Smart Billing System for Water Suppliers

1.INTRODUCTION

1.1.Project Overview

The Smart Billing System for Water Suppliers is a project that will develop and implement a new billing system for water suppliers. The system will use RFID technology to track water usage, generate bills automatically, and provide customers with online access to their billing information. The project is expected to be a valuable investment for water suppliers and will help them improve their operations and provide better service to their customers

1.2.Purpose

The project is expected to be a valuable investment for water suppliers and will help them improve their operations and provide better service to their customers.The project is expected to provide a number of benefits for water suppliers, including:

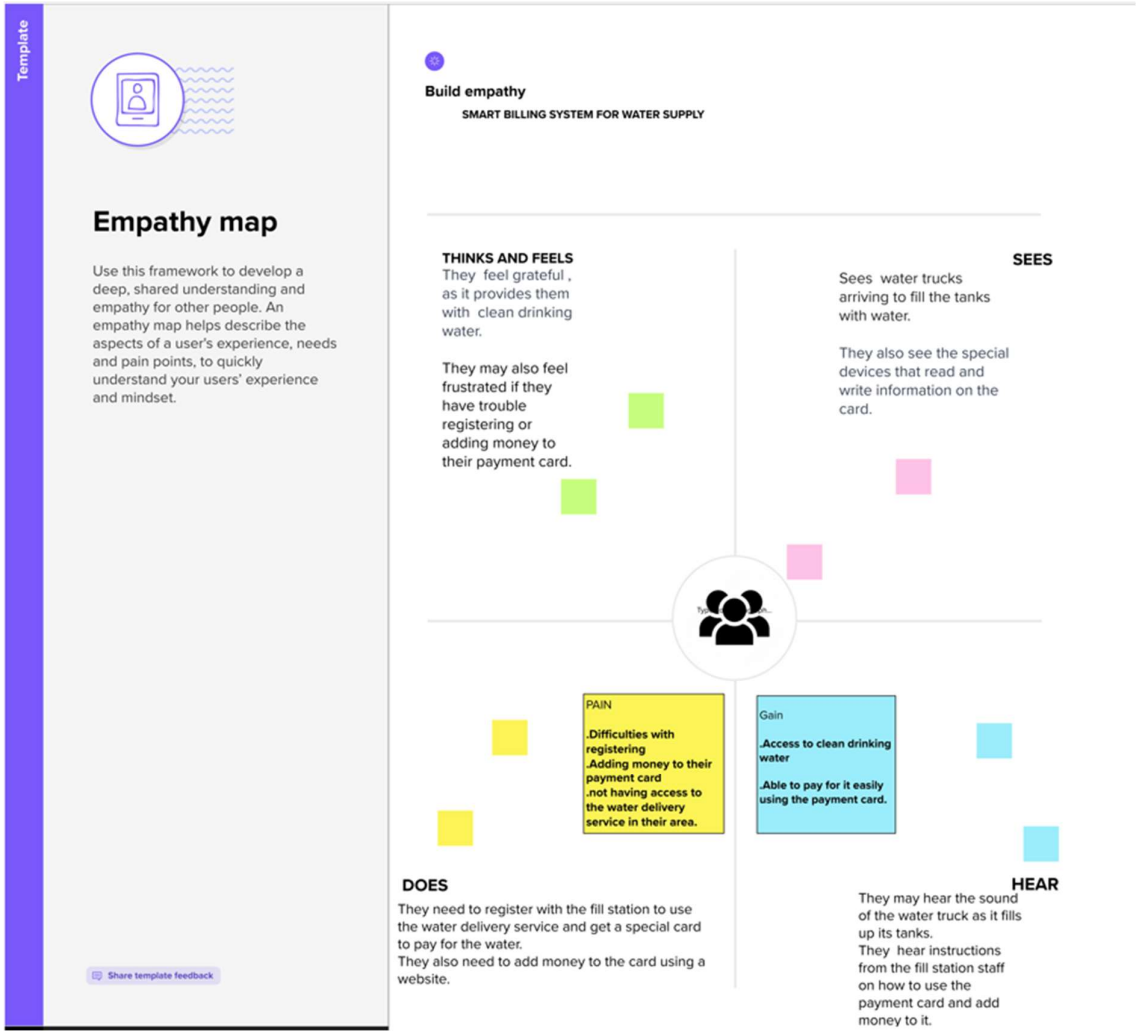
- Increased efficiency and accuracy in billing
- Reduced time and cost of billing
- Improved customer satisfaction
- Increased customer engagement
- Reduced risk of fraud
- Improved compliance with regulations

