PROJECT REPORT

1.INTRODUCTION:

Project Overview:

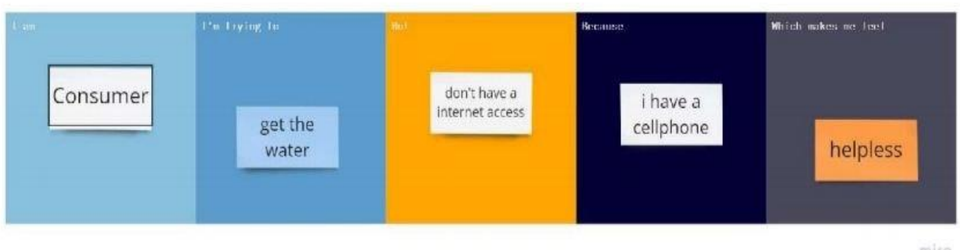
A water billing system is a software or process designed to manage and calculate charges for water usage in residential, commercial, or industrial settings. It is used by water utilities or service providers to accurately bill customers based on their water consumption.The primary goal of a water billing system is to streamline the billing process, automate calculations, and ensure accurate invoicing for water services. The system maintains a database of customer information, including names, addresses, contact details, and billing history. This information is crucial for accurate billing and customer communication.Water usage is typically measured using water meters installed at customer locations. The billing system collects meter readings either manually or through automated meter reading (AMR) technology. AMR systems use various technologies such as radio frequency or cellular communication to remotely collect meter data.The billing system calculates the water consumption based on the meter readings. It takes into account factors such as the previous reading, current reading, and the billing period to determine the volume of water used by each customer.

Purpose:

The purpose of a water billing system is to efficiently and accurately manage the billing process for water services provided by water utilities or service providers.The primary purpose of a water billing system is to ensure accurate and fair billing for water consumption. By automating the calculation of water usage based on meter readings and applying the appropriate tariff rates, the system helps eliminate errors and discrepancies in the billing process.Water utilities rely on the revenue generated from water billing to fund their operations and infrastructure maintenance. The billing system facilitates timely and efficient collection of payments from customers, ensuring a steady cash flow for the utility.

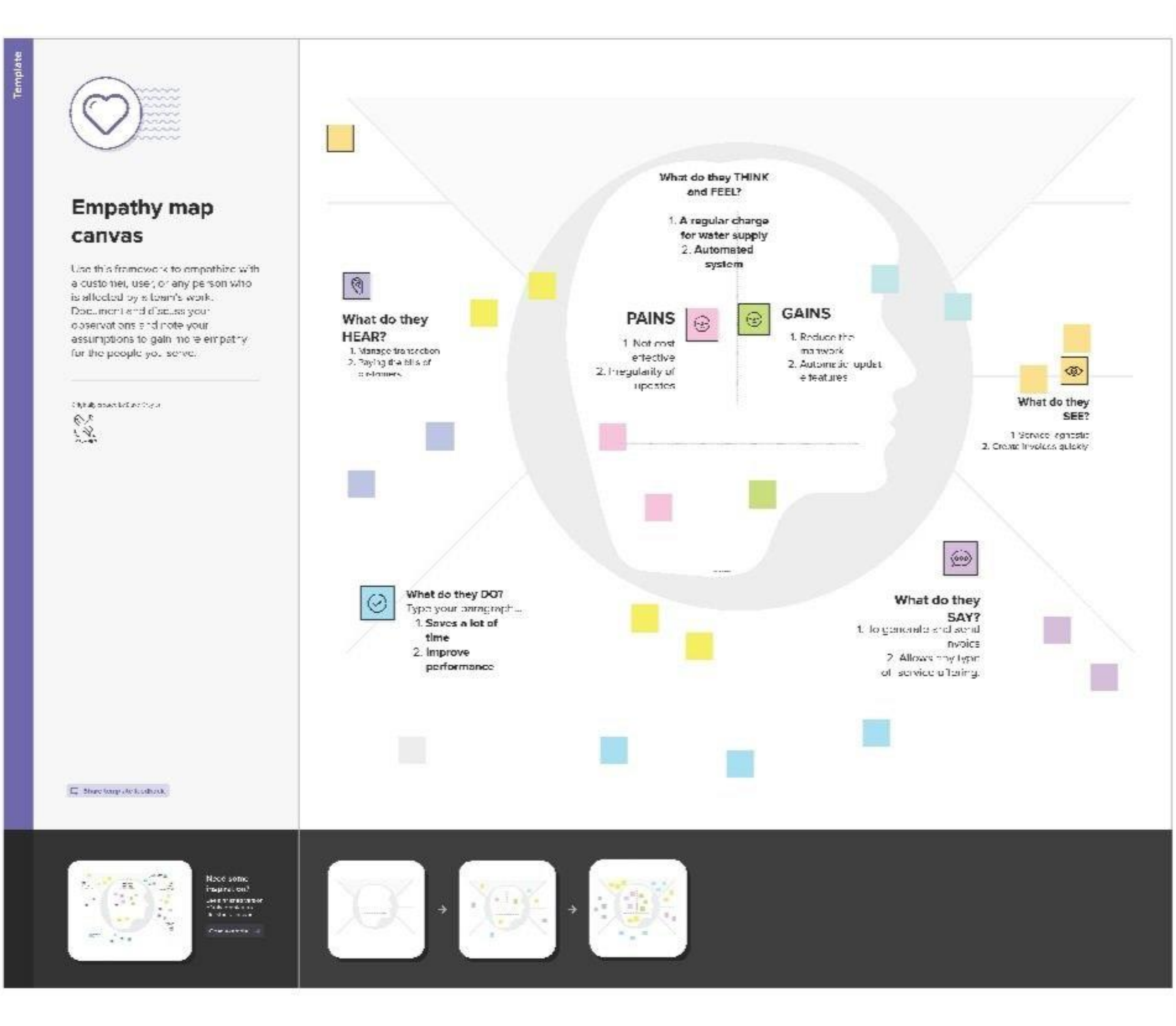
2.IDEATION & PROPOSED SOLUTION:

Problem Statement Definition:



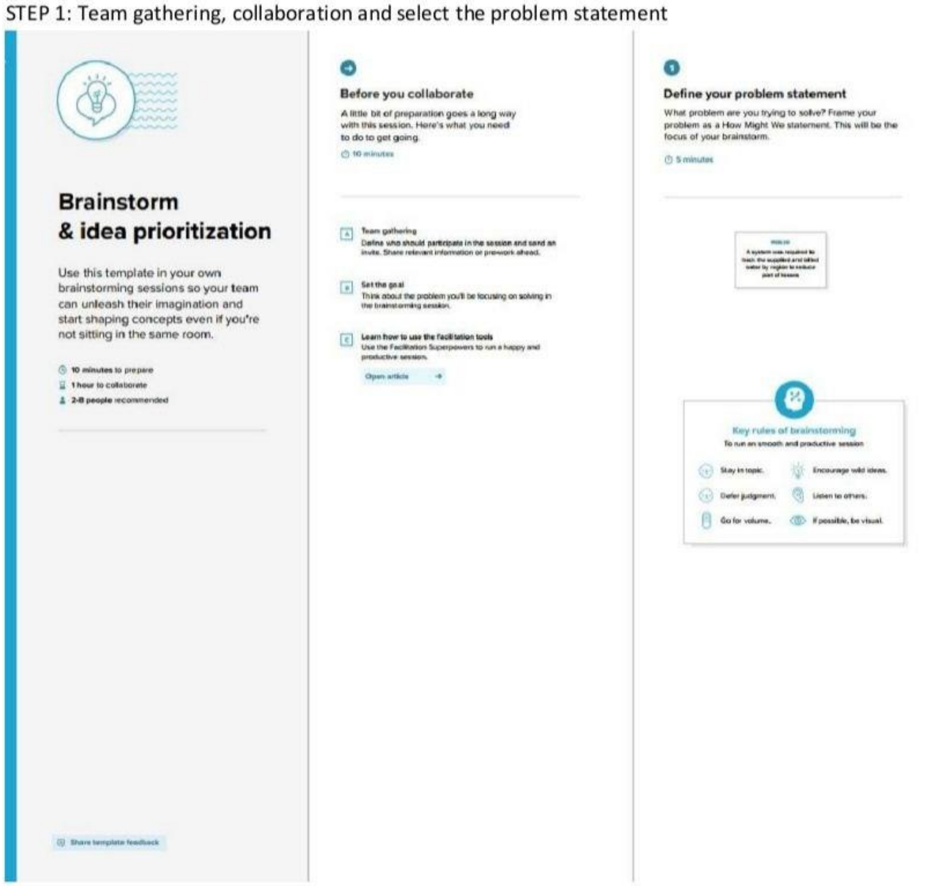
Problem statement(PS)	I am (customer)	I'm trying to	but	because	Which makes me feel
PS-1	Customer	Get the water	It costs	automated	frustrated
PS-2	Consumer	Get the water	Don't have a internet access	I have a cell phone	helpless

Empathy Map Canvas:



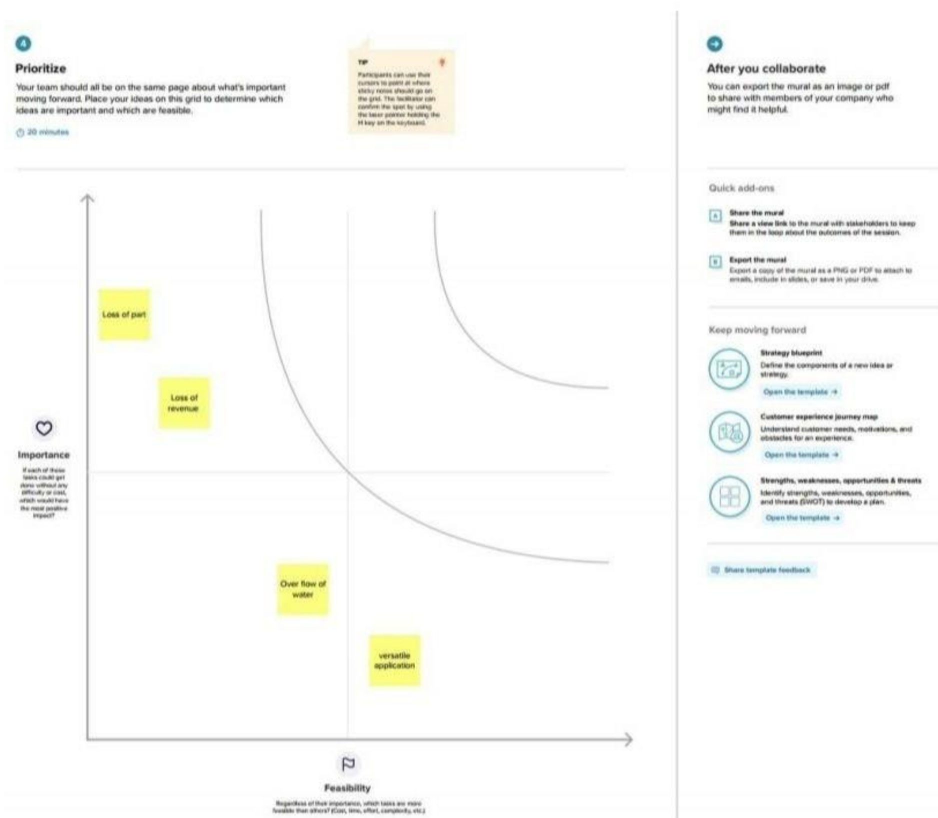
Ideation & Brainstorming:

STEP 1: Team gathering, collaboration and select the problem statement



STEP 2:Brainstrom,idea listing and grouping.

Step 3:Idea prioritization:



Proposed Solution:

Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No	Parameter	Description
1.	Problem Statement (Problem to be solved)	Nowadays several fill stations are set up across the cities to operate water tanker service delivering water to all the local households.
2.	Idea/Solution description	These hand-held devices have the facility to read/write into RFID based smart cards as well as WIFI modem to communicate with the central server over the cloud.
3.	Novelty/Uniqueness	This data can then be viewed by the users on their respective mobile applications connected to the cloud.
4.	Social Impact/Customer Satisfaction	The requirements and satisfaction of customers are low on priority in government owned organizations, mainly due to lack of professional approach in customer services.
5.	Business Model (Revenue Model)	social business model can be understood as a business model whose factors that stimulate development include social aspects expressed in balancing economic, environmental, and social issues with the involvement of communities and their dynamic communication focused on the selected attributes of business models that stimulate growth and that are conducive to achieving success, expressed by economic and/or social profit.
6.	Scalability of the Solution	The presence of scaling in water systems at power plants, heating, and cooling plants, and other process facilities can reduce plant efficiency by blocking flow and reducing heat transfer capabilities of piping systems.

3.REQUIREMENT ANALYSIS:

FUNCTIONAL REQUIREMENTS:

Following are the functional requirements of the Proposed Solution:

FR.NO	FUNCTIONAL REQUIREMENT (EPIC)	SUB REQUIREMENT (STORY/SUB-TASK)
FR-1	Data Collection	Data Collection: The system should be able to collect data about street conditions, including road surface quality, potholes, cracks, uneven surfaces, and other relevant parameters. This can be done through various means such as sensors, cameras, or crowdsourcing.
FR-2	Sensor Integration	Sensor Integration: If sensors are used for data collection, the system should support integration with different types of sensors capable of measuring street quality. This may include accelerometers, vibration

		sensors, GPS, or other relevant technologies.
FR-3	Data Processing and Analysis	Data Processing and Analysis: The collected data should be processed and analyzed to assess the quality of the street. This may involve techniques such as signal processing, image recognition, machine learning algorithms, or statistical analysis.
FR-4	Street Quality Identification	Street Quality Assessment: The system should provide an accurate assessment of the street quality based on the collected data. It should be able to identify and categorize different types of street defects, such as potholes, cracks, or bumps, and assign a severity level to each identified issue.
FR-5	Real-time Monitoring	Real-time Monitoring: The system should be capable of providing real-time monitoring of street conditions. It should detect and report changes in street quality promptly to enable timely maintenance or repair actions.
FR-6	Visualization and Reporting	Visualization and Reporting: The system should have a user-friendly interface that allows stakeholders to visualize the street quality data and reports. It should provide clear and understandable representations of the street conditions, such as maps, charts, or graphs.
FR-7	Mobile Application	Mobile Application or Web Interface: To enable widespread participation and engagement, the system should have a mobile application or web interface that allows users to report street quality issues they encounter. This would enhance data

		collection and provide valuable input from the community.
FR-8	Historical Data Analysis	Historical Data Analysis: The system should store historical data about street quality to enable long-term analysis and trend identification. This information can be used to assess the effectiveness of maintenance activities over time and make data-driven decisions for future improvements.

