char* server = "api.thingspeak.com";
long duration, distance;
Adafruit_ADS1115 ads(0x48);
intval, val1, val2;
WiFiClient client;
void setup(void)
{
Serial.begin(115200);
delay(10);
Serial.println();
Serial.print("Connecting");
WiFi.begin("F For Family", "drabdullatif197116");    //change
while (WiFi.status() != WL_CONNECTED)
  {
delay(500);
Serial.print(".");
  }
Serial.println("");
Serial.println("wifi connected");
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
ads.begin();
}
void loop(void)
{
  int16_t adc0;
  int16_t adc1; // we read from the ADC, we have a sixteen bit integer as a result
  int16_t adc2;
  adc0 = ads.readADC_SingleEnded(0);
  adc1 = ads.readADC_SingleEnded(1);
  adc2 = ads.readADC_SingleEnded(2);
  val0 = (adc0);
  val1 = (adc1);
  val2 = (adc2);
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
```

```
//Calculate the distance (in cm) based on the speed of sound.
distance =  58- duration/58.2;
if (client.connect(server,80))
{
String postStr = apiKey;
postStr +="&field1=";
postStr += String(val);
postStr +="&field2=";
postStr += String(val1);
postStr +="&field3=";
postStr += String(val2);
postStr +="&field4=";
postStr += String(distance);
postStr += "\r\n\r\n";
client.print("POST /update HTTP/1.1\n");
client.print("Host: api.thingspeak.com\n");
client.print("Connection: close\n");
client.print("X-THINGSPEAKAPIKEY: "+apiKey+"\n");
client.print("Content-Type: application/x-www-form-urlencoded\n");
client.print("Content-Length: ");
client.print(postStr.length());
client.print("\n\n");
client.print(postStr);
Serial.print("\tGas1: ");
Serial.println(val);
Serial.print("\tGas2: ");
Serial.println(val1);
Serial.print("\tGas3: ");
Serial.println(val2);
Serial.println();
Serial.println(distance);
delay(20000);
}
client.stop();
Serial.println("Waiting…");
// thingspeak needs minimum 15 sec delay between updates
delay(20000);
}
```