IoT based automated biogas system

BY

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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DAFFODIL INTERNATIONAL UNIVERSITY
DHAKA, BANGLADESH
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APPROVAL

This Project titled "**IoT based automated biogas system**", submitted by Tareq Rahman Jisan to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 02-May-2021.

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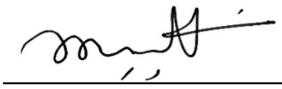

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Dr. Fizar Ahmed, Assistant Professor, Department of CSE,** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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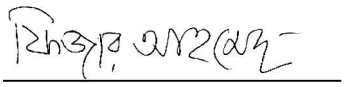

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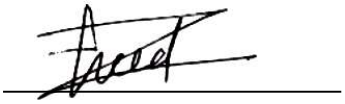

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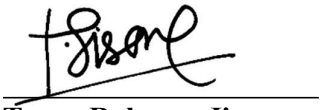

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First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project successfully.

We really grateful and wish our profound our indebtedness to **Dr. Fizar Ahmed**, **Assistant Professor**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Data Science*" to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project.

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We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

We the people cannot live without mine energy. In Bangladesh we have largest gas mine. But only five percent gas use for cook, vehicle. But mine gas is limited. So any time the gas will be finished. So we need to find alternative way and Bio-Gas is the best way. This production Eco-friendly. It's core material are Organic waste, Animal Bird Sanitary, cow dung also uses Human feces. So we can easily collect the material with free cost. But Bio – Gas only available in Deep village. But in Developed villages or city's people not want to use Bio-Gas. There behind a reason. The reason is Proper Controlling or Smart Controlling System. **IoT based automated biogas system** is solution. Because by using the system people can easily monitor the plant. Also people will be more interest for use the IoT based automated biogas system. It is possible to make industrial plant we can produces large amount of gas. The gas can be use as Fuel. So we can produce electric energy by using the gas. If most of the people in our country used IoT based automated biogas system**.** Country will be more clean and beautiful. so Small amount of Toxic substances from the environment will be reduced.

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CHAPTER 1

Introduction

1.1 Introduction

Biogas is a renewable energy. This is very easy process. there is no any chemical used in the process. so it is environment friendly. Not only Bangladesh also development country use biogas. Because this production helps to nature neat and clean. Also this process produces two product one is gas and other is organic fertilizer. once upon a time this gas used for cooking. But today its can use for produce small amount of electrical energy. so villagers can use electrical light and fan also other electronics device for easier their life.

Even though biogas is an important alternative fuel power, sometimes it is not popular for some issues such as suddenly reducing gas pressure, scarcity of cow dung etc. These issues can be occurred due to prior knowledge and operating problem of assigned gas plant operator.

"IoT based automated biogas system" is a cross platform solution integrated with hardware. It's a complete package for monitoring bio-gas plant. In our country many bio-gas plant available. But it's not automated. That's why developed village or city's peoples are not want to use bio-gas. So we use cross platform, open sources and own framework with personal or business application.

1.2 Motivation

In Bangladesh 80 % of people direct or indirectly connected with farming. I am a Data Center infrastructure designer. For infrastructure security & monitoring purpose I was made some embedded & plc based hardware. That when I visit YouTube for get knowledge and skill I saw I can use my knowledge, skill and talent in farming industry.

Technology is my passion and profession but farming is life. So I concern to farming technology and select “IoT based automated biogas system”. Because its core material is Organic waste. When we input Organic waste we get gas and Organic fertilizer.

1.3 Objectives

Developing automated biogas is the important objective of this research. Mobile Apps based remote monitoring system will be the additional part of this research.

1.4 Expected Outcomes

- Gas yield has dropped
- Methane concentration dropped
- Foaming problem
- pH dropped

An Internet of Things (IoT) technology with mobile apps can be helpful to solve these above problems. By using IoT a Biogas plant can be converted automated mostly.

1.5 Project Management and Finance

A. Work plan/ time frame:

Table 1.5.1: work plant / time frame

Task/Month	1st	2nd	3rd	4th	5th	6th
Create Biogas Plant						
Mobile Apps Development						
IoT implementation						
Final Report						

Total: Six Months

B. Budget shall be 50 thousand to 5 lac.

1.6 Report Layout

The following figure 1.6.1 Application dashboard.

Figure 1.6.1: Application Dashboard contain latest Temperature, Pressure, Humidity, Gas Resistance, Read Altitude, Methane.

TABLE 1.6.1: TEMPERATURE, PRESSURE, HUMIDITY, GAS RESISTANCE, READ ALTITUDE, METHANE HISTORY IN GAS PLANT.

SL	Time	Temperature	Pressure	Humidity	Gas Resistance	Read Altitude	Methane
1	29-Sep-20 02:07:19 PM	15	77	78	95	50	10
2	29-Sep-20 01:07:19 PM	20	85	65	50	50	7

CHAPTER 2

Background

2.1 Terminologies

For this project development we are use open sources platform. We used **React JS**. It is an open source JavaScript library. Which is developed by Facebook. The library uses for develop single page web page. Also using this library possible to developed IOS or android application. In Bangladesh most of the people use android smart phone. Small amount of people uses IOS. So if we use different environment for android or IOS platform it will be costly. So we choose React JS for this project.

For server side processing we used **Node JS**. This is an open source java script library based server side cross platform language developed by google. So the language is absolutely perfect for the project. Because we can easily develop and live the project with Docker application.

Use MySQL is core database. Once a time the database is open souce. But today this is licensed based engine maintain by Oracle corporation. But the database has community edition available. Basically this database engine is very faster than other database engine. For initially we used MySQL Database. But in future we will use Oracle, MongoDB, AWS Database engine because MySQL database engine has some. It's has no good backup solution and security.

Use Red Hat as Operating System. It is an USA based software developer company. This is most famous Operating system for high secure solution. It's very popular enterprise OS over the world. But this is license free operating system. So will use the OS as a server for our project.

We are used **NodeMCU** as core component of Hardware part. It is 32bit MCU based hardware. Which has some digital pin and analog pin. Before NodeMCU we used Arduino UNO and esp8266 module for solution. Which is costly and complex solution. But NodeMCU is very low cost and easy solution.

BME 680 is use as Gas Sensor BME680.It is a gas sensor introduce by spark fun. Basically it was developed for fun. But this sensor has capability to handle industry based solution.

