SMART BILLING SYSTEM FOR WATER SUPPLIERS

Date	**19 May 2023**
Team ID	NM2023TMID01199
Project Name	Smart billing system for water suppliers

PREFACE

In today's rapidly advancing digital era, technology continues to reshape various industries, revolutionizing the way we conduct business and deliver services. The water supply sector is no exception to this transformation. As water suppliers face the challenges of efficiently managing resources and providing accurate billing services to consumers, the implementation of a Smart Billing System emerges as a game-changing solution.

This preface introduces the concept and significance of a Smart Billing System tailored specifically for water suppliers. It aims to shed light on the key aspects, benefits, and potential outcomes that can be achieved through the integration of advanced technology into the billing process.

The primary objective of any water supplier is to ensure the consistent delivery of high-quality water while efficiently managing the operational costs and revenue generation. However, traditional billing systems often fall short in meeting these objectives, leading to inaccuracies, inefficiencies, and customer dissatisfaction. The advent of Smart Billing Systems presents an opportunity to address these challenges effectively.

A Smart Billing System for water suppliers utilizes cutting-edge technologies such as Internet of Things (IoT), data analytics, and automation to streamline the billing process, enhance accuracy, and improve customer experiences. By leveraging real-time data from smart water meters, sensors, and advanced monitoring systems, this system enables precise measurement and monitoring of water consumption, leak detection, and usage patterns.

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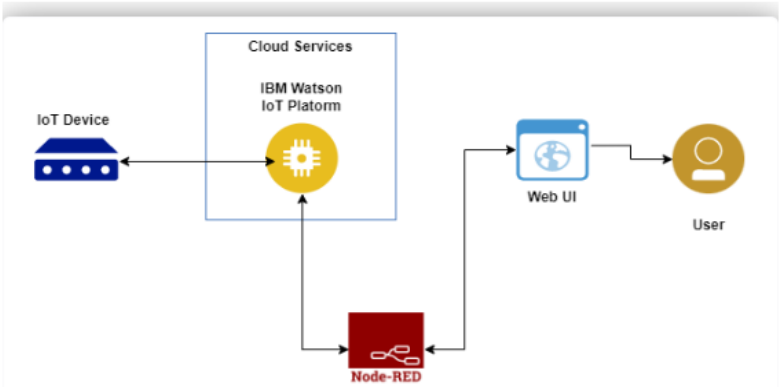
1. INTRODUCTION:

The Internet of Things (IoT) refers to the network of physical devices embedded with sensors, software, and connectivity capabilities that enable them to collect and exchange data over the internet. These devices can range from everyday objects like appliances and vehicles to industrial machinery and infrastructure. Connecting everyday things embedded with electronics, software and sensors to the internet enabling them to collect and exchange data.

1.1. PROJECT OVERVIEW:

Nowadays several fill stations are set up across the cities to operate water tanker service delivering water to all the local households. Tankers get registered and a card is issued for the users which can be used for payments. They can also top-up their card through the mobile application. Each fill station is equipped with hand-held devices (based on the number of pumps in the fill station). 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. This data can then be viewed by the users on their respective mobile applications connected to the cloud.

Technical Architecture:



1.2. PURPOSE:

The purpose of a smart billing system for water suppliers is to streamline and enhance the billing process by leveraging technology and automation. Here are some key purposes and benefits of implementing a smart billing system:

- Accurate and Timely Billing
- Transparency and Customer Empowerment
- Efficient Metering and Data Collection
- Automated Billing
- Revenue Assurance
- Customer Service and Support

Overall, the purpose of a smart billing system for water suppliers is to modernize and improve the billing process, enhance customer experience, optimize revenue management, and promote sustainability and efficiency in the water supply industry.

2. IDEATION AND PROPOSED SOLUTION:

The ideation phase is a crucial step in the process of developing new products, services, or solutions which includes 3 stages namely Defining the Problem Statement, Empathy Map, Brainstorming and idea prioritization.

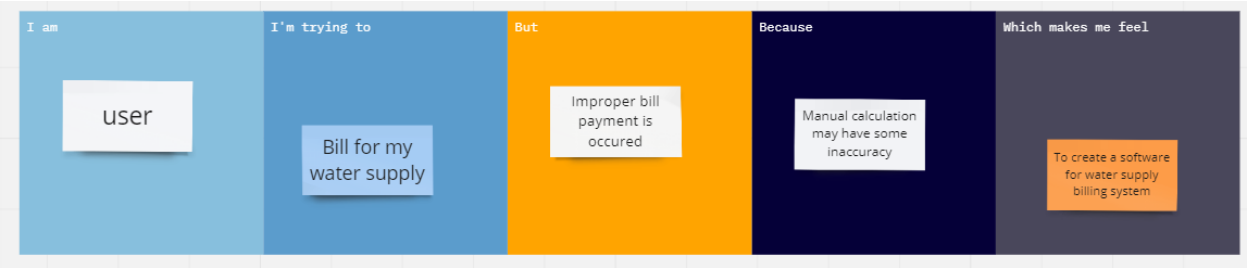
2.1. PROBLEM STATEMENT DEFINITION:

Create a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love.
A well-articulated customer problem statement allows you and your team to find the ideal solution for the challenges your customers face. Throughout the process, you'll also be able to empathize with your customer opinions also.

The various problem statements are defined by the various persons related to water supplies are tabulated below.

Problem Statement (PS)	**I'm a (Customer)**	**I'm trying to**	**but**	**because**	**Which makes me feel**
PS-1	Water supplier	Provide a water for some money	Billing system is not effective	Manual calculations of bill may inaccurate in nature	To create an efficient water billing system for customers
PS-2	User	Buy a water from supplier	Many malpractices are done while paying the bill	Unrecognized charges on payment	Proper way of billing system is necessary.
PS-3	Socialist	Save water	Excessive water usage may lead to water scarcity.	Water usage for domestic purpose like washing clothes, utensils, bathing etc., may lead to run-off water.	To provide a water with some amount of cost. So that, people may use it efficiently and don't waste it unnecessarily.
PS-4	Water Supplier	Utilize all types of customers via online billing.	Reaching offline customers who do not access the internet makes the process difficult	They don't have any internet access at all and proper way of communicatio n is lagging here	A regular charge that is made to those people for the use of their local water supply.