NON-FUNCTIONAL REQUIREMENTS:

Following are the Non-functional requirements of the Proposed Solution :

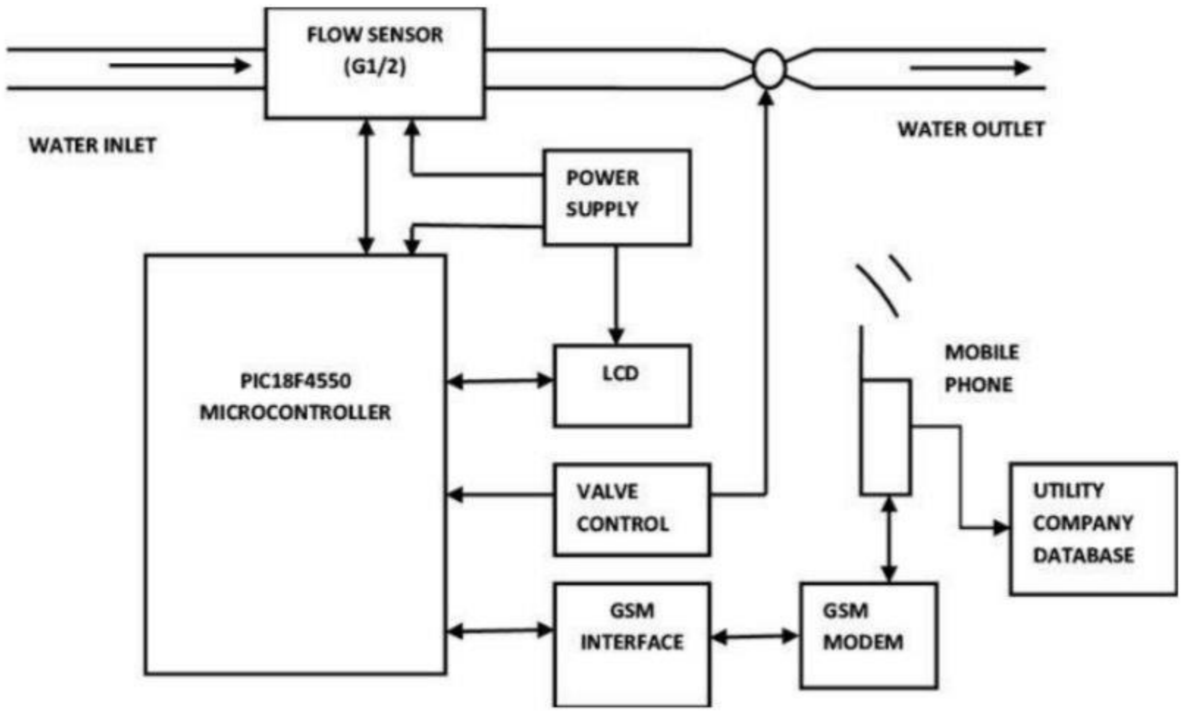
NFR	Non-Functional Requirement	Description
NFR-1	Accuracy and Precision	Accuracy and Precision: The system should aim to provide accurate and precise street quality assessments. The measurements and analysis should be reliable and consistent, ensuring that identified issues reflect the actual condition of the streets.

NFR-2	Real -Time Performance	Real-time Performance: The system should be designed to provide real-time or near real-time performance. This means that data collection, processing, and analysis should be efficient and responsive, enabling timely identification and reporting of street quality issues.
NFR-3	Scalability	Scalability: The system should be able to handle a large volume of data and accommodate future growth. It should be scalable to handle increasing numbers of users, data sources, and geographic areas without sacrificing performance.
NFR-4	Reliability and Availability	Reliability and Availability: The system should be highly reliable and available to ensure uninterrupted street quality monitoring. It should have minimal downtime and robust mechanisms to handle system failures, ensuring that street quality assessment is consistently available.
NFR-5	Security	Security: Data security and privacy are crucial for a Street Quality Identification project. The system should incorporate appropriate security measures to protect sensitive data, prevent unauthorized access, and comply with relevant regulations.
NFR-6	User Experience	User Experience: The system should provide a user-friendly interface and intuitive interaction to facilitate user engagement. It should be easy to navigate, understand, and use, catering to a wide range of users, including maintenance personnel, local authorities, and the general public.