2.2 Related Work

There are lots of Idea can get from SEO result. There are many sensors like MQ4, MQ8, bme 280 available in SparkFun. Which are used for Gas Related working areas.But we they never used those sensors for bio-gas plant. So project idea is unique Finally we say that whole project idea is unique but part of this project may be match with other project. There is some project Available which is matched to some feature of our project like **Smart Biogas, Gas leakage detection, Methane gas finder.**

2.3 Comparative Analysis

Table 2.3.1: Comparative analysis table.

Feature	Smart Biogas	Gas Detector	Our Project
Generally Inside the box	• Smart Biogas Device • Flow, Pressure and thermistor • Venturi pipe fitting • Lithium Ion battery • Solar Panel	• Gas Detector Device • Battery • Power Adapter	• Device • Battery • Solar • Power Adapter • Sensors
Generally Data Collection	• Average pressure • Average flow rate		• Temperature • Pressure • Humidity • Gas Resistance • Read Altitude • Methane All data send to server every 10 seconds. But real time is proposed.

GSM	Yes	Yes	Proposed
Price (tk.)	8,000-10,000 tk.	1500-10000	4,000-15,000

2.4 Scope of Problem

Table 2.4.1: Scope of Problem Table.

Problems	Most likely causes
Low gas production	• fall in quality of substrates • fall of temperature • Compounds obstacle • Non-homogenous substrates • Methanogenic bacteria low production
Low methane Percentage	• fall in quality of substrates • Drop of temperature • Compounds obstacle
Foaming problem	• high protein content has been dropped • Air is produce problem the digestion • Temperature changing
pH dropped	• Uncontrolled feeding rate. • Operating temperature not controlled • Uncontrolled Agitation .

2.5 Challenges

We face some major challenges for developed the project. Fist sensors can't provide demand able. Sensors compromised any time. Lab problem is main challenge for the project.

CHAPTER 3

Requirement Specification

3.1 Business Process Modeling

The following figure 3.1.1 Business process modeling for Bio-gas plant. Which will be help to us how the system works.

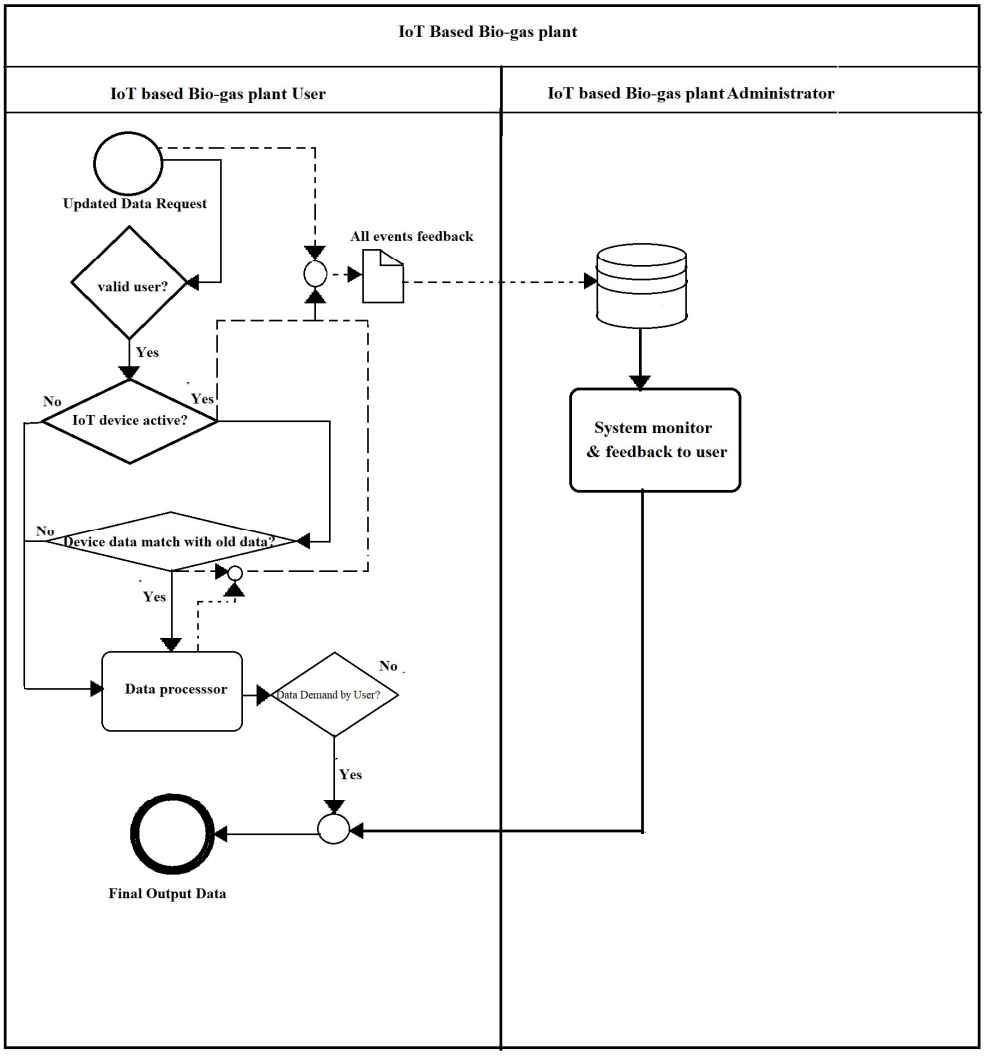


Figure 3.1.1: Business process modeling.

3.2 Requirements Collection and Analysis

Requirements: -

- Functional Requirements
  - First implements the bio-gas production plant.
  - Install IoT based device.
  - The device mac should be register in database.
  - User must be register in the system.
  - Use must login.
  - All activities should be store in database as log.
  - The mac should be sync with user account.
  - The device must active.
  - Internet/GSM must active.
  - For monitoring the system user must be login.
  - User must be see history of production plant gas information
  - Dash board should contain Temperature, Pressure, Humidity, Gas Resistance, Read Altitude, Methane, last update time.
  - Only application administrator can make any change in the system.
- Non Functional Requirements
  - User must be change assign login password, contact number, email.
  - User must be creating user with access control.
  - User do not assign device mac without developer permission.
  - All unsuccessful attempt must be generating log and send notification user.
  - Website must be capable enough to handle 50 thousand users and 2 thousand heat per second with performance.
  - Backend environment must support portable feature. Like product must be developed using portable language.
  - Database admin must be maintain user privacy. Log must be generate when DBA try to access user data..
  - All SQL must be store in database and project interface must be dynamic.
  - Project must be developer's friendly.