The problem statement in user point of view is represents as



Similarly, The Problem statement in water supplier point of view is shown below.

Reference link:

1. https://miro.com/app/board/uXjVMLDwKcI=/?share_link_id=432138224679
2. https://miro.com/app/board/uXjVMLDwLvQ=/?share_link_id=673506632823

So, using these problem statement definitions, it is clearly seen that is an essential step in problem-solving and project development phase. It helps to articulate the challenge or issue that needs to be addressed.

2.2. EMPATHY MAP CANVAS:

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.It is a useful tool to helps teams better understand their users.

Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

The Empathy map of our project with pain and gain aspects are shown below.

Reference link:

https://app.mural.co/invitation/mural/student8824/1683365629611?sender=ue8654612212f85b546d56901&key=7964cb2c-9018-4a4b-8f5c-c737e37e251c

By completing an empathy map, you gain a deeper understanding of your target users, their needs, and their emotional responses. This understanding helps inform the development of solutions that are more user-centric and effectively address their pain points and desires.

2.3. IDEATION AND BRAINSTORMING:

Brainstorming provides a free and open environment that encourages everyone to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

There are 3 steps in brainstorming and idea prioritization process namely

- Team Gathering, Collaboration and Select the Problem Statement.
- Brainstorm, Idea Listing and Grouping.
- Idea Prioritization

Remember that brainstorming and idea prioritization are iterative processes, and multiple rounds may be needed to refine and narrow down the options. It's important to involve stakeholders and subject matter experts in the process to gather diverse perspectives and ensure comprehensive evaluation.

Reference link:

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The Brainstorming and idea prioritization of this Smart Water billing system is shown below.

The Ideation phase is done for developing the water supply billing system. Now, we move into the Project Solution finding part.

2.4. PROPOSED SOLUTION:

A proposed solution refers to a suggested approach or course of action to address a specific problem or meet a particular need. It is a recommendation or idea put forward as a potential resolution to the identified challenge. These solutions contain six different parameters, that are tabulated below.

S.no	Parameter	Description
1.	Problem Statement (Problem to be solved)	1. Malpractices are occurred while billing. 2. Calculation errors, missing or misapplied payments and unrecognized charges on a statement. 3. Reaching offline customers who do not access the internet which makes the process difficult. These are the problem statements that we need to reduce.
2.	Idea / Solution description	To overcome the above problem, my solution is to create a regular charge that is made to people for the use of their local water supply and simplifies the process of billing by creating an automatic record of all bills and invoices. (An automated system based on paying water bills).
3.	Novelty / Uniqueness	Traditional billing system is not cost-effective to both water supplier and customer. Hence the uniqueness in this Modern billing system idea is 1. Cost-effective 2. Accurate results 3. Reducing man-power 4. Consumption of Time and Effort is low 5. Most flexible

		6. Establishing the good relationship between customer and water suppliers.
4.	Social Impact / Customer Satisfaction	**Social impact:** Water utilities are vital components of any community. Excessive water usage may lead to water scarcity. Increased water usage for domestic purposes like washing clothes, utensils, bathing etc., may lead to run-off of water. Hence, by providing the water for some amount of cost, people may aware to save it and use it efficiently. **Customer Satisfaction:** Proper billing process is achieved without any malfunctions and misleading by the suppliers. The flexible and trustable bill payment technique is created. This satisfies the customer who had face improper and inaccurate billing system.
5.	Business Model (Revenue Model)	To create a model for managing a transactions. Such as creating the invoice and paying the bills of customers.
6.	Scalability of the Solution	The major scalability, flexibility and agility of our project is 1. It helps companies to improve performance and reducing errors by automating document preparation and other routine task. 2. The valuable resources they provide has a significant impact on the environmental, socio-economic health of individuals, families, business and industries they serve. 3. It uses SAAS (Software as a service) – reduce time, effort and calculated errors respectively.

It is important to note that a proposed solution is just a recommendation and should be thoroughly evaluated, refined, and validated before implementation. It should consider the unique circumstances, constraints, and requirements of the problem at hand and take into account stakeholder input and feedback.

3. REQUIREMENT ANALYSIS:

Requirement analysis is a systematic process of gathering, documenting, and analysing the needs and expectations of stakeholders for a specific project or system. It involves identifying, organizing, and prioritizing the requirements to guide the development or procurement of the desired solution. It involves two types. Such as Functional and Non-functional requirements. Let us see the requirement tabulation below.

3.1. FUNCTIONAL REQUIREMENTS:

It defines what a product must do, what its feature and functions are. Following are the functional requirements of the proposed solution.

FR. No	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Detects Motor (ON) time	The detection which is based on, how many hours/ minutes a motor is in ON condition and depends on this time, the bill will generated for each customers.
FR-2	Customer billing	The system should generate accurate and timely bills for customers based on their water usage data.
FR-3	Usage monitoring	The system should monitor and record water usage data, including meter readings and historical usage data, to accurately bill customers and

		identify trends or anomalies in water usage.
FR-4	Payment processing	The system should process payments from customers, including online payments and automatic payment processing.
FR-5	Customer service	The system should provide customers with access to their billing information and usage data, as well as the ability to report issues and contact customer service.
FR-6	Data analytics	The system should provide water suppliers with data analytics and reporting tools to help them analyze usage patterns, identify trends, and optimize their water supply operations.
FR-6	Integration with other systems	The system should integrate with other water supply systems, such as customer relationship management (CRM) and meter reading systems, to streamline operations and improve efficiency.
FR-7	Compliance with regulations	The system should comply with local regulations and standards related to water supply and billing.