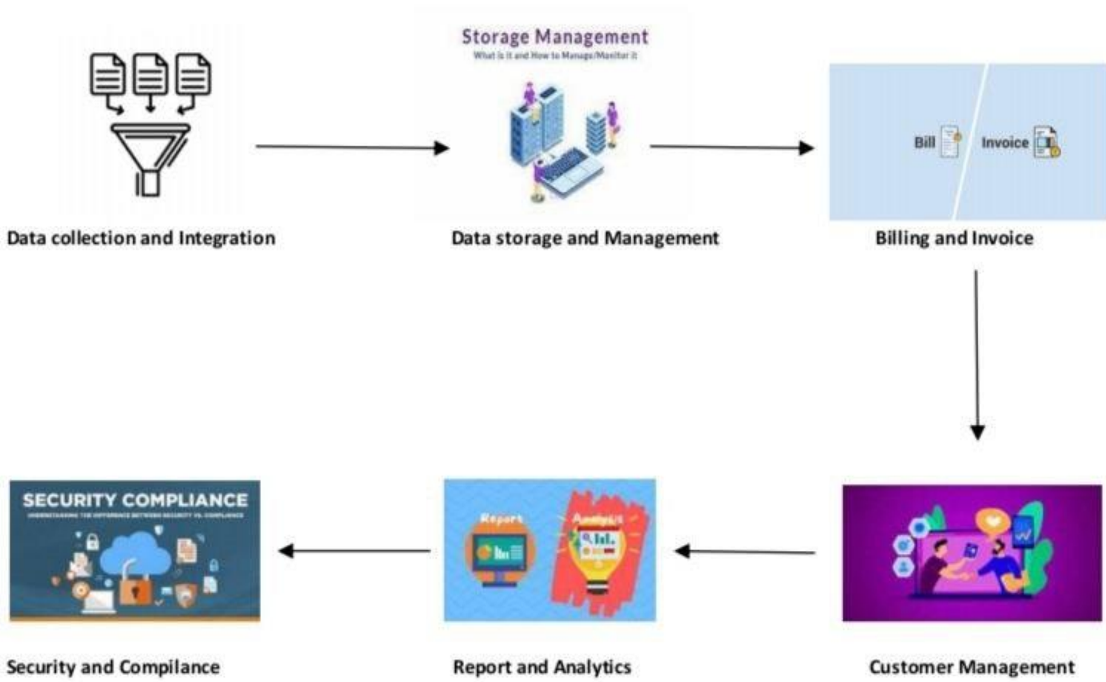
NFR -7	Integration And Interoperability	Integration and Interoperability: The system should be designed to integrate with existing infrastructure and systems, such as maintenance management systems or transportation databases. It should support interoperability standards to enable seamless data exchange and collaboration with other relevant systems.
NFR-8	Adaptability And Flexibility	Adaptability and Flexibility: The system should be adaptable to different geographic locations and street types. It should be capable of handling diverse street conditions, road surfaces, and environmental factors to provide accurate assessments across various contexts.

4.PROJECT DESIGN:

Data Flow Diagram:



Solution Architecture:



Technical Architecture:

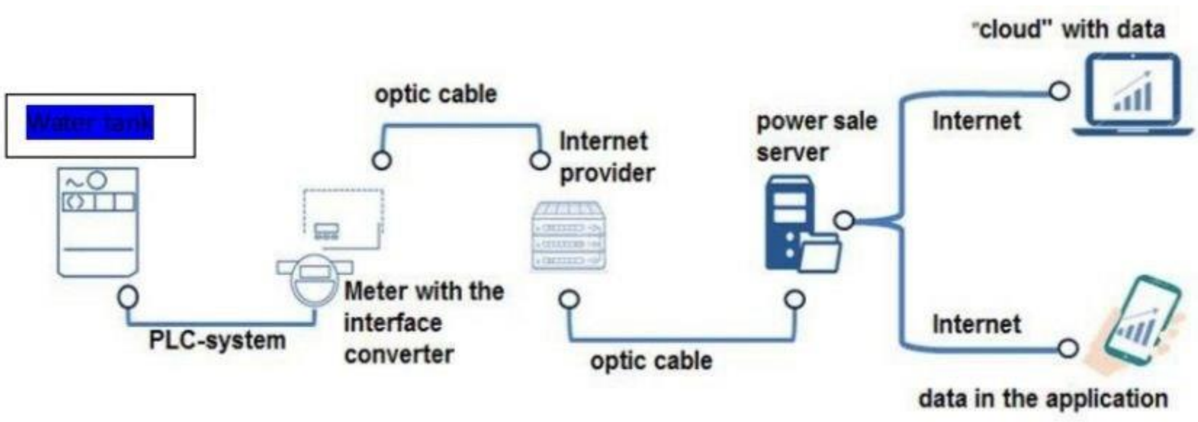


TABLE 1:

Components	Description	Technology
1.Sensors	These are the physical devices responsible collecting data about water passing through a specific area.	Software