- Project must have a module for public users.

Analysis part will be describing in part 3.3, 3.4.

3.3 Use case Modeling and Description

The following figure 3.3.1 use case modeling for Bio-gas plant. Which will be help to us how the system works.

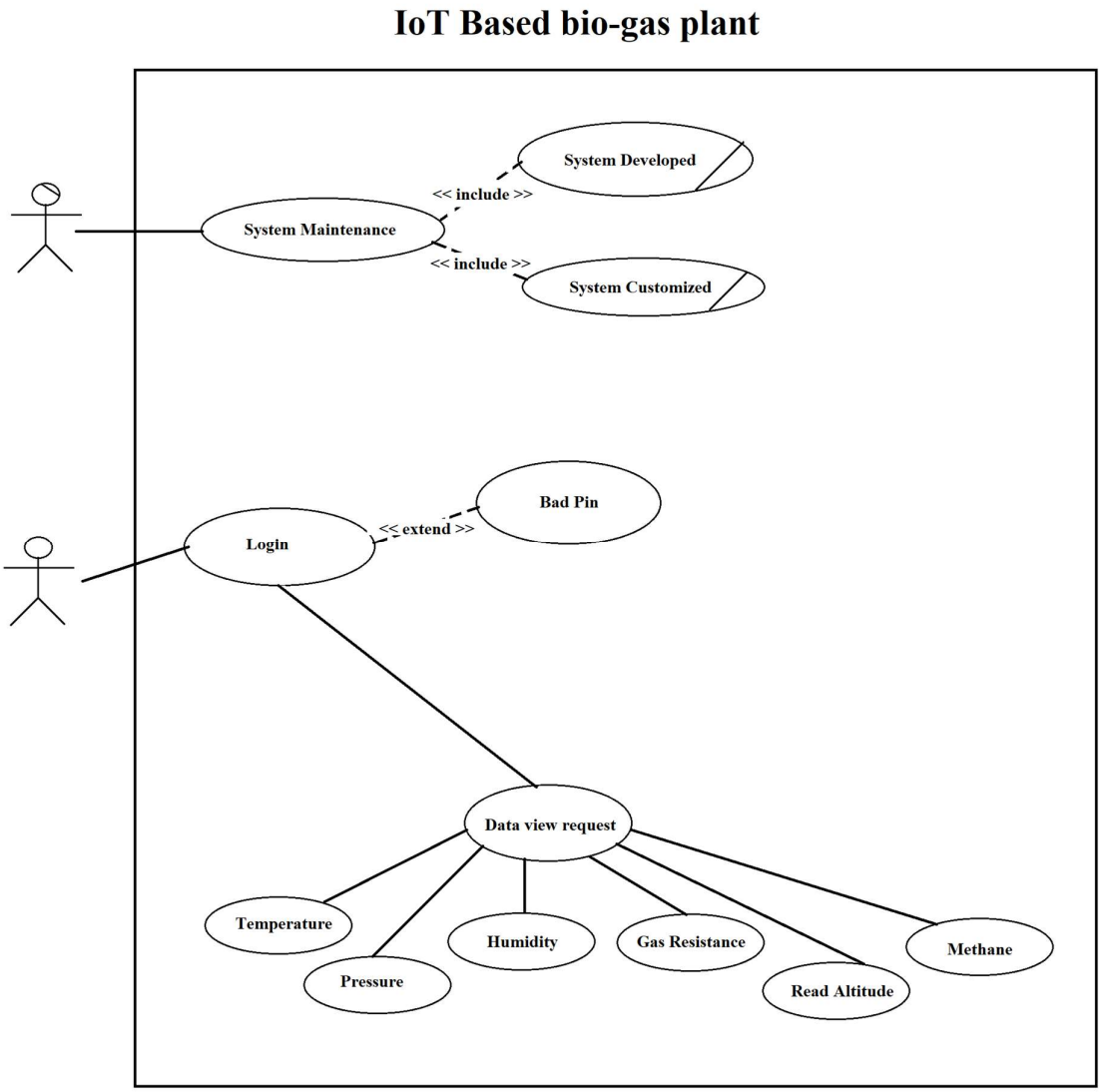


Figure 3.3.1: use case modeling.

3.4 Logical Data Model

The following figure 3.4.1 logical data model for Bio-gas plant. Which will be help to us how the system works.