2.IDEATION & PROPOSED SOLUTION

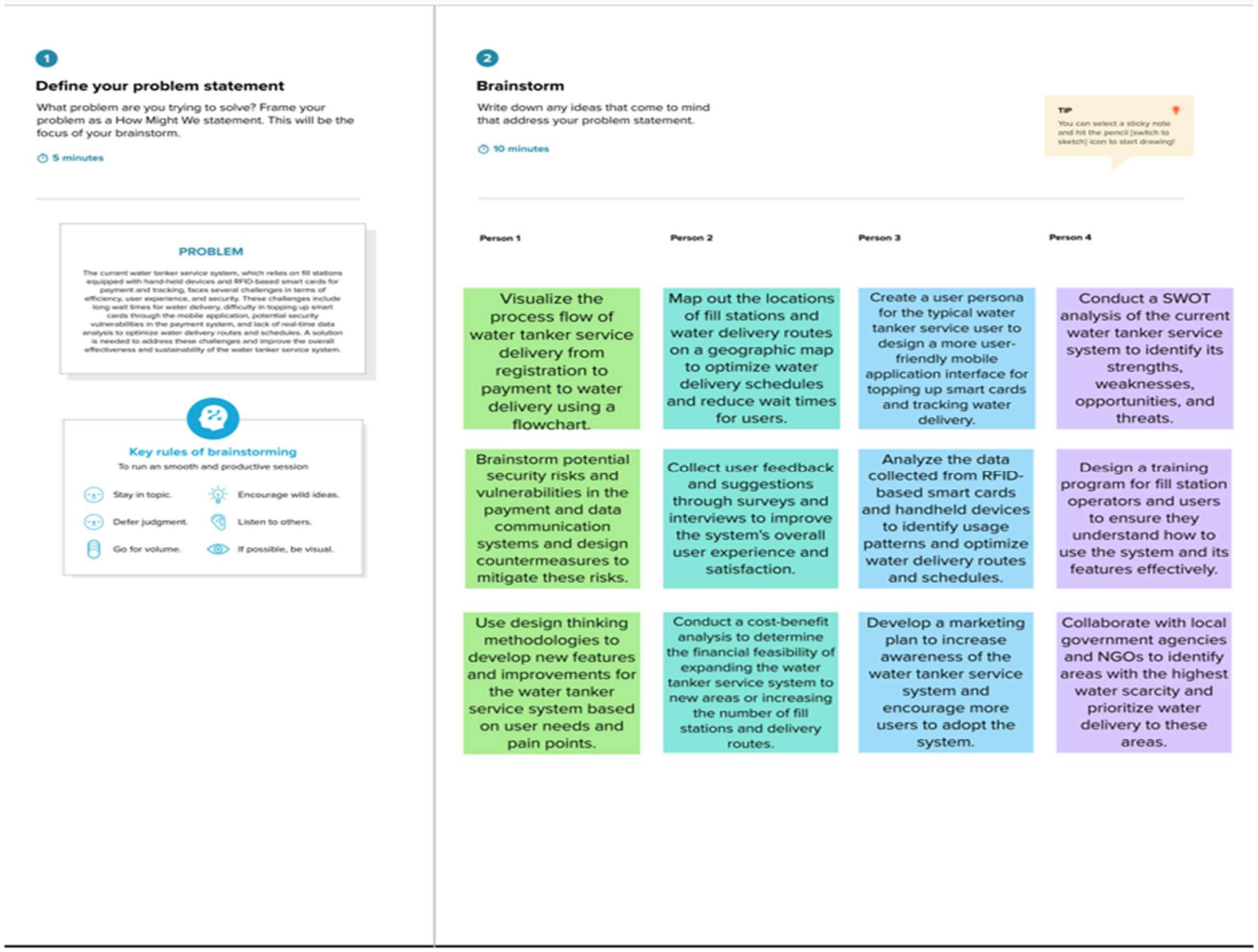
2.1. Problem Statement Definition

Residents are unable to access clean drinking water due to the lack of a proper billing system. The current billing system is cash-based, which makes it difficult for residents to pay their bills. This is frustrating residents and preventing them from accessing clean drinking water.

2.2.Empathy Map Canvas



2.3.Brainstorming & Ideation



1

Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

The current water tanker service system, which relies on fill stations equipped with hand-held devices and RFID-based smart cards for payment and tracking, faces several challenges in terms of efficiency, user experience, and security. These challenges include long wait times for water delivery, difficulty in topping up smart cards through the mobile application, potential security vulnerabilities in the payment system, and lack of real-time data analysis to optimize water delivery routes and schedules. A solution is needed to address these challenges and improve the overall effectiveness and sustainability of the water tanker service system.

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

Person 1	Person 2	Person 3	Person 4
Visualize the process flow of water tanker service delivery from registration to payment to water delivery using a flowchart.	Map out the locations of fill stations and water delivery routes on a geographic map to optimize water delivery schedules and reduce wait times for users.	Create a user persona for the typical water tanker service user to design a more user-friendly mobile application interface for topping up smart cards and tracking water delivery.	Conduct a SWOT analysis of the current water tanker service system to identify its strengths, weaknesses, opportunities, and threats.
Brainstorm potential security risks and vulnerabilities in the payment and data communication systems and design countermeasures to mitigate these risks.	Collect user feedback and suggestions through surveys and interviews to improve the system's overall user experience and satisfaction.	Analyze the data collected from RFID-based smart cards and handheld devices to identify usage patterns and optimize water delivery routes and schedules.	Design a training program for fill station operators and users to ensure they understand how to use the system and its features effectively.
Use design thinking methodologies to develop new features and improvements for the water tanker service system based on user needs and pain points.	Conduct a cost-benefit analysis to determine the financial feasibility of expanding the water tanker service system to new areas or increasing the number of fill stations and delivery routes.	Develop a marketing plan to increase awareness of the water tanker service system and encourage more users to adopt the system.	Collaborate with local government agencies and NGOs to identify areas with the highest water scarcity and prioritize water delivery to these areas.

3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

Developing a loyalty program for regular users, where they can earn rewards and discounts for frequent use.

Adding a feature for users to request water delivery at specific times or dates, such as for a party or event.

Offering different pricing tiers for different amounts of water delivered, such as a bulk discount for larger orders.

Implementing a notification system to alert users when their card balance is running low or when a delivery is on its way.

Developing a mobile app feature for users to rate their experience with each delivery and leave feedback.

Partnering with local schools or community organizations to provide water delivery to those in need.

Creating a referral program where users can refer friends and family and earn credit towards their account.

Creating a feature for users to track their water usage and see how much water they are consuming.