2.Data Processing Unit	This component receives the data from the sensors/cameras and processes it to extract relevant information. It may include image processing algorithms or computer vision techniques to identify and track water accurately.	Artificial Intelligence
3.Cloud Platform	Transmit the processed data from the IoT gateway to a cloud platform for further processing, storage, and analysis. Cloud platforms like Amazon Web Services (AWS), Microsoft Azure, or Google Cloud Platform (GCP) provide services for data ingestion, storage, and analytics.	Cloud Service
4.Data Storage	The counted water data and associated metadata are stored in a database or data storage system. This allows for data	Cloud Computing

	retrieval, historical analysis, and reporting.	
5.User Interface	The User Interface maybe web based ,mobile based ,desktop based depending on the specific requirements of the system and alerts them to any issues they may arise.	IBM Watson
6.Monitoring and Alerting	Employ monitoring tools and logging mechanisms to track the system's performance, detect anomalies, and generate alerts in case of failures or deviations from expected behavior.	Web applications include mail
7.Control And Response System	The control and response system is responsible for taking action in response to detected issues.	Nodered
8.Reporting And Analytics	The reporting and analytics system generate reports on water ,that is amount of water.	IOT Platform

Table 2:

APPLICATION CHARACTERISTICS:

Characteristics	Description	Technology
1.Open Source Frameworks	Open source frameworks provides a rich set of functions and algorithms for image processing, including object detection and tracking. OpenCV can be utilized for Water billing by applying computer vision techniques to analyze sensor data.	Tensorflow ,YOLO , Darknet
2.Security Implementations	The system should have appropriate security measures in place to protect the data it collects and stores. It should ensure the confidentiality, integrity, and availability of the data, preventing unauthorized access or tampering	Encryption,IAM,VPN
3.Scalable Architecture	The system should be scalable to handle varying levels of tank volume. It should be able to handle high traffic loads during peak periods without sacrificing performance	Cloud computing

	or accuracy.	
4.Availability	By considering factors like redundancy,fault tolerance, disaster recover plans , upgrades and updates maximize the availability of water billing system , ensuring that it remains operational and accessible to users as needed.	Cloud computing
5.Performance	The system should be designed to process and analyze data in real-time. It should be capable of handling data from multiple sensors simultaneously and provide immediate feedback on the water count.	Internet of Things (IOT) Devices-These devices can includes sensors, cameras and other monitoring equipments.

USER STORIES:

USER TYPE	FUNCTIONAL REQUIREMENT	USER STORY/TASK	ACCEPTANCE CRITERIA	PRIOIRITY
Tenant	Consumes water	The system generates bills or invoices for each customer, typically on a regular billing cycle (e.g., monthly or quarterly). The bills include details such as the customer's name, address, meter reading period, consumption volume, and the total amount due.	Checks easily	High
Passenger	Metro stations	The system performs validation checks on the meter readings to ensure their accuracy and integrity. This includes verifying the data format, identifying outliers or suspicious readings, and flagging any potential issues or errors.	Can be more useful an easier to collect due	High
civilians	Municipality	The system can generate reports and provide insights into consumption patterns, revenue trends, and other key metrics.	Easy to charge	Medium

Workers	**Organisations**	**Based on the validated meter readings and the applicable tariff rates, the system calculates the amount owed by each customer for their water consumption.**	**Consumption by workers in organizations**	**Low**
Patients	**Hospital**	**The received meter readings are stored in a database or data repository. The system maintains a record of historical consumption data for each customer.**	**Hospital purposes**	**Medium**

5. CODING & SOLUTIONING:

• The features added in the project along with the

code are IBM Watson IOT Platform,NodeRed.

• We use Wokwi to stimulate the circuit.

Feature-1:

IBM Watson IOT platform is a fully managed, cloudhosted service with capabilities for device registration,

connectivity, control, rapid visualization and data

storage.we use it to get the captured data from the

device and store it in the dashboard.

Feature-2:

Node-RED is a flow-based development tool for visual

programe for wiring together hardware devices, APIs and

online services as part of the Internet of Things.

6.RESULTS:

Performance Metrics:

<table>
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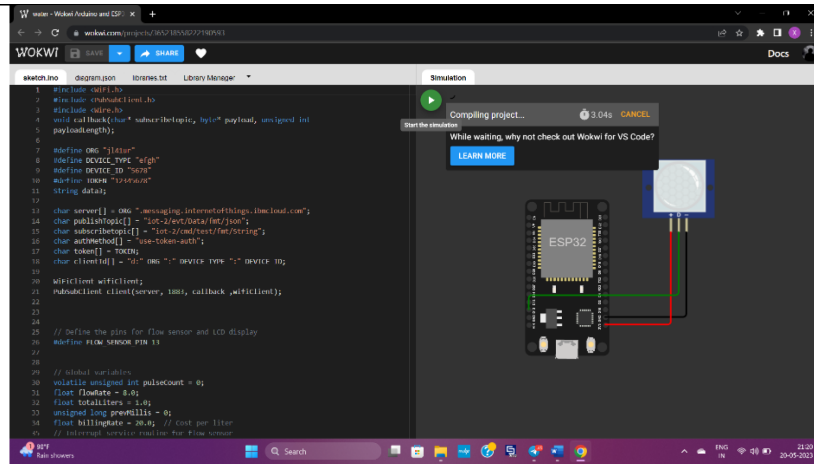
<tr><td rowspan="2">Metrics</td><td>Wokwi execution time: 3.04s</td><td>
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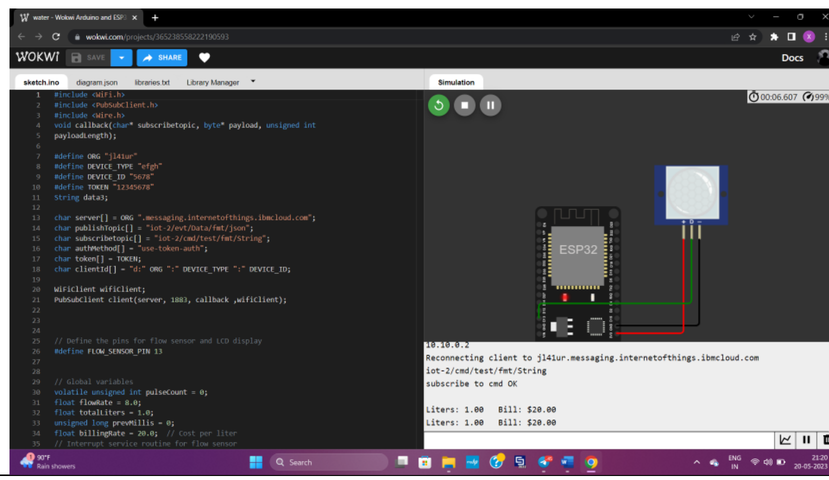
<tr><td>Output screenshot:</td><td>
</td></tr>
</table>

7.ADVANTAGES:

Accuracy: Water billing systems use advanced metering technologies that provide accurate readings of water consumption. This reduces the chances of billing errors and ensures that customers are billed correctly based on their actual usage.

Efficiency: Automated water billing systems streamline the entire billing process, reducing the need for manual data entry and paperwork. This improves efficiency and reduces the time and effort required to generate and distribute bills.

Cost Savings: By automating billing processes, water utilities can reduce administrative costs associated with manual meter reading, data entry, and bill generation. Additionally, accurate billing ensures that customers pay for the water they consume, reducing revenue losses due to underbilling or unpaid bills.

Customer Convenience: Water billing systems often provide online portals or mobile apps where customers can view their consumption data, billing history, and make payments. This enhances customer convenience and allows them to monitor their water usage, detect leaks, and budget their expenses effectively.

Data Analysis: Water billing systems generate valuable consumption data that can be used for data analysis and demand forecasting. This information helps water utilities optimize their operations, identify patterns, and plan infrastructure investments more effectively.

DISADVANTAGES:

Initial Investment: Implementing a water billing system requires an initial investment in hardware, software, and training. This can be a significant cost for smaller water utilities with limited budgets.

Technical Issues: Like any technology-driven system, water billing systems can experience technical glitches, such as meter reading errors or system failures. These issues may require additional time and resources to address, impacting the accuracy and efficiency of the billing process.

Customer Resistance: Some customers may be resistant to the change from traditional billing methods to automated systems. They may face challenges in adapting to new technologies or have concerns about data privacy and security.

Dependency on Infrastructure: Water billing systems rely on robust infrastructure, including smart meters and communication networks, to collect and transmit consumption data. Any disruptions or failures in these components can affect the accuracy and timeliness of billing.

Limited Accessibility: In regions with limited internet connectivity or where customers have limited access to online services, implementing a water billing system may pose challenges. It could exclude certain segments of the population who are unable to use or access the system effectively.

8.CONCLUSION:

A water billing system automates the meter reading and billing process, reducing human errors and ensuring accurate calculations. It streamlines the entire billing cycle, from meter reading to invoice generation, saving time and resources.With a reliable water billing system in place, consumers can have confidence in the accuracy of their bills. It enables transparent and equitable billing based on actual water usage, promoting fairness among users.A well-designed water billing system often includes features such as online bill payment, self-service portals, and mobile apps. These options enhance customer convenience by providing easy access to billing information, payment history, and the ability to report issues or submit meter readings online.Advanced water billing systems may integrate with smart metering technologies, allowing real-time monitoring of water consumption. This helps both consumers and utility providers identify any unusual usage patterns, leaks, or inefficiencies promptly, leading to timely resolutions.Water billing systems can generate detailed reports and analytics based on consumption patterns, trends, and historical data. This information can assist utility providers in optimizing their operations, identifying areas for conservation, and implementing efficient water management strategies.A robust billing system improves revenue management for water utilities. It enables accurate tracking of payments, timely invoicing, and efficient debt collection processes, contributing to financial stability and sustainability.