Overall, the functional requirements of a smart billing system for water suppliers will depend on the specific needs and goals of the supplier, as well as the preferences and expectations of their customers. A well-designed and implemented system can improve billing accuracy, streamline operations, and provide valuable insights into water usage patterns and trends.

3.2. NON- FUNCTIONAL REQUIREMENTS:

It is not related to the system functionality, rather than define how the system should perform. Here, we'll briefly describe the most typical non-functional requirements. There are six different NFR are considered here to implemented this system. Following are the non-functional requirements of the proposed solution.

NFR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The usability of a smart billing system for water suppliers will depend on the specific features and functionality of the system, as well as the needs and preferences of the supplier and their customers. However, in general, a well-designed and implemented smart billing system can bring significant benefits to both the supplier and the end-users. Here we design a model with S**imple Handed Criteria (SHC)**. So that everyone can use it efficiently.
NFR-2	**Security**	Security is an important consideration for any smart billing system, including those used by water suppliers. Such systems typically collect and store sensitive data, such as customer billing information and usage data, which can be a target for cyberattacks and data breaches. To ensure the security of a smart billing system for water suppliers, several measures can be taken: • Data encryption

		• Access controls • Regular updates and patches • Monitoring and logging • Employee training In addition, it is important for water suppliers to work with trusted vendors who have a strong track record in developing and maintaining secure smart billing systems.
NFR-3	**Reliability**	Reliability is a critical aspect of any smart billing system, as accuracy and timely delivery of bills are essential to the smooth functioning of water supply operations. A reliable smart billing system ensures that customers are accurately billed for their water usage, and that suppliers can efficiently manage their billing processes. To ensure the reliability of a smart billing system for water suppliers, several measures can be taken: • Robust infrastructure • Regular maintenance and upgrades • Data validation and accuracy checks • Customer support
NFR-4	**Performance**	Performance is an important consideration for any smart billing system, as it affects the speed and accuracy of billing processes, data collection and management, and customer service. A high-performing smart billing system can help water suppliers to optimize their operations, improve customer satisfaction, and enhance revenue collection. To ensure optimal performance, the following are the steps taken by a system are:

		• Hardware and software optimization • Network optimization • Data management • Automation • Monitoring and maintenance By taking these measures, water suppliers can ensure that their smart billing system delivers fast and reliable performance, helping them to optimize their operations and provide high-quality customer service.
NFR-5	**Availability**	The availability of a system refers to its ability to be operational and accessible to users when needed. To ensure the availability of a smart billing system for water suppliers, several measures can be taken: • Redundancy and failover • Monitoring and alerts • Disaster recovery plans • Regular maintenance and updates
NFR-6	**Scalability**	Scalability is an important consideration for any smart billing system, including those used by water suppliers. As the number of customers or water usage data grows, a scalable system can accommodate the increased demand without sacrificing performance or accuracy. To ensure the scalability of a smart billing system for water suppliers, several measures can be taken: • Design for scalability • Flexible architecture • Cloud-based infrastructure **(IBM CLOUD IOT PLATFORM)**

		• Distributed computing • Load testing By taking these measures, water suppliers can ensure that their smart billing system can scale up or down as needed to accommodate changing demand and growth.

These are all the solution requirements for my project. Hence, by meeting these solution requirements, a smart billing system for water suppliers can improve accuracy, efficiency, and customer satisfaction, while also helping the water supplier optimize their operations and improve their bottom line.

4. PROJECT DESIGN:

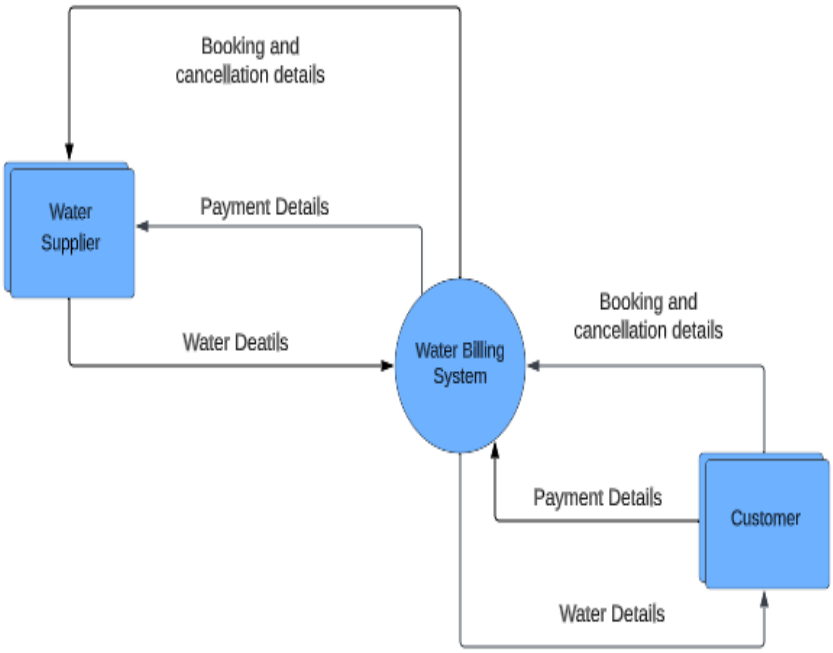
The project design phase, also known as the planning phase, is a crucial stage in project management where the project scope, objectives, and approach are defined in detail. It involves developing a comprehensive plan that outlines the project's structure, tasks, timelines, resources, and deliverables So, Let us design a Smart billing System for water Suppliers.

4.1. DATA FLOW DIAGRAMS:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored. Generally, It will be diagrammed by DFD – level 0, level 1, level 2 and So on.