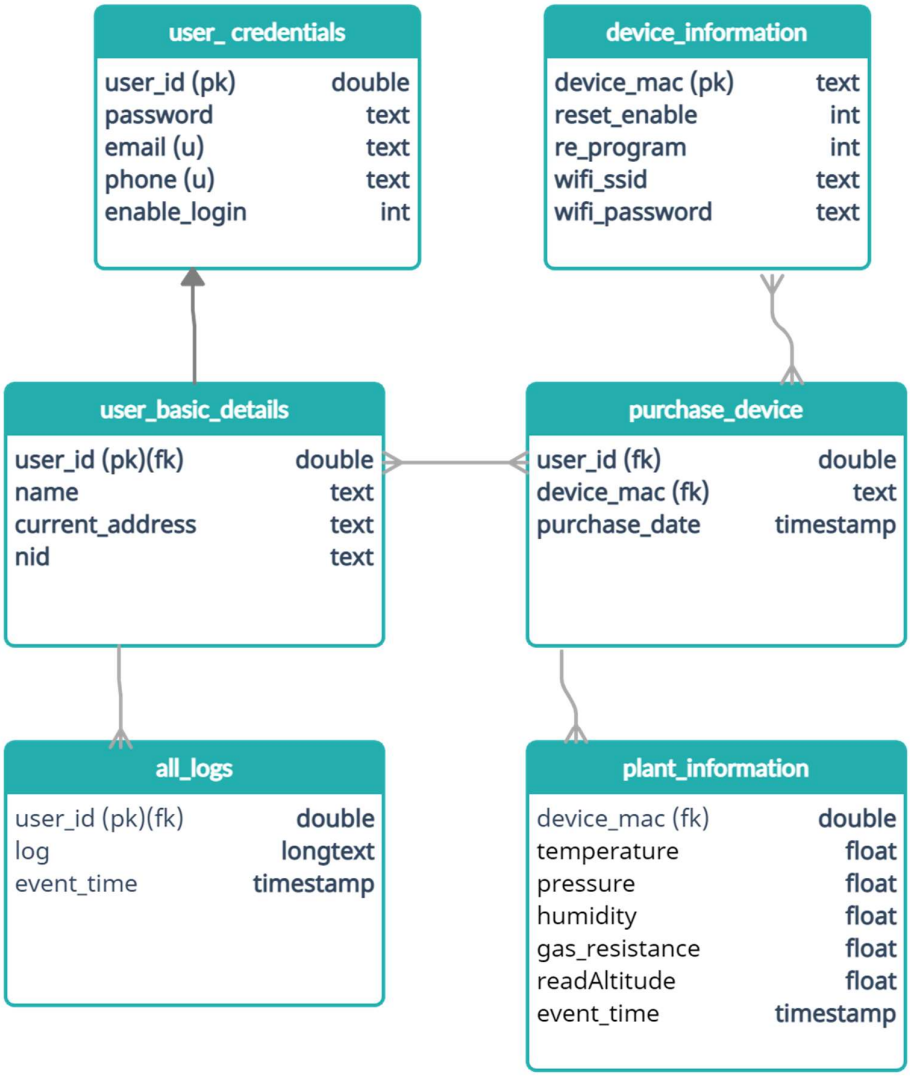
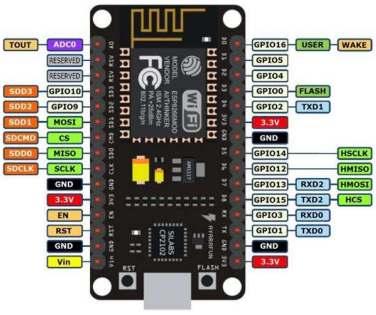


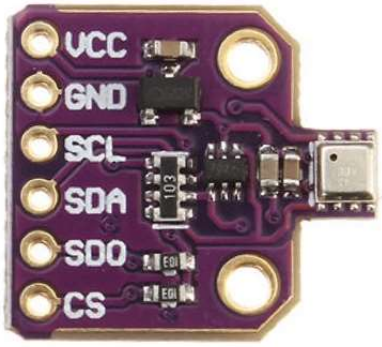
Figure 3.4.1: logical data model..

3.4 Design Requirement

Table 3.4.1: Design Requirements.

SL	Requirements	Image / Logo	Remarks
1	Ubuntu OS		Ubuntu is developer friendly debian karnel based open source license free edition
2	Redhat OS		For live the web based application we use Redhat OS. Because Redhat is a enterprise, secured, highly efficient server OS.
3	NGINX engine		NGINX is an alternative web server application. Which is very light, faster, cluster base load balancer application.
4	Visual Studio Code		Code editor

5	Mysql Database		Need enterprise database server.
6	MySQL Workbench 8.0 CE		For SQL editor
7	Arduino IDE		C+ editor
9	Nodemcu v2		Use as core hardware part

10	Bme680		Gas sensor
11	Electronics Lab		For project device manufacture.
12	Bio gas plant		For project testing

CHAPTER 4
Design Specification

4.1 Front-end Design

For this project Front-end Design is very challenging. Because of this project mainly developed for Bangladeshi People. Most of the Bangladeshi people are not comfortable with Smart Digital System. Now most of the people has Smart phone, Windows / Mac / Linus OS based Personal Computer. So we find a solution for Faster Production.

We used some Framework for solution. More describing in part 4.4.

4.2 Back-end Design

Back-end design is a major part for any project. This is very complex & challenging. Because in this part we think about security, performance, reliability, scalability. Main component for this part programing language, database engine. Because all programing language are not same, not contain same feature, not contain cross library support. So how we solve the challenge we describing in part 4.4.

4.3 Interaction Design and User Experience (UX)

This is very sensitive part for any application. Because user have no idea how back-end work. User only work with front-end. UX will be the final output for the user. In below all UX will present.

The following figure 4.3.1 login page for application

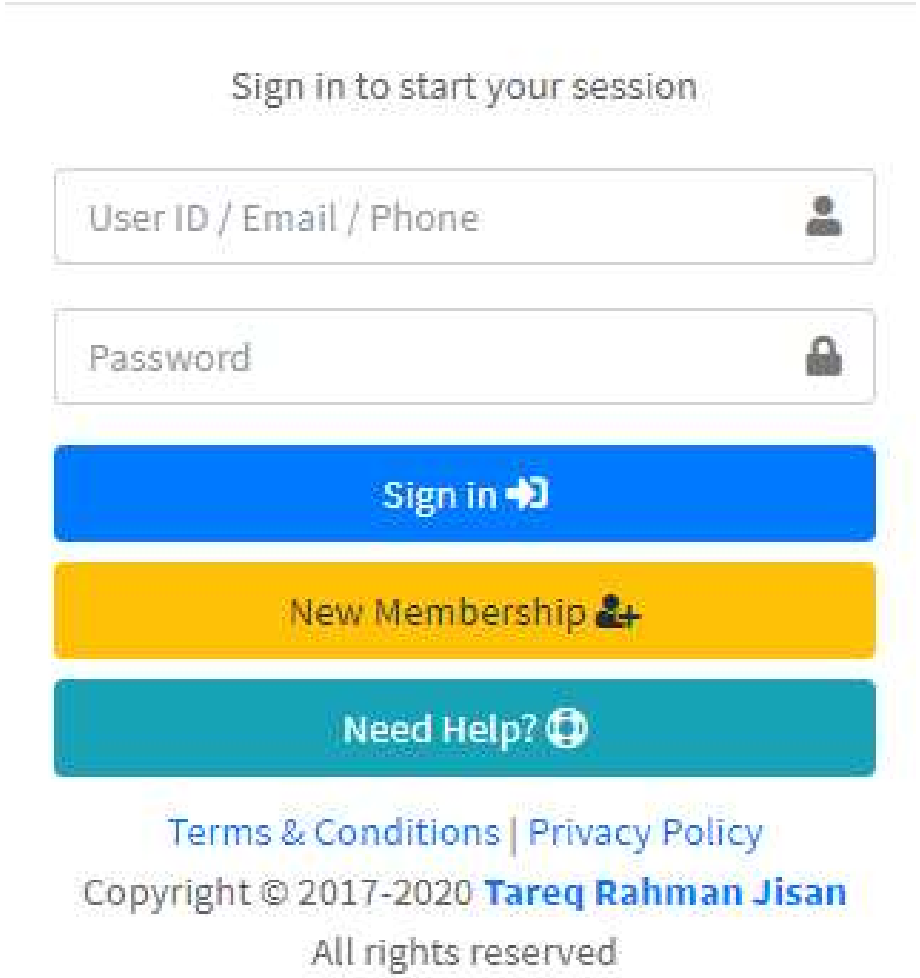


Figure 4.3.1: Login page.