Introducing a subscription-based model for frequent users to automatically receive water delivery on a regular basis.

4

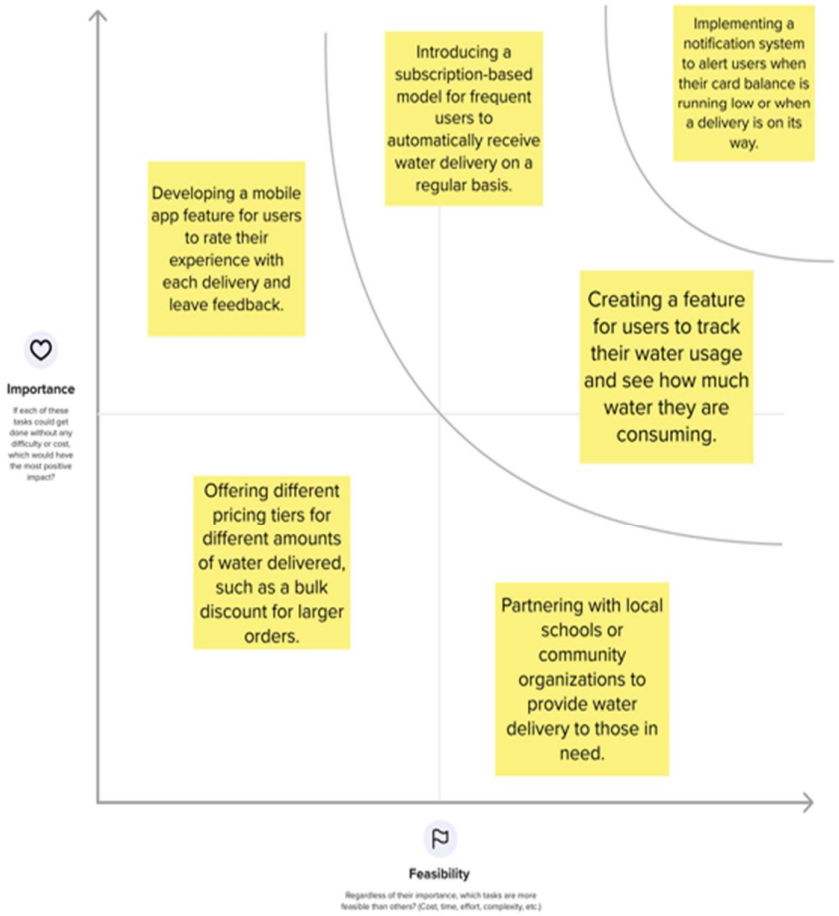
Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

TIP

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the **H key** on the keyboard.



2.4.Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To provide a smart and easy to access water billing system and meet the user's water requirements accordingly.
2.	Idea / Solution description	To enable RFID based smart cards, which allows tankers to be filled easily and a water usage tracking and payment application for the users which allows trouble-free billing system.
3.	Novelty / Uniqueness	The proposed system has a RFID based billing system which makes use of IOT and an analytics system which provides historical usage data to provide customized recommendations to users on how they can save water and reduce their bill.
4.	Social Impact / Customer Satisfaction	A transparent system with timely notifications, accurate billing and an easy-to-use interface would satisfy the customer and all their needs.
5.	Business Model (Revenue Model)	The primary revenue stream for the smart water billing system would come from charging users for their water usage. The system could also generate revenue by offering value-added services, such as personalized water-saving recommendations, for an additional fee.

6.	Scalability of the Solution	The infrastructure such as the RFID scanners and cloud databases and computing algorithms are highly scalable. The customer base can be expanded depending on the number of filling stations and tankers.

3.REQUIREMENT ANALYSIS

3.1.Functional requirement:

Following are the functional requirements of the proposed solution.

User Registration	Registration through Form
User Confirmation	Confirmation via Email
User Booking	Request to book an order for water supply
Tank Filling	When lorry is filling the water tank, the total time taken to fill the tank is monitored and updated into the database.
Bill Display	The total time that was taken along with the pipe speed and motor capacity is used to mathematically calculate the total amount of water supplied. Along with lorry and motor charges the total bill amount is displayed to the user.
Bill payment	The user is able to pay the bill amount through the RFID smart card and is also able to recharge

	the smart card whenever needed.
Usage Statistics	The water usage statistics can be viewed by the user whenever needed. All orders, bills and recharges can also be viewed whenever needed.
View and edit details	The user is allowed to view his profile, edit personal details.
Logout	The user can also logout of their account and login whenever needed.

3.2.Non-Functional requirement:

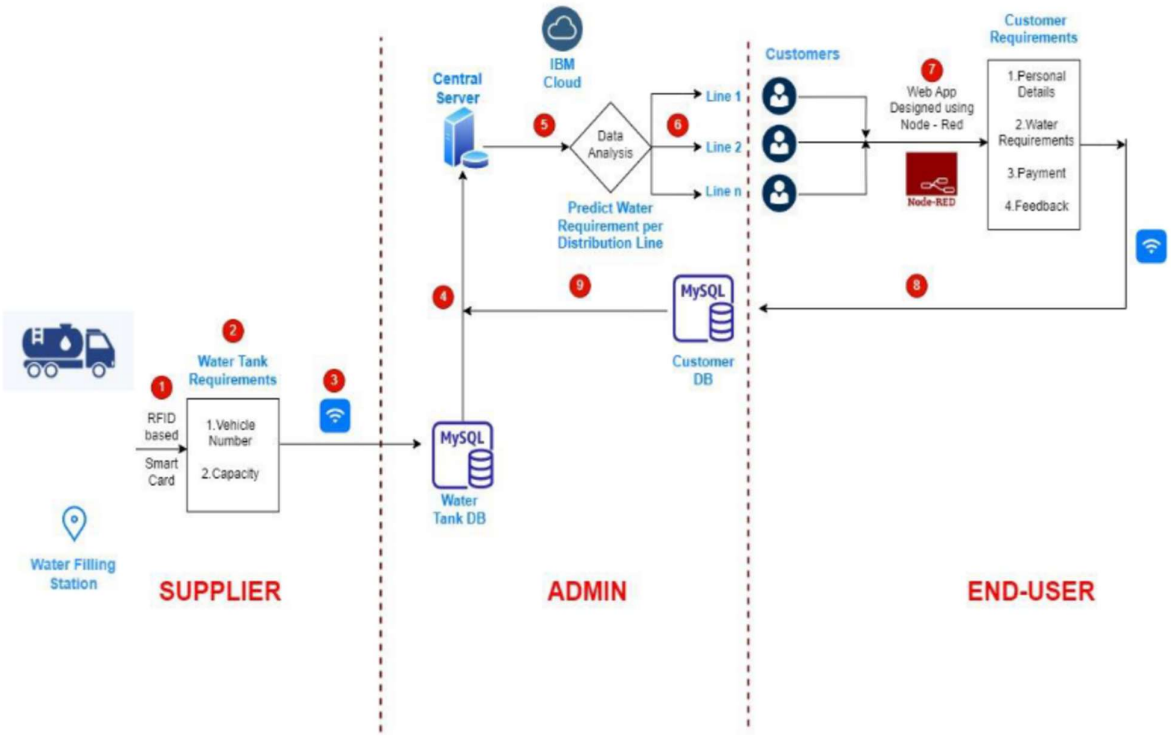
Following are the non- functional requirements of the proposed solution.

Non-Functional Requirement	**Description**
Usability	The application is really easy to use and interact with and it provides an easy water billing system and usage report in seconds.
Security	The data collected is secured and private. The usage report is unique to all users and is not made public. The user is only able to login after password verification and hence the account is accessible only by the user.
Reliability	The application is highly reliable with a secure database to store user data and a backend which processes the water usage of the user and the calculation of the water bill as well.

	The user is able to interact with a dynamic frontend website which displays the bill amount and water usage statistics as well. The application is reloaded in case of a system failure and obtains the data stored in the backend easily.
Performance	The application has a fast response time as the requests are handled quickly and sent to the frontend. Data insertion, updation and retrieval is done easily. Usage analysis is done simultaneously using python and hence the computed data is quickly sent to the frontend as well.
Availability	The requests sent to the backend are processed accurately and data retrieval is done accordingly as well. The system is ensured to work without any system failures as much as possible.
Scalability	The system is highly scalable. The water supplying system can be expanded to more regions and the database and processing servers can be scaled easily. As more and more users add on, the system infrastructure can be scaled to handle more users as well.

4.PROJECT DESIGN

4.1.Data Flow Diagrams



1. The supplier have a RFID card, using which they fill their details.

2. The filled data will be transferred to Water Tank DB, which is then transferred to Central Server.

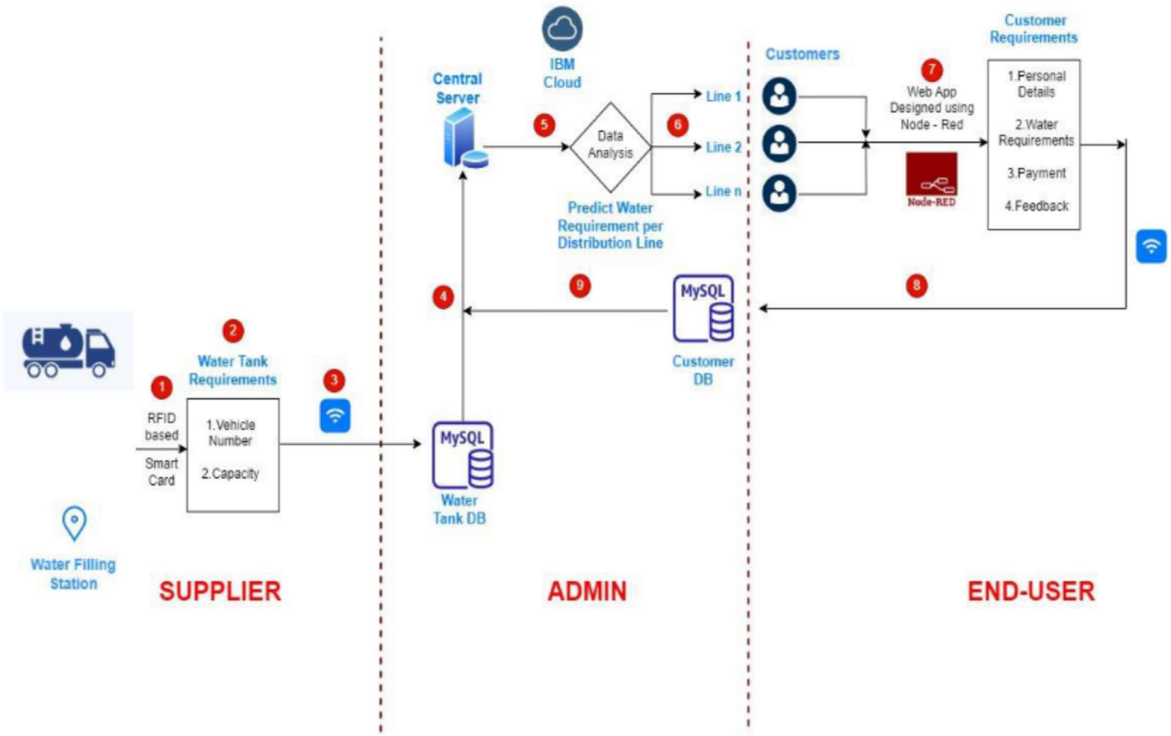
3. Each customer fill their details and makes request for water supply.