4.1.1. DFD LEVEL 0:

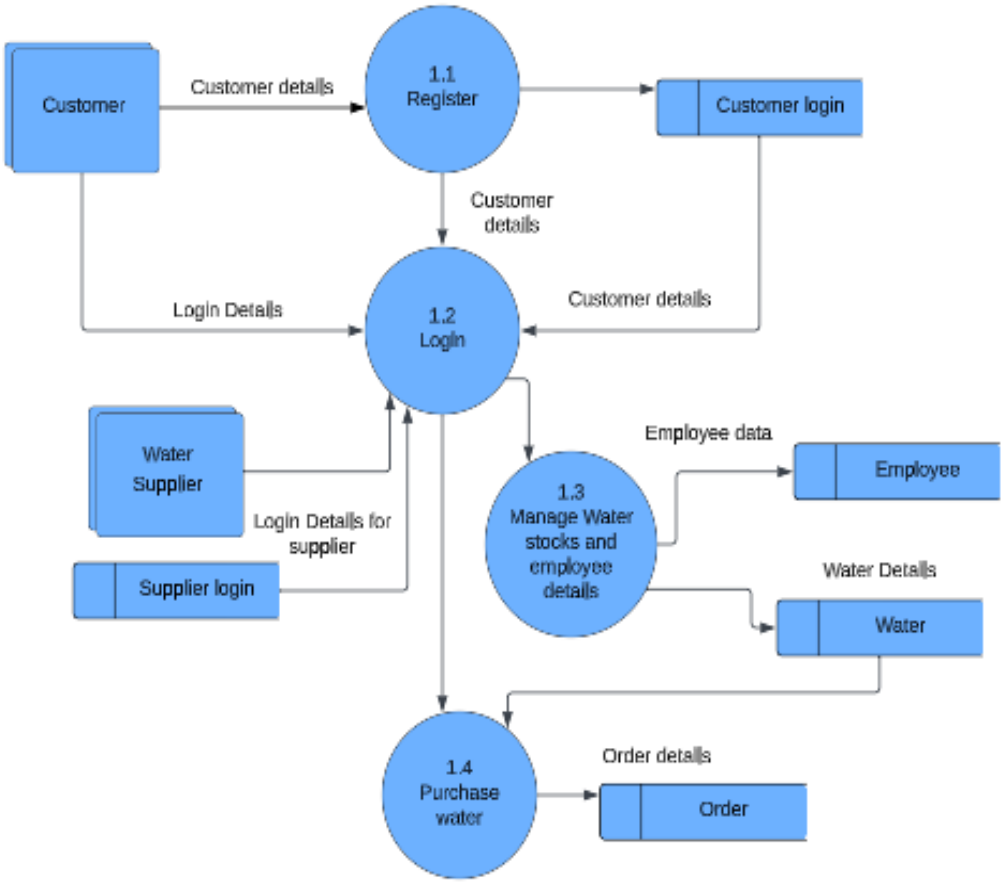
Also known as a context-level DFD, the level 0 diagram represents the system as a single process and shows the major processes or subsystems within the system. It illustrates the main data flows between processes and external entities, providing a broad view of the system's functionality.



4.1.2. DFD LEVEL 1:

A Level 1 Data Flow Diagram (DFD) provides an overview of the main processes and data flows within a system. It shows the major components and their interconnections at a high level. Level 1 DFDs provide a more detailed view of the system by decomposing the major processes or subsystems identified in the level 0 DFD into sub-processes. Each process in the level 1 DFD represents a more detailed description of the activities involved in the system.

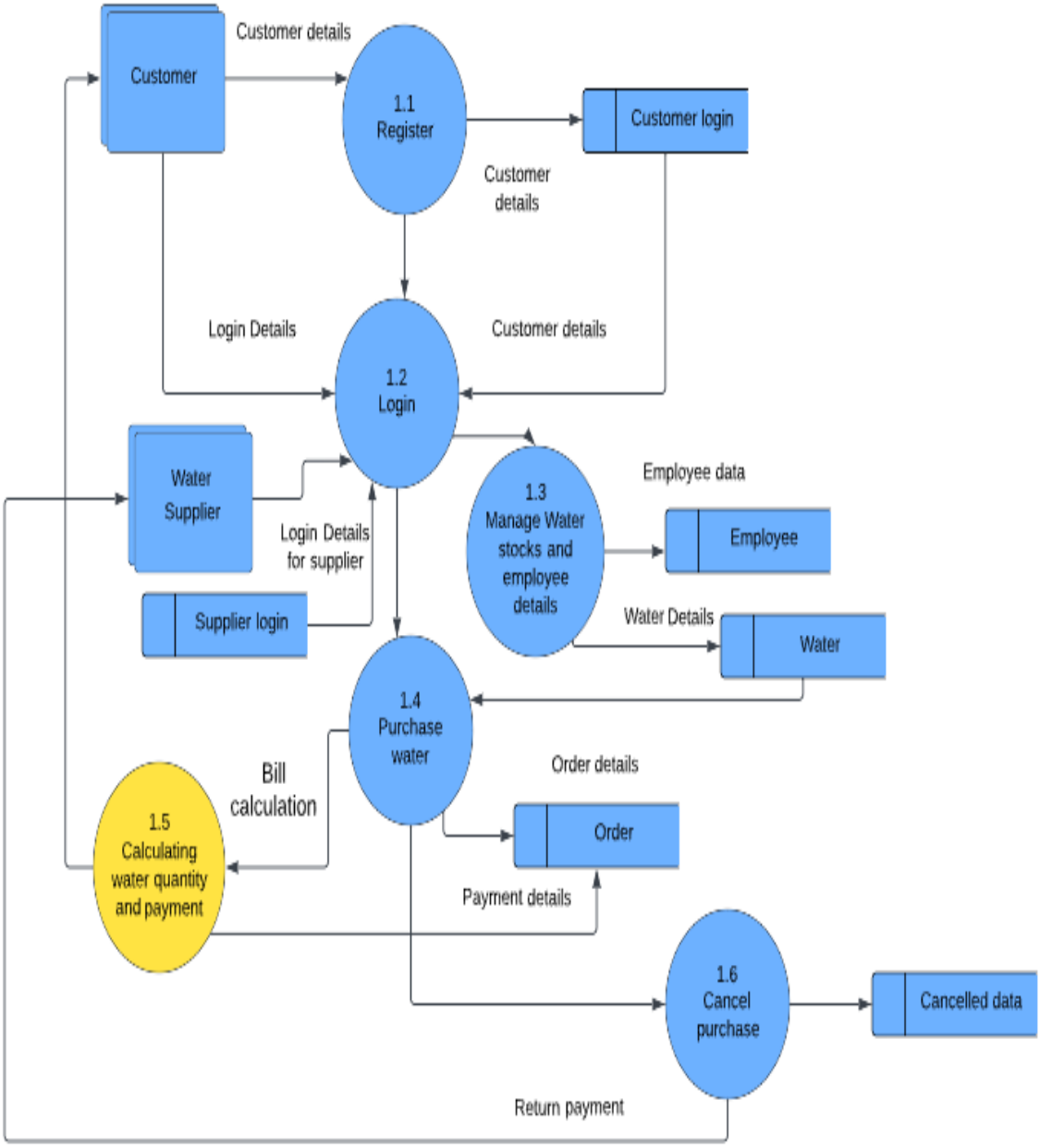
Level 1 DFD:



4.1.3. DFD LEVEL 2 (AND SUBSEQUENT):

If further detail is required, the level 1 DFD can be decomposed into more detailed DFDs, such as level 2, level 3, and so on. These diagrams continue to break down the processes into finer levels of detail, allowing for a comprehensive understanding of the system's processes and data flows.

Level 2 DFD:



In this Level 2 DFD, we have expanded the Smart Billing System process into more detailed subprocesses, such as Customer Information Management, Administrator Management, Billing Data Management, and Usage Data Analysis.

Reference link:

1) Level 0 DFD:
https://lucid.app/lucidchart/3c3acc87-8731-4202-bab18d7f75696863/edit?viewport_loc=-208%2C-98%2C2220%2C1038%2C0_0&invitationId=inv_f1c15d57-baec-4e13-89ea-1b8d3cc0292c

2) Level 1 DFD:
https://lucid.app/lucidchart/3c3acc87-8731-4202-bab1-8d7f75696863/edit?viewport_loc=-377%2C153%2C2775%2C1298%2CsmcY5e91tNlH&invitationId=inv_f1c15d57-baec-4e13-89ea-1b8d3cc0292c

3) Level 2 DFD:
https://lucid.app/lucidchart/7402ce6c-e46b-41ab-80ae-f777b9317593/edit?viewport_loc=-204%2C202%2C2467%2C1153%2C0_0&invitationId=inv_5250e341-6c74-4bbe-a8f6-f65928c58462

DFDs are hierarchical in nature, allowing for a progressive breakdown of processes and data flows into smaller, more manageable components. They help in visualizing and communicating system requirements, understanding dependencies, and identifying potential areas for improvement or optimization.

4.2. SOLUTION AND TECHNICAL ARCHITECTURE:

These architecture plays a crucial role in the successful development and implementation of a system or software solution. It provides a high-level design and framework for the solution, guiding the development team throughout the project.

4.2.1. SOLUTION ARCHITECTURE:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology sources

Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behaviour, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