The following figure 4.3.2 Public Registration page for application

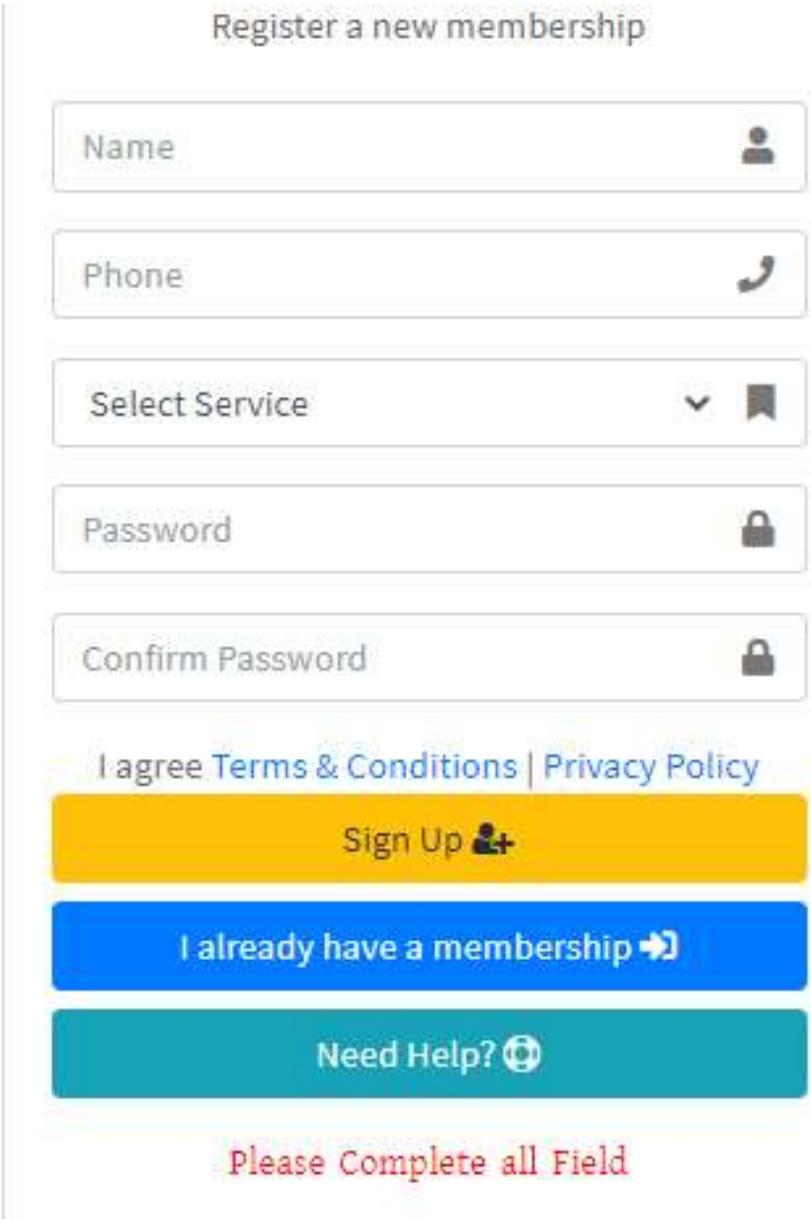


Figure 4.3.2: Registration Page.

The following figure 4.3.3 navigation menu for application

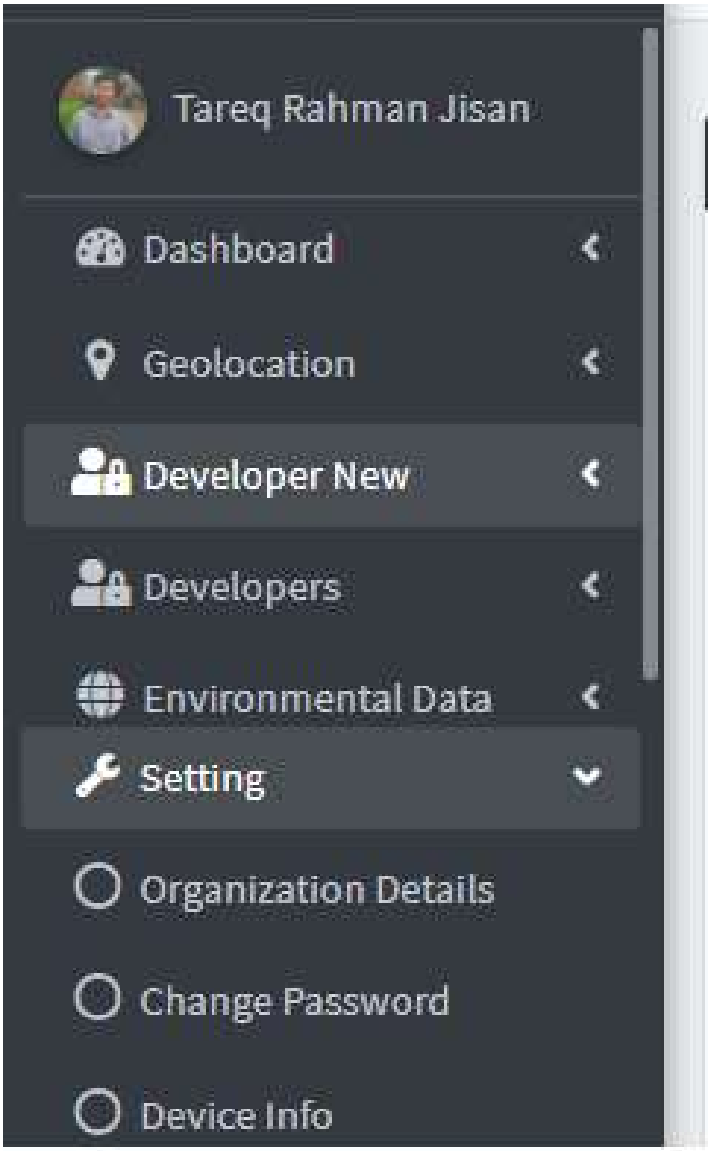


Figure 4.3.3 Navigation Menu.