4. Now the Data Analysis phase occurs, where the transaction histories and customer statistics are analyzed and displayed in website developed by Node Red.

5. The entered data is then moved into Customer DB and further into Central Server.

6. Water is now supplied by the supplier, bill is generated and customer makes the payment using RFID Smart Card

4.2.Solution & Technical Architecture



4.3.User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Team Member
Customer (Webuser)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sanjay
		USN-2	As a user, I will receive confirmationemail once I have registered for the application	I can receive confirmation email& click confirm	High	Sanjay
	Login	USN-3	As a user, I can log into the applicationby entering email & password	I can login and view my dashboard	High	Sanjay
	Dashboard	USN-4	As a user I can view my profile, book orders for water supply, view my water usage analytics and view my wallet aswell.	I can view profile, water usagesuggestions and view and recharge wallet	High	Deepak
	Profile	USN-5	As a user I can see my profile details,update it, edit my details etc.	I can see my personal details displayed and it can be updatedtoo.	High	Deepak
	Book Orders	USN-6	As a user I can make a booking forwater supply.	I can book an order after whichthe supplier arrives with the water lorry.	High	Deepak
	Water usage statistics	USN-7	As a user I can see my water usage graphs and recommendations regardingmy usage.	I can view my usage analytics how much water I spend in a specified time (Eg. Weekly) and make use of the suggestions.	Low	Shrish

	Wallet	USN-8	As a user, I can view my wallet, myremaining balance and options to recharge as well.	I am able to see my balance andrecharge it.	High	Shrish
Supplier	Registration	USN-9	As a water supplier, I can register for theapplication by entering my email, password, and confirming my password, details about lorry capacity and pipediameter.	I can access my account / dashboard	High	Jeffrey

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Team Member
	Login	USN-10	As a water supplier, I can log into theapplication by entering email & password	I can view my profile, dashboardetc.	High	Jeffrey
	Incoming orders	USN-11	As a water supplier, I can view see incoming requests for orders and buttons for accepting orders.	I can either accept or deny theorder.	High	Deepak
	Lorry Filling	USN-12	I can fill my lorry with water from locations and pay a bill through rfid cards.	I can obtain water to carry onwith orders.	High	Shrish
	Profile	USN-13	As a user I can see my profile details, update it, edit my details etc.	I can see my personal details displayed and it can be updated too.	Low	Deepak
Administrator	Login	USN-14	As an admin, I can login with my admin login and password.	I can view admin dashboard	High	Jeffrey

	Dashboard	USN-15	As an admin, I can monitor that requests, replies to the backend takes place smoothly. I can make changes to the database and oversee the application as well.	I have control over the workingof the application. I can make any updates if needed	High	Shrish

5. CODING & SOLUTIONING

5.1. Feature 1

Wokwi Coding for establishing connection between ESP32 based circuit and Node Red based Website

1.Sketch.ino

```
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#define RELAY_PIN 18 // ESP32 pin GIOP18 connected to the IN pin of relay
#include "time.h"
float time1=0;
float motorbill;
void callback(char* subscribetopic, byte* payload, unsigned int payloadLength);

//-------credentials of IBM Accounts------

#define ORG "yzoyjz"//IBM ORGANITION ID
#define DEVICE_TYPE "test"//Device type mentioned in ibm watson IOT Platform
```

```
#define DEVICE_ID "1234" //Device ID mentioned in ibm watson IOT Platform
#define TOKEN "123456789"     //Token
String data3;
float h, t;
const char* ntpServer = "pool.ntp.org";
const long  gmtOffset_sec = 0;
const int   daylightOffset_sec = 3600;

//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server Name
char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type of event perform and format in which data to be
send
char subscribetopic[] = "iot-2/cmd/test/fmt/String";// cmd  REPRESENT command type AND COMMAND IS TEST OF FORMAT STRING
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id



//-------------------------------------
WiFiClient wifiClient; // creating the instance for wificlient
PubSubClient client(server, 1883, callback ,wifiClient);



// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin as an output.
  Serial.begin(115200);
  pinMode(RELAY_PIN, OUTPUT);
  delay(10);
```

```
  Serial.println();
  configTime(gmtOffset_sec, daylightOffset_sec, ntpServer);
  wificonnect();
  mqttconnect();
}

// the loop function runs over and over again forever
void loop() {
 // digitalWrite(RELAY_PIN, HIGH);
  //delay(1000);
  //digitalWrite(RELAY_PIN, LOW);
  //delay(1000);
 // motorbill=random(60,200);
  //motorbill=motorbill*5;
  //delay(1000);
  //PublishData(motorbill);
  if (!client.loop()) {
    mqttconnect();
  }
}

void PublishData(float motorbill) {
  mqttconnect();//function call for connecting to ibm
  /*
     creating the String in in form JSon to update the data to ibm cloud
  */
  String payload = "{\"motorbill\":";
  payload += motorbill;

  payload += "}";
```

```
  Serial.print("Sending payload: ");
  Serial.println(payload);


  if (client.publish(publishTopic, (char*) payload.c_str())) {
    Serial.println("Publish ok");// if it sucessfully upload data on the cloud then it will print publish ok in Serial
monitor or else it will print publish failed
  } else {
    Serial.println("Publish failed");
  }

}

void mqttconnect() {
  if (!client.connected()) {
    Serial.print("Reconnecting client to ");
    Serial.println(server);
    while (!!!client.connect(clientId, authMethod, token)) {
      Serial.print(".");
      delay(500);
    }

     initManagedDevice();
     Serial.println();
  }
}
void wificonnect() //function defination for wificonnect
{
  Serial.println();
  Serial.print("Connecting to ");
```

```
  WiFi.begin("Wokwi-GUEST", "", 6);//passing the wifi credentials to establish the connection
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}

void initManagedDevice() {
  if (client.subscribe(subscribetopic)) {
    Serial.println((subscribetopic));
    Serial.println("subscribe to cmd OK");
  } else {
    Serial.println("subscribe to cmd FAILED");
  }
}

void callback(char* subscribetopic, byte* payload, unsigned int payloadLength)
{


  Serial.print("callback invoked for topic: ");


  Serial.println(subscribetopic);

  for (int i = 0; i < payloadLength; i++) {
```

```
    //Serial.print((char)payload[i]);
    data3 += (char)payload[i];
  }

  Serial.println("data: "+ data3);
  if(data3=="on")
  {
Serial.println(data3);
digitalWrite(RELAY_PIN, HIGH);
PublishData(0);
Serial.println("The time at which the motor is switched on:");
printLocalTime();

time1+=1;

  }

  else if(data3=="off")
  {
  //Serial.print(time1);
Serial.println(data3);
digitalWrite(RELAY_PIN, LOW);
//motorbill=random(60,200);
motorbill=time1*5;
delay(1000);
PublishData(motorbill);
Serial.println("The time at which the motor is switched off:");
printLocalTime();
time1=0;

  }
```

```
data3="";



}
void printLocalTime(){
  struct tm* timeinfo;
  time_t now;
  time(&now);

  timeinfo = localtime(&now);
  Serial.print(timeinfo,"%H:%M:%S");

  /* Serial.println("Hour: ");
  Serial.println(timeinfo, "%H");
  Serial.print("Hour (12 hour format): ");
  Serial.println(timeinfo, "%I");
  Serial.print("Minute: ");
  Serial.println(timeinfo, "%M");
  Serial.print("Second: ");
  Serial.println(timeinfo, "%S");*/


  Serial.println();
}
```