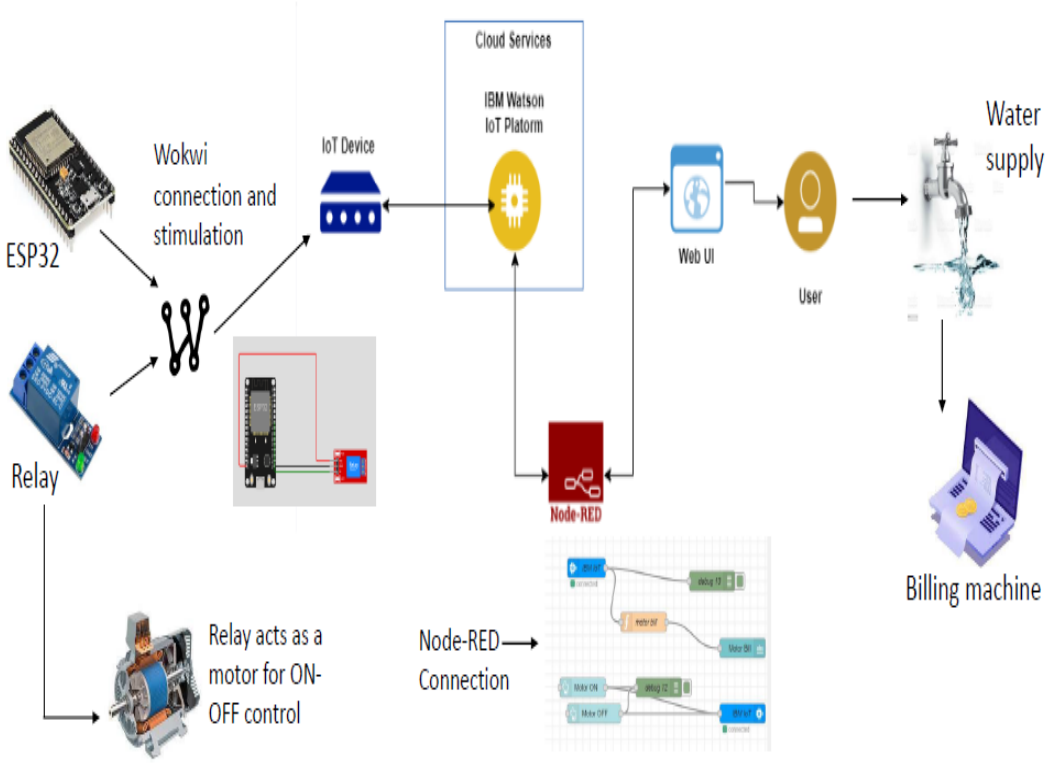


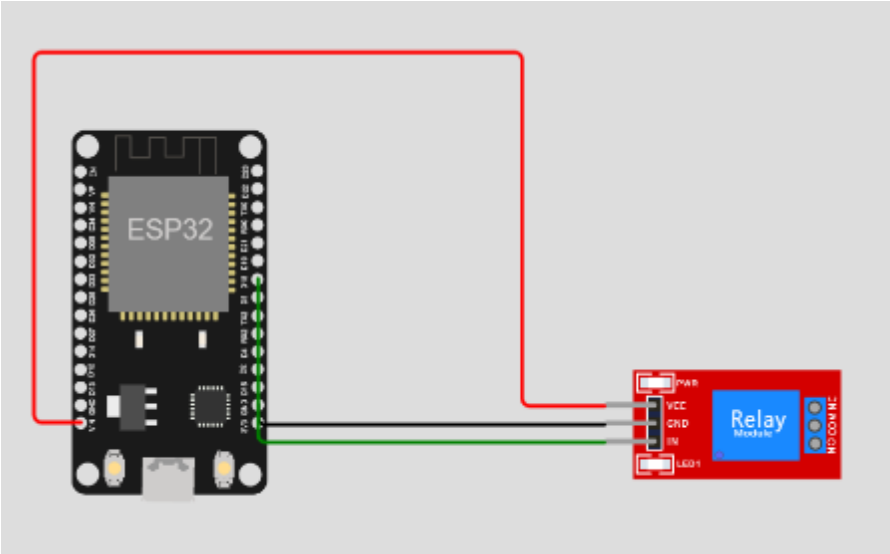
Fig. Architecture and data flow of the Smart billing system for water suppliers.

FLOW OF A SYSTEM:

The data flow of my project is discussed with step by step process as below.

Step-1: (Wokwi Connections)

Using wokwi software, the ESP32 (Microcontroller) and Relay is connected as shown in fig below.



Here, the relay is acts as a MOTOR such that when the relay (motor) is ON and OFF. After the Connections are made, the coding part is begin as per the project requirements.

Step-2: (IOT Device)

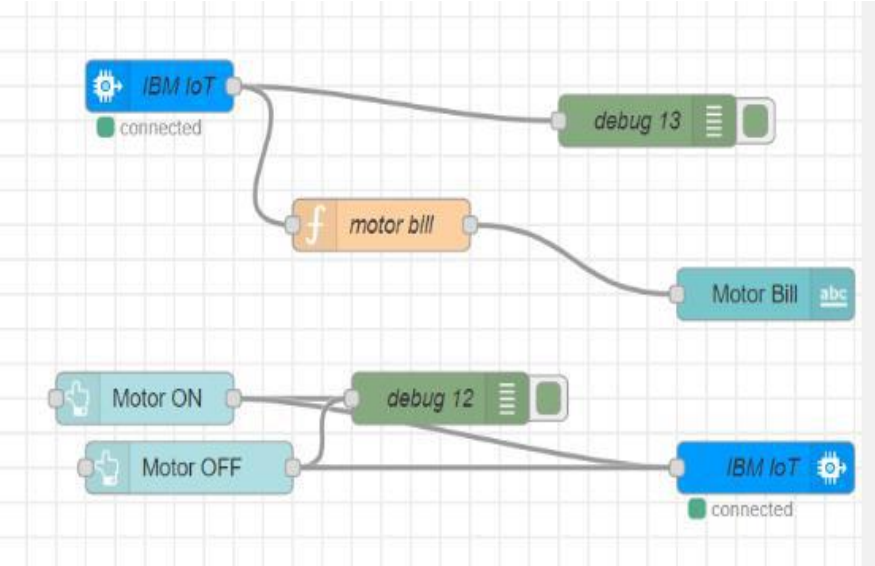
The above mention connections are made with physical components is referred as an “IOT Device”

Step-3: (IBM Watson platform)

The IBM Watson IOT Platform is a fully managed, cloud-hosted service that makes it simple to derive value from Internet of Things (IOT) devices. It provides capabilities such as device registration, connectivity, control, rapid visualization and storage of IOT data. So here, our Wokwi Connections is fed to the Cloud services via IBM watson IOT Platform for further steps.

Step-4: (Node-RED)

Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palatte that can be deployed to its runtime in a single-click. So, after the IBM Platform coordination, We Connect this source file to Node-RED and make a connections like as shown below.



Step-5: (Web UI)

A web-User interface or web app allows the user to interact with content or software running on a remote server through a web browser. The content or web page is downloaded from the Web server and the user can interact with this content in a web browser, which acts as a client.

Step-6: (User)

Finally, the web application is ready in previous step. So that the user can easily access it for billing their respective water payment process. In our Project, We designed this web application with considering two cases namely

a) When motor=OFF, No payment is generated.

b) When motor=ON, it noted how many hours it is On and calculate the bill immediately with respect to time.

Features:

- There are many vital features that our solution model had. Such as
- To reduce many malpractices are done while paying the bill
- Inorder to Compromise Unrecognized charges on payment
- Statement errors, calculated errors on the bill is reduced
- Missing or misapplied payments or other credits is recovered
- Reducing man-power
- Consumption of time and effort is low
- Establishing good relationship between water supplier and customer.
- Reduce Financial loss of supplier due to manual errors

These are the Flow of our respective Project “SMART BILLING SYSTEM FOR WATER SUPPLIERS” and its Solution Architecture.

4.2.2. TECHNICAL ARCHITECTURE:

Technical architecture refers to the design and structure of a system or software application from a technical perspective. It encompasses the various components, modules, interfaces, and technologies that are used to build and support the system. The technical architecture defines how different components of a system interact with each other and how they are organized to achieve the desired functionality. It includes decisions about hardware infrastructure, software platforms, programming languages, communication protocols, databases, and other technical aspects.

The Technical architecture of my project “Smart billing system for water suppliers” is shown below.