9.FUTURE SCOPE:

The future scope of water billing systems holds several potential advancements and improvements. Here are some possibilities:

Smart Metering: Water billing systems can integrate with smart meters that provide real-time data on water consumption. These meters can automatically transmit usage information, eliminating the need for manual meter readings and reducing billing errors.

Internet of Things (IoT) Integration: IoT devices can be employed to monitor water usage in homes and businesses. These devices can provide data on water flow, leaks, and usage patterns, enabling more accurate billing and proactive leak detection.

Automated Billing and Payments: Future water billing systems may automate the entire billing and payment process. Bills could be generated automatically based on real-time usage data, and payments could be processed electronically through various channels, including mobile apps, online platforms, and digital wallets.

Data Analytics and Predictive Modeling: Advanced data analytics and predictive modeling techniques can be applied to water usage data. This can help identify patterns, forecast demand, detect anomalies, and optimize water distribution systems. It can also enable dynamic pricing models based on peak and off-peak demand, promoting water conservation.

Water Conservation Initiatives: Water billing systems can play a vital role in promoting water conservation. Future systems may include features such as personalized water usage reports, comparative benchmarks, and incentives for reducing consumption. This can create awareness among consumers and encourage responsible water usage.

Integration with Renewable Energy Sources: Water billing systems could integrate with renewable energy sources, such as solar or wind, to power water treatment and distribution facilities. This synergy can help reduce operational costs, decrease carbon footprint, and contribute to sustainable practices.

Blockchain Technology: Blockchain technology can enhance the security, transparency, and efficiency of water billing systems. It can provide an immutable ledger for recording water usage and transactions, preventing fraud and ensuring accurate billing.

Integration with Smart Cities: Water billing systems can be integrated into broader smart city initiatives, where data from various urban systems is collected and analyzed. This integration can lead to better resource management, improved infrastructure planning, and enhanced quality of life for residents.

Mobile Applications and Customer Engagement: Water billing systems can leverage mobile applications to provide consumers with instant access to their usage data, billing history, and payment options. These apps can also offer water-saving tips, alerts for leaks or unusual consumption, and personalized recommendations to help users manage their water consumption more efficiently.

10.APPENDIX:

Link:

https://wokwi.com/projects/365238558222190593

Source Code:

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>


// Define the I2C address for the LCD display

#define LCD_ADDRESS 0x27
```

```
// Define the pins for flow sensor and LCD display
#define FLOW_SENSOR_PIN 2
#define LCD_COLS 16
#define LCD_ROWS 2

// Global variables
volatile unsigned int pulseCount = 0;
float flowRate = 8.0;
float totalLiters = 1.0;
unsigned long prevMillis = 0;
float billingRate = 20.0;  // Cost per liter

// LCD display object
LiquidCrystal_I2C lcd(LCD_ADDRESS, LCD_COLS, LCD_ROWS);

// Interrupt service routine for flow sensor
void pulseCounter()
{
  pulseCount++;
}

// Setup function
```

```
void setup()

{

  // Initialize LCD display

  lcd.begin(LCD_COLS, LCD_ROWS);

  lcd.print("Water Billing");

  lcd.setCursor(0, 1);

  lcd.print("System");


  // Attach interrupt to flow sensor pin

  attachInterrupt(digitalPinToInterrupt(FLOW_SENSOR_PIN), pulseCounter,
FALLING);


  // Initialize serial communication

  Serial.begin(9600);

}


// Loop function

void loop()

{

  unsigned long currentMillis = millis();

  unsigned long elapsedTime = currentMillis - prevMillis;
```

```
  // Update flow rate every second
  if (elapsedTime >= 1000)
  {
    detachInterrupt(digitalPinToInterrupt(FLOW_SENSOR_PIN));
    flowRate = pulseCount / (elapsedTime / 1000.0);
    pulseCount = 0;
    prevMillis = currentMillis;
    attachInterrupt(digitalPinToInterrupt(FLOW_SENSOR_PIN), pulseCounter,
FALLING);
  }

  // Calculate total liters
  float liters = flowRate / 60.0;
  totalLiters += liters;

  // Calculate bill amount
  float billAmount = totalLiters * billingRate;

  // Display data on LCD
  lcd.setCursor(0, 0);
  lcd.print("Liters: ");
  lcd.print(totalLiters);
```

```
  lcd.setCursor(0, 1);
  lcd.print("Bill: $");
  lcd.print(billAmount, 2);

  // Send data to serial monitor
  Serial.print("Liters: ");
  Serial.print(totalLiters);
  Serial.print("   Bill: $");
  Serial.println(billAmount, 2);

  // Wait for a second
  delay(1000);
}
```