2.Diagram.json

```
{
  "version": 1,
```

```
  "author": "sai charitha challa",
  "editor": "wokwi",
  "parts": [
    { "type": "wokwi-esp32-devkit-v1", "id": "esp", "top": 5.33, "left": -130.67, "attrs": {} },
    { "type": "wokwi-relay-module", "id": "relay1", "top": 136.07, "left": 158.93, "attrs": {} }
  ],
  "connections": [
    [ "esp:TX0", "$serialMonitor:RX", "", [] ],
    [ "esp:RX0", "$serialMonitor:TX", "", [] ],
    [ "relay1:GND", "esp:GND.1", "black", [ "h0" ] ],
    [ "relay1:VCC", "esp:VIN", "red", [ "h-44.76", "v-189", "h-265.33", "v197.33" ] ],
    [ "relay1:IN", "esp:D18", "green", [ "h0" ] ]
  ],
  "dependencies": {}
}
```

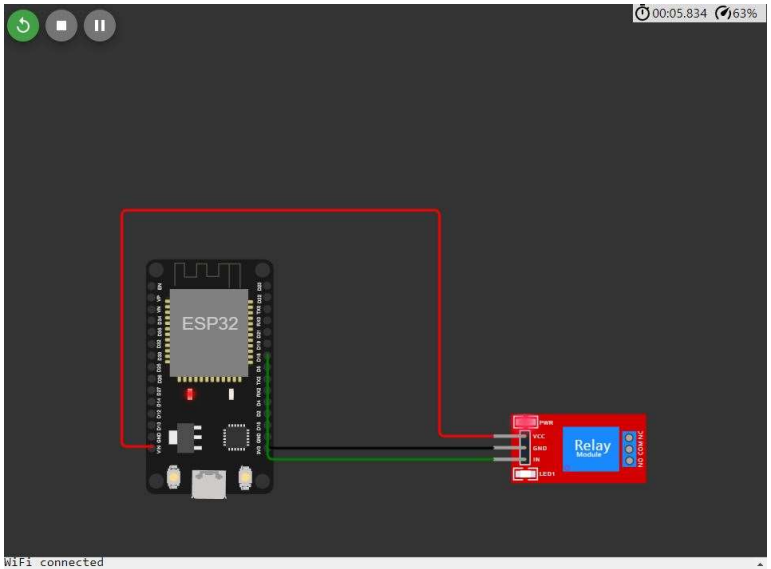
5.2.Feature 2

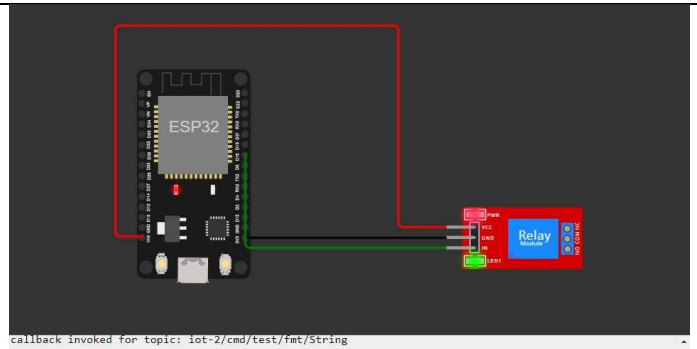
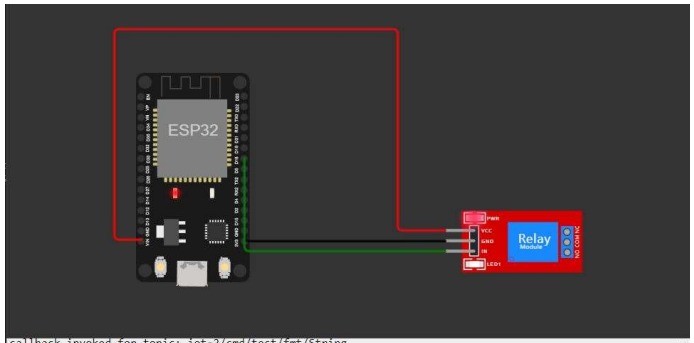
Motor Billing Code in Node-Red