The following figure 4.3.4 Device Registration page for application

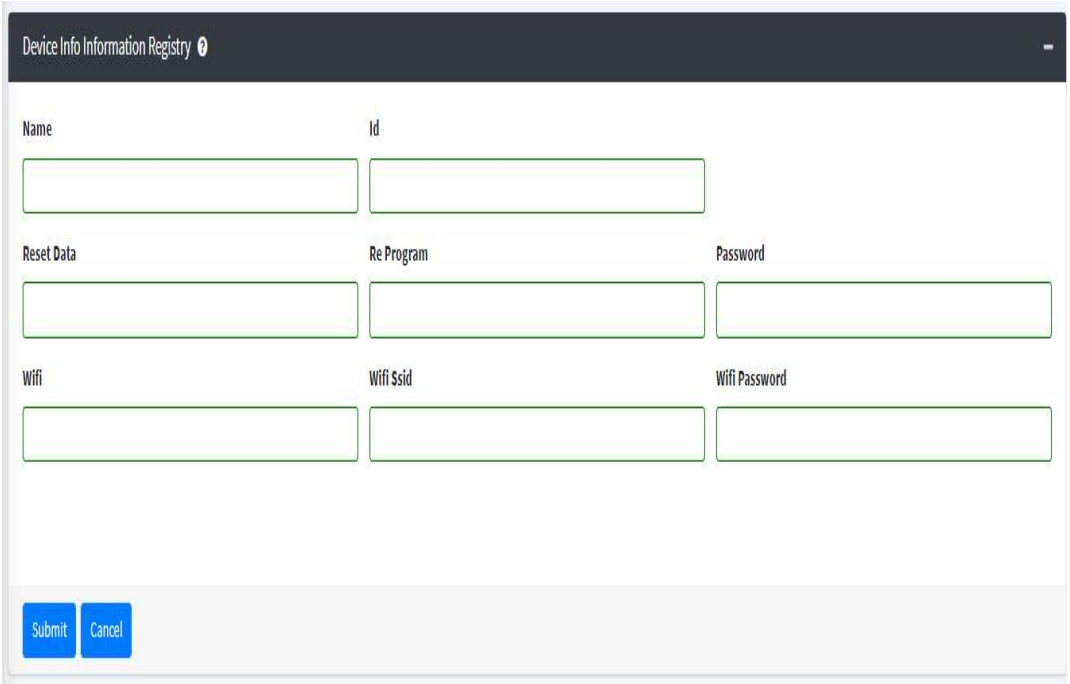


Figure 4.3.4: Device Registration page.

The following figure 4.3.5 report table

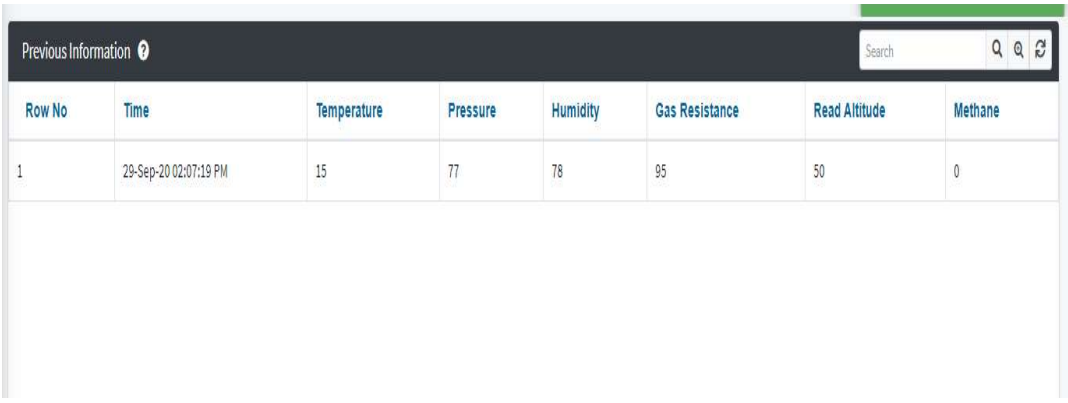


Figure 4.3.5: report table.

The following figure 4.3.6 dashboard for application

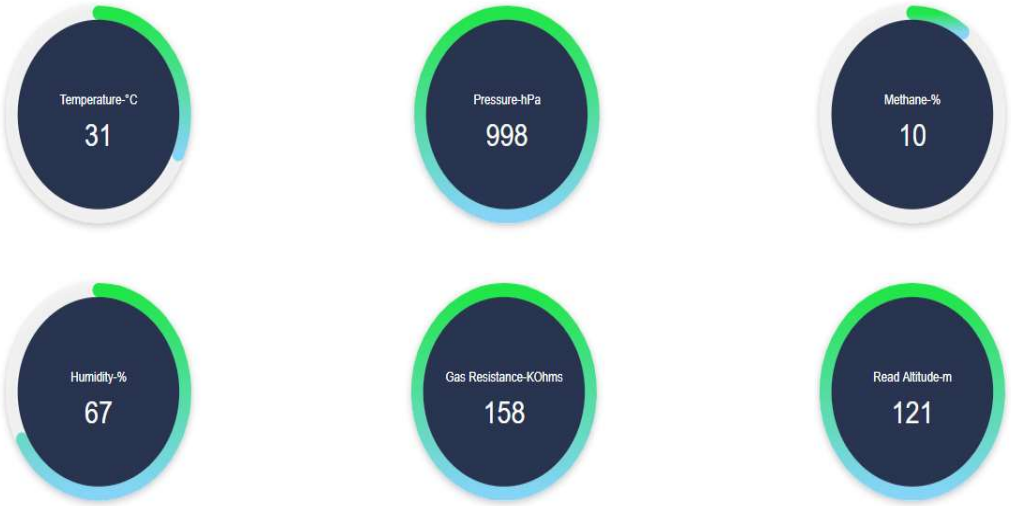


Figure 4.3.6: Dashboard.