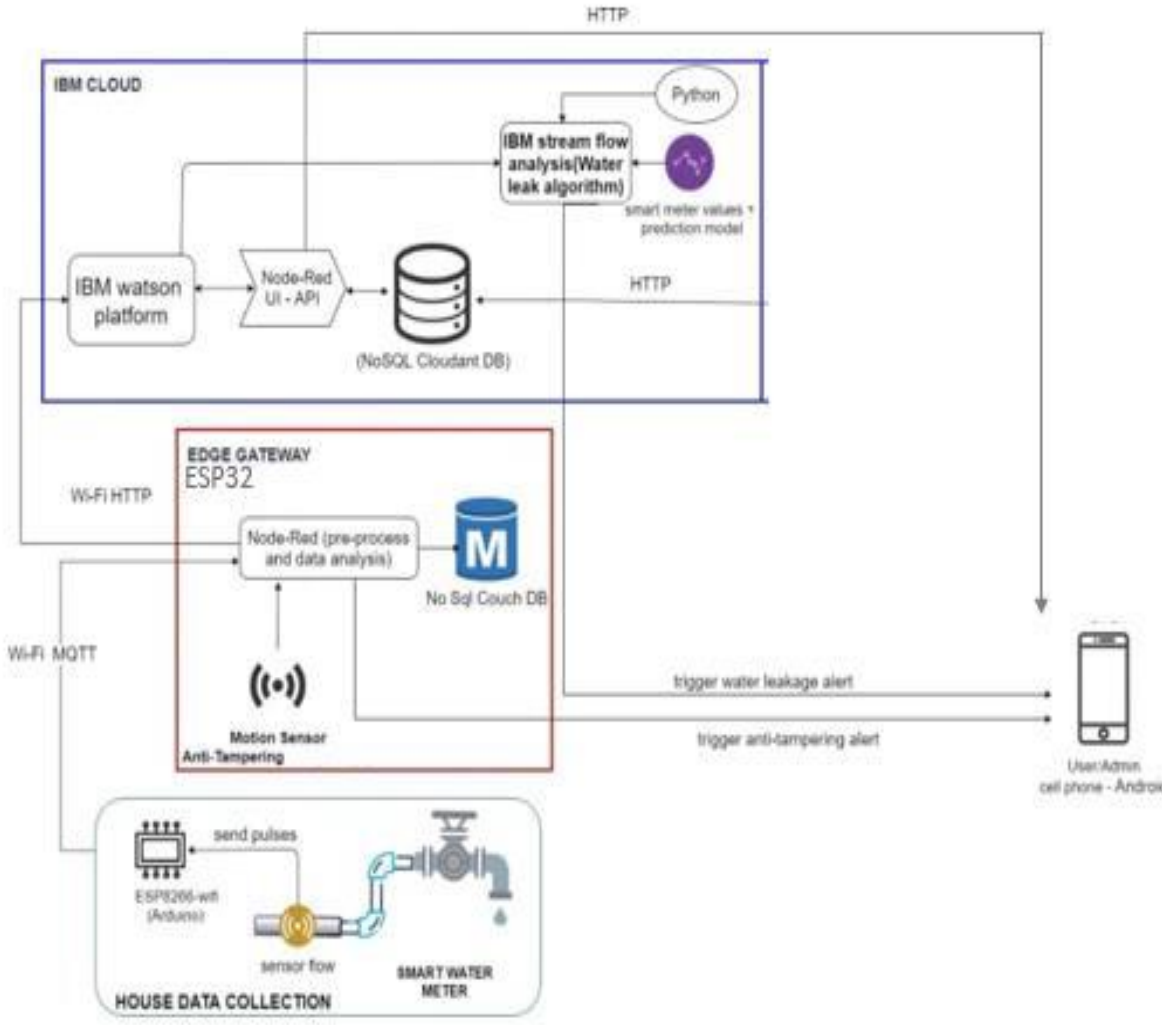


Fig. Technical architecture

The various technology stacks, I used for this project is tabulated below.

Table 1: (Technical Characteristics)

A technology stack for a smart billing system for water suppliers may vary depending on the specific requirements and the technological preferences of the organization. However, here are some commonly used technologies and components that can be part of such a system.

S. No	Component	Description	Technology
1.	**Backend Development**	Programming languages	Java, Python, or Node.js are popular choices for backend development.
		Frameworks	Spring Boot (Java), Django (Python), or Express.js (Node.js) can provide a solid foundation for building the backend.
		Database	Relational databases like MySQL or PostgreSQL are commonly used for data storage and management.
		ORM (Object-Relational Mapping):	Hibernate (Java) or SQLAlchemy (Python) can be used to simplify database operations
2.	**Frontend Development:**	Web technologies	HTML, CSS, and JavaScript form the core of web development.
		Frontend frameworks	Angular, React, or Vue.js can provide a rich and interactive user interface.
		UI libraries	Bootstrap or Material-UI offer pre-built components and styles for faster frontend development
3.	**Data Management**	Real-time data processing	Apache Kafka is a popular distributed streaming platform that can handle real-time data ingestion and processing.
		Data storage	MongoDB, a NoSQL database, can be used for storing and retrieving large volumes of data efficiently.
		Data analytics	Technologies like Apache Spark or Elasticsearch can be employed for data analysis and reporting
4.	**IoT Integration**	IoT platforms	Systems like AWS IoT, Microsoft Azure IoT, or Google Cloud IoT can be used to connect and manage IoT devices such as water meters. But

			here, we are IBM CLOUD IOT PLATFORM for integrating IOT
		Protocols	MQTT or CoAP are commonly used lightweight protocols for IoT device communication.
5.	**Security**	Authentication and authorization	Implementing secure user authentication using technologies like OAuth or JWT (JSON Web Tokens) can be crucial for protecting user accounts and data.
		Encryption	Transport Layer Security (TLS) or Secure Socket Layer (SSL) can be employed for secure data transmission.