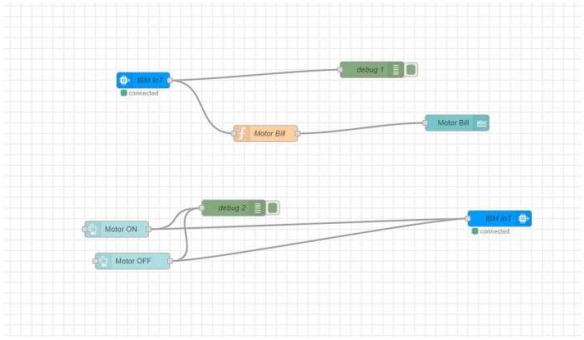
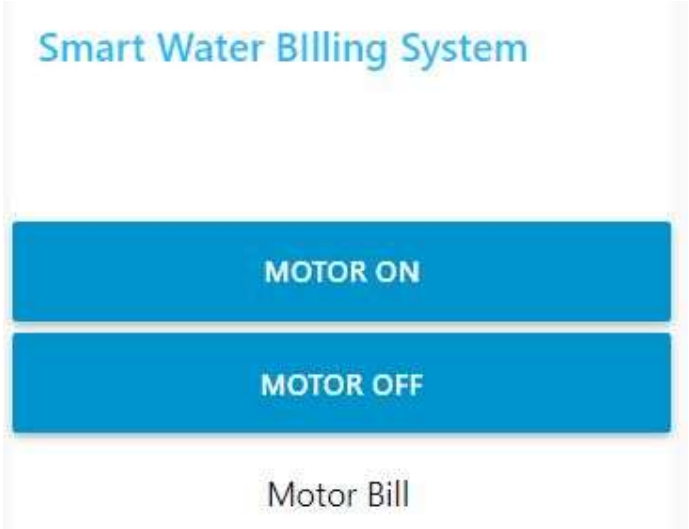
```
msg.payload=msg.payload.motorbill
if(msg.payload==0){
    msg.payload="The motor is switched on!"+"->Billing started"
}
else{
    msg.payload="The motor is switched off!"+"->Elapsed motor bill is:"+msg.payload+"$";
}
return msg;
```

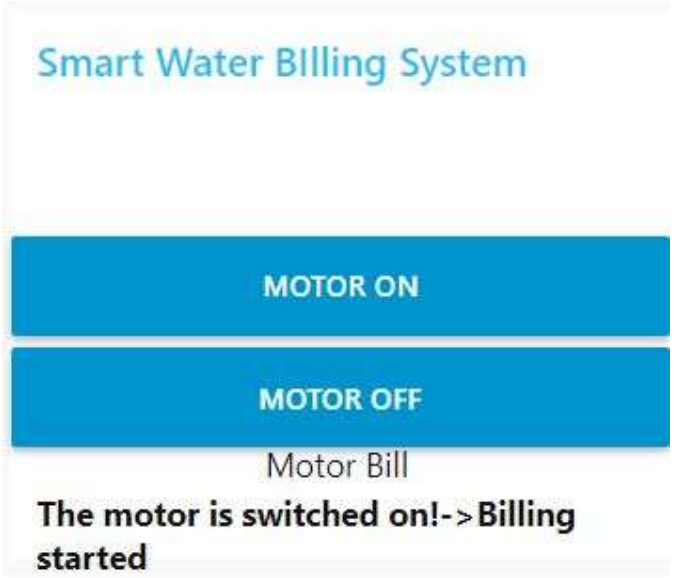
6. Results

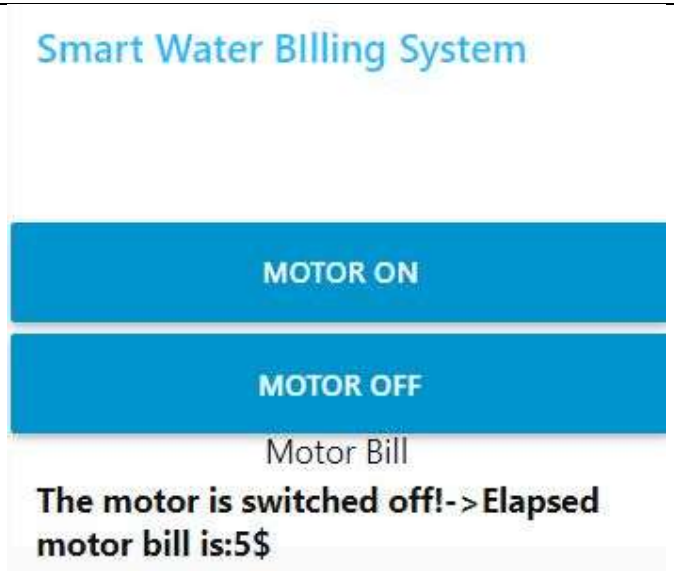
6.1.Performance Metrics

Parameter	Values	Screenshot
Wokwi	Execution time	

Wokwi	Motor ON	 callback invoked for topic: iot-2/cmd/test/fmt/String data: on on Sending payload: {"motorbill":0.00} Publish ok The time at which the motor is switched on: 12:52:54
Wokwi	Motor OFF	 callback invoked for topic: iot-2/cmd/test/fmt/String data: off off Sending payload: {"motorbill":5.00} Publish ok The time at which the motor is switched off: 12:53:09