4.4 Implementation Requirement

- Bootstrap Framework
- JQuery
- React JS
- Core UI Framework
- Admin LTE Template
- JavaScript XML

CHAPTER 5

Implementation and Testing

5.1 Implementation of Database

```
CREATE TABLE `backup` (
  `sl` double NOT NULL,
  `dml_old_data` text COLLATE utf8mb4_bin DEFAULT NULL,
  `dml_data` text COLLATE utf8mb4_bin DEFAULT NULL,
  `dml_time` timestamp NULL DEFAULT NULL,
  `dml_table` text COLLATE utf8mb4_bin DEFAULT NULL,
  `dml_by` bigint(20) DEFAULT NULL
)
ALTER TABLE `backup`
  ADD PRIMARY KEY (`sl`);

ALTER TABLE `backup`
  MODIFY `sl` double NOT NULL AUTO_INCREMENT;
COMMIT;
```

The following figure 5.1.1 Backup Table

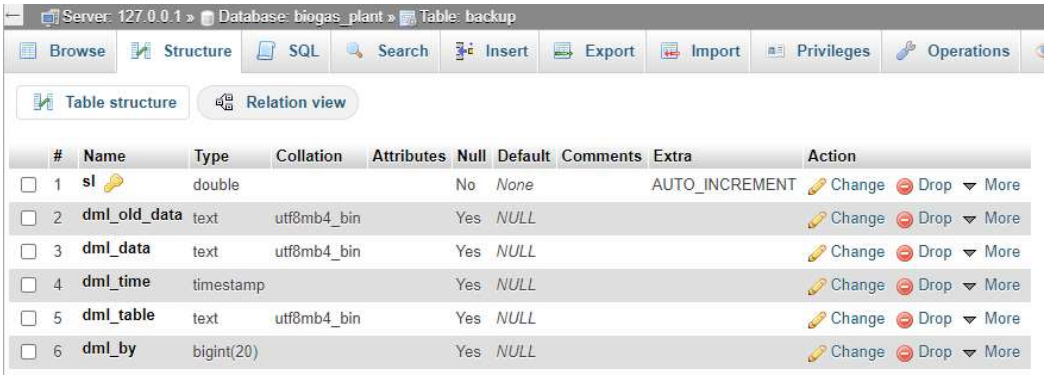


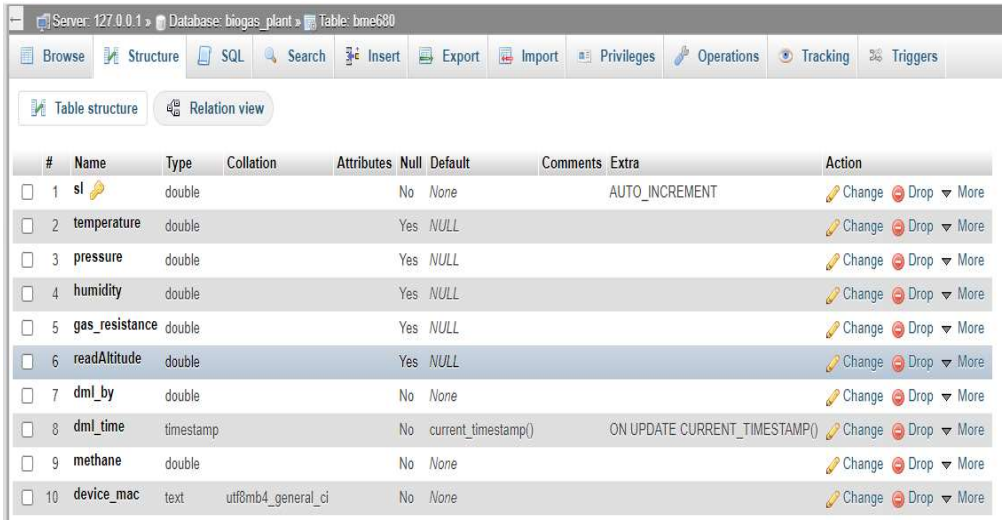
Figure 5.1.1: Backup Table.

```
CREATE TABLE `bme680` (
  `sl` double NOT NULL,
  `temperature` double DEFAULT NULL,
  `pressure` double DEFAULT NULL,
  `humidity` double DEFAULT NULL,
  `gas_resistance` double DEFAULT NULL,
  `readAltitude` double DEFAULT NULL,
  `dml_by` double NOT NULL,
  `dml_time` timestamp NOT NULL DEFAULT current_timestamp() ON
UPDATE current_timestamp(),
  `methane` double NOT NULL,
  `device_mac` text NOT NULL
);

ALTER TABLE `bme680`
  ADD PRIMARY KEY (`sl`);

ALTER TABLE `bme680`
  MODIFY `sl` double NOT NULL AUTO_INCREMENT;
COMMIT;
```

The following figure 5.1.2 bme680 table



#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	sl	double			No	None		AUTO_INCREMENT	Change Drop More
2	temperature	double			Yes	NULL			Change Drop More
3	pressure	double			Yes	NULL			Change Drop More
4	humidity	double			Yes	NULL			Change Drop More
5	gas_resistance	double			Yes	NULL			Change Drop More
6	readAltitude	double			Yes	NULL			Change Drop More
7	dml_by	double			No	None			Change Drop More
8	dml_time	timestamp			No	current_timestamp()		ON UPDATE CURRENT_TIMESTAMP()	Change Drop More
9	methane	double			No	None			Change Drop More
10	device_mac	text	utf8mb4_general_ci		No	None			Change Drop More

Figure 5.1.2: bme680 table.

```
CREATE TABLE `device_info` (
  `sl` double NOT NULL,
  `id` text COLLATE utf8mb4_bin DEFAULT NULL,
  `reset_data` double DEFAULT NULL,
  `re_program` double DEFAULT NULL,
  `password` text COLLATE utf8mb4_bin DEFAULT NULL,
  `dml_time` timestamp NOT NULL DEFAULT current_timestamp() ON
UPDATE current_timestamp(),
  `wifi` int(11) DEFAULT NULL,
  `wifi_ssid` text COLLATE utf8mb4_bin DEFAULT NULL,
  `wifi_password` text COLLATE utf8mb4_bin DEFAULT NULL,
  `name` text COLLATE utf8mb4_bin NOT NULL
);


ALTER TABLE `device_info`
  ADD PRIMARY KEY (`sl`);

ALTER TABLE `device_info`
  MODIFY `sl` double NOT NULL AUTO_INCREMENT;
COMMIT;
```

The following figure 5.1.3 device table

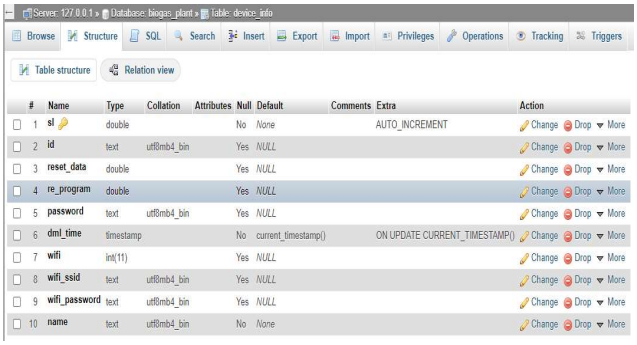


Figure 5.1.3: device table.

```
CREATE TABLE ` user_info ` (
  `sl` double NOT NULL,
  `name` varchar(100) COLLATE utf8mb4_bin DEFAULT NULL,
  `father_name` varchar(100) COLLATE utf8mb4_bin DEFAULT NULL,
  `dob` datetime DEFAULT NULL,
  `current_address` text COLLATE utf8mb4_bin DEFAULT NULL,
  `permanent_address` text COLLATE utf8mb4_bin DEFAULT NULL,
  `phone_sms` varchar(11) COLLATE utf8mb4_bin DEFAULT NULL,
  `dml_time` timestamp NOT NULL DEFAULT current_timestamp() ON
UPDATE current_timestamp()
);
ALTER TABLE `user_info`
  ADD PRIMARY KEY (`sl`);
ALTER TABLE `user_info`
  MODIFY `sl` double NOT NULL AUTO_INCREMENT;
COMMIT;
```

The following figure 5.1.4 user_info table

Figure 5.1.4: user_info table.

```
CREATE TABLE `users` (
  `sl` double NOT NULL,
  `password` varchar(512) COLLATE utf8mb4_bin NOT NULL,
  `active` double DEFAULT NULL,
  `access` double DEFAULT NULL,
  `email` varchar(100) COLLATE utf8mb4_bin NOT NULL,
  `phone` varchar(30) COLLATE utf8mb4_bin NOT NULL
) ENGINE=MyISAM DEFAULT CHARSET=utf8mb4 COLLATE=utf8mb4_bin;

ALTER TABLE `users`
  ADD PRIMARY KEY (`sl`);

ALTER TABLE `users`
  MODIFY `sl` double NOT NULL AUTO_INCREMENT;
COMMIT;
```

The following figure 5.1.5 user table

Figure 5.1.5: user table.

**** **Note**: No relation established between table. Because this action will be handle from application part. *****

5.2 Implementation of Front-end design

The following figure 5.2.1 Full user interface.

Figure 5.2.1: full user interface.

5.3 Testing Implementation

The whole project is tested by following method: -

- Program Testing
- Aim of Testing
- Verification vs Validation
- Design of Test Cases
- Functional Testing Vs. Structural Testing
- Black Box Testing
- White Box Testing

5.3 Testing Results & Reports

TABLE 5.3.1: VERSION HISTORY.

Version #	Implemented By	Revision Date	Approved By	Approval Date	Reason
1.0	Tareq Rahman Jisan	15-02-21	N/A	N/A	For IoT based bio-gas plant
1.3	Tareq Rahman Jisan	28-04-21	N/A	N/A	For IoT based bio-gas plant

Table 5.3.2: System Testing

Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
#1	05-03-21	Tareq Rahman Jisan	Pass			Yes	

Table 5.3.3: User Acceptance Testing

Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
#2	05-03-21	Tareq Rahman Jisan	Pass			Yes	

Table 5.3.4: Performance Testing

Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
#3	05-03-21	Tareq Rahman Jisan	Pass			Yes	

Table 5.3.5: Testing Report

GENERAL INFORMATION			
Test Stage:	☒Unit ☒Functionality ☒Integration ☒System ☒Interface ☒Performance ☒Regression ☒Acceptance ☒Pilot Specify the testing stage for this test case.		
Test Date:	25-04-21	**System Date, if applicable:**	25-04-21
Tester:	Tareq Rahman Jisan.	**Test Case Number:**	#4
Test Case Description:	Before live the project we need to insure sensitive transection must be commit.		
Results:	☒Pass ☐Fail	**Incident Number, if applicable:**	
INTRODUCTION			
Requirement(s) to be tested:	Run Time error		
Roles and Responsibilities:	Work properly		
Set Up Procedures:	Work Properly		
Stop Procedures:	Dynamic UI function's bug not fixed.		
ENVIRONMENTAL NEEDS			
Hardware:	Some bug available		
Software:	Some bug available		
Procedural Requirements:	Need real time update		

TEST	
Test Items and Features:	Work properly
Input Specifications:	Validation work properly.
Procedural Steps:	Dynamic UI function's bug not fixed.
Expected Results of Case:	Result is accurate.
ACTUAL RESULTS	
Output Specifications:	Output accept by users.

CHAPTER 6

Impact on Society, Environment and Sustainability

6.1 Impact on Society

This will help the villagers in meeting the energy needs. The use of state-of-the-art IoT technology with mobile application in rural areas will erode the role of the present government in the exchange of digital Bangladesh.

6.2 Impact on Environment

Most important impact is protecting green environment.

6.3 Ethical Aspects

This project is legal from government side, society side. Also application api is very secure.

6.4 Sustainability Plan

In future the project hardwire will be shift own development board. Database engine will be shift to Oracle.

CHAPTER 7

Conclusion and Future Scope

7.1 Discussion and Conclusion

This project is like a seed for IoT based bio-gas plant. Initially this project ready for production. But there is lots of scope for development. We need motivation and support for better this project.

7.2 Scope for Future Development

Currently this project has no Machine learning or AI based feature. But in future we will include more feature.

Reference:

Websites:

[1] StrongQA, available at <<https://strongqa.com/qa-portal/testing-docs-templates/test-report>>, last accessed on 20-04-21 at 02:41pm.

[1] Guru99, available at <<https://www.guru99.com/how-test-reports-predict-the-success-of-your-testing-project.html>>, last accessed on 22-04-21 at 12:41am.

IoT based automated biogas system

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