Flow Diagram	Connections in Node Red	
Web App	Home Screen	

Web App	Motor ON	

Web App	Motor OFF	

7. ADVANTAGES & DISADVANTAGES

The smart billing system can accurately measure water consumption, eliminating errors that may occur in manual readings or estimations. This ensures that customers are billed correctly, reducing disputes and improving customer satisfaction. It can provide real-time data on water usage, allowing both customers and utility providers to monitor consumption patterns. This enables proactive management of water resources and early detection of leaks or abnormalities, leading to quicker resolutions and reduced water wastage. With the smart billing system, customers can access detailed information about their water usage, including historical consumption patterns, through user-friendly interfaces such as online portals or mobile applications. This transparency fosters better understanding and awareness of water consumption, encouraging conservation efforts. The system also enables remote reading of water usage data, eliminating the need for personnel to physically visit customer premises. This reduces operational costs, minimizes the risk of errors or inaccuracies, and improves overall efficiency. The Smart billing system provide a platform for implementing flexible pricing structures such as peak and off-peak rates, encouraging customers to shift their water usage to non-peak hours. Additionally, incentives such as rebates or discounts can be offered to customers who actively conserve water, promoting sustainable water management practices. By promoting awareness and facilitating efficient water management, smart billing systems contribute to reducing overall water consumption and conserving natural resources. This has a positive impact on the environment by preserving water sources and reducing energy consumption associated with water treatment and distribution.

Implementing the smart water billing system can require significant upfront costs. This includes the installation of smart meters, communication infrastructure, and data management systems. The expenses associated with this setup may pose a financial burden, particularly for small water utility companies or individual households. Privacy and data security concerns: The system relies on the collection and transmission of detailed consumption data. This data can be sensitive and may raise privacy concerns if not adequately protected. Any breach in data security could compromise the personal information of consumers or their water usage patterns, potentially leading to privacy violations or unauthorized access to sensitive data. It depends on reliable communication networks and infrastructure. Issues such as network outages, connectivity problems, or software glitches can disrupt the accurate collection and transmission of data. If not addressed promptly, these technological challenges can result in billing errors or delays,

causing inconvenience for both consumers and utility companies. The system may not be accessible or user-friendly for all consumers. Older adults or those with limited technological literacy might find it challenging to interact with the system or understand the data provided. This can create barriers and make it difficult for certain segments of the population to participate fully in the system or take advantage of its benefits. While the system can help promote water conservation, they may also exacerbate existing inequalities. Some individuals or households may not have the financial means to invest in the necessary technology or adapt their water usage patterns based on the detailed data provided. This can create a disparity in the ability to manage and control water consumption, potentially burdening economically disadvantaged communities.

8. CONCLUSION

In conclusion, the development and implementation of a smart billing system for water supplies present numerous advantages and benefits for both utility providers and consumers. By leveraging advanced technologies such as smart meters, real-time monitoring, and automated billing, the system ensures accuracy, transparency, and efficiency in the billing process. Moreover, the system promotes better water management practices by enabling customers to access detailed usage information, facilitating leak detection, and encouraging conservation efforts. The availability of data analytics and remote meter reading further enhances operational efficiency while reducing costs. Ultimately, the smart billing system not only improves customer satisfaction but also contributes to sustainable water resource management and environmental conservation. As we move towards a more connected and efficient future, the implementation of smart billing systems for water supplies becomes an essential step in optimizing operations, enhancing customer experiences, and preserving our precious water resources.

9. FUTURE SCOPE

The Internet of Things (IoT) and sensor technologies can enhance the capabilities of the smart billing system. By deploying additional sensors throughout the water distribution network, it becomes possible to gather more detailed data on water quality, pressure levels, and system performance. This information can be utilized to improve maintenance, identify potential issues, and ensure the overall health of the water supply infrastructure. Leveraging

advanced analytics techniques, such as machine learning and data mining, can enable predictive modeling and forecasting of water usage patterns. By analyzing historical data and considering various factors like weather patterns, population growth, and economic trends, utility providers can make more accurate predictions about future demand, allowing for better planning and resource allocation. The smart billing system can be extended to include features that actively promote water conservation among consumers. This can involve personalized water usage recommendations, real-time alerts for excessive usage, and gamification elements to incentivize conservation efforts. The system could also provide actionable insights and tips for reducing water consumption based on individual usage patterns. Integrating the smart billing system with smart home devices, such as intelligent water fixtures and appliances, can provide a more holistic approach to water management. By connecting these devices to the billing system, customers can have real-time visibility into their water usage and receive notifications or automatic adjustments to optimize consumption. Developing user-friendly mobile applications can empower customers to actively monitor their water usage, view bills, and access educational resources on water conservation. Additionally, integrating customer feedback mechanisms and implementing responsive customer support channels can enhance overall customer engagement and satisfaction.

10. APPENDIX

GitHub & Project Video Demo Link

Github: https://github.com/naanmudhalvan-SI/PBL-NT-GP--7639-1681100587

Video Demo Link: https://drive.google.com/file/d/1bbfnsDz1pRWeuAx4cZ-Qh76DaTJz5HLp/view