It's important to note that these technologies are just examples of our project, and the actual technology stack for a smart billing system for water suppliers may vary based on specific requirements, scalability needs, existing infrastructure, and the expertise of the development team.

Table-2: (Application Characteristics)

The application characteristics of a smart billing system for water suppliers typically include the following:

S. No	Characteristics	Description	Technology
1.	**Automated Meter Reading**	The system should have the capability to automatically collect meter readings from water meters installed at customer locations. This eliminates the need for manual reading and reduces human error.	Advanced Metering Infrastructure (AMI)
2.	**Real-time Data Processing**	The system should process and analyze meter data in real-time, enabling quick and accurate billing calculations. It should be able to handle a large volume of data efficiently.	Supervisory Control and Data Acquisition (SCADA) Systems, Cloud Computing, Data analytics and machine learning, telemetry system. But

			here we use Internet of things (IOT)
3.	**Billing Accuracy**	The system should ensure accurate calculation of water consumption and generate precise bills based on the collected meter data. It should take into account factors like tariff rates, discounts, and any applicable taxes or fees.	Automated Meter Reading (AMR)
4.	**Usage Monitoring and Analysis**	The system should provide insights into water consumption patterns, allowing suppliers to monitor and analyze usage trends. This information can help in identifying potential leaks, anomalies, or opportunities for conservation.	Smart Water Meters and Internet of Things (IoT) Sensors
5.	**Customer Self-Service**	The system should offer self-service features that allow customers to access their billing information, usage history, and payment records. It should provide online portals or mobile applications where customers can view and manage their accounts.	Web Portals and mobile applications, Email and Text Messaging.
6.	**Notifications and Alerts**	The system should be capable of sending notifications and alerts to customers regarding their billing information, due dates, and any relevant updates. This helps in improving communication and keeping customers informed.	SMS (Short Message Service), Email, Web Portals and mobile applications
7.	**Integration with Payment Gateways**	The system should integrate with secure payment gateways, enabling customers to conveniently make payments online. It should support various payment methods, such as credit/debit cards, bank transfers, or digital wallets.	Online Payment Gateways: Gpay, Phonepe, payPal etc., Bank transfer, Prepaid cards or vouchers, Point-of-Sale (POS) Systems (Cash on delivery)

8.	**Data Security and Privacy**	The system should prioritize data security and ensure the privacy of customer information. It should implement encryption, access controls, and adhere to data protection regulations to safeguard sensitive data.	Encryption, Data Backup and Disaster Recovery, Security Audits and Compliance.
9.	**Scalability and Performance**	The system should be scalable to accommodate a growing customer base and handle increasing data volumes. It should be designed to deliver high performance and responsiveness to ensure smooth operations.	Load balancing, Caching, cloud Computing, Content Delivery Networks (CDNs), Monitoring and Performance Testing
10.	**Integration with Existing Systems**	The system should be able to integrate with other existing systems used by water suppliers, such as customer relationship management (CRM) systems, accounting systems, or enterprise resource planning (ERP) systems. This facilitates seamless data exchange and streamlines overall operations.	Application Programming Interfaces (APIs), Enterprise Service Bus (ESB), Web services, Message Queueing Systems, Database

These characteristics contribute to the efficient management of water billing processes, accurate customer invoicing, improved customer experience, and better operational insights for water suppliers.

4.3. USER STORIES:

A user story is a concise, informal description of a desired feature or functionality from the perspective of an end user or customer. They focus on the "who," "what," and "why" of a requirement, leaving the details of how it will be implemented to be determined during the development process. It is a simple and user-centric way of capturing requirements in agile software development. User stories are typically written in a specific format:

"As a [type of user], I want [a feature or functionality], so that [benefit or reason]."

User Stories:

Use the below template to list all the user stories for the product.

User type	Functional requirements (Epic)	User story number	User Story/Task	Acceptance Criteria	Priority	Team Member
Customer (Online user)	**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	Jayapal
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Jayapal
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Dhanush
		USN-4	As a user, I can register for the application through Gmail		Medium	Gowri shankar
	Login	USN-5	As a user, I can log into the application by entering email & password	I can login & access the dashboard	High	Arun prasad
	Dashboard	USN-6	As a user, I can access my dashboard for booking, cancelling and billing with respect to my water usage details	I can access my account / Dashboard	High	Dhanush
		USN-7	As a customer, I want to receive detailed and transparent billing statements from the smart billing system, including the amount of water consumed, the tariff	No malfunctions may occur	High	Gowri shankar

			rates, and any additional charges, to better understand and manage my water usage.			
	Booking and cancellation	USN-8	As a customer, I want the smart billing system to provide a self-service portal where I can access my billing history, view historical consumption data, booking and cancellation of order and request adjustments or dispute charges if needed, to ensure accuracy and transparency in billing.	The customer can book or cancel their orders.	High	Jayapal
	Payment	USN-8	As a customer, I want the smart billing system to provide convenient and flexible payment options, such as online payment portals and mobile apps, so that I can easily pay my bills and have a hassle-free billing experience.	The customer can pay for their water usage via online mode	High	Arun Prasad
Customer (Offline User)	**Purchase water from supplier**	USN-9	As a customer, I want to purchase a water from a good trustable vendor.	A customer can purchase their required water	High	Dhanush
	Billing and payment	USN-10	As a customer, I want to calculate my water consumption and bill according to that.	The customer can pay for their water usage via offline mode	High	Jayapal
Water Supplier	**Trustable deal**	USN-11	As a water supplier, I want to automate meter reading to eliminate manual errors and reduce operational costs. The system should be able to retrieve accurate consumption data from smart	Every customer and supplier must need a trustable deal with each other	High	Arun prasad

			water meters installed at customer premises.			
	Billing software	USN-12	As a water supplier, I want the billing system to generate accurate and timely bills based on the consumption data collected from the smart water meters. The system should calculate the charges according to the tariff structure, taking into account factors such as different rates for residential and commercial customers or peak and off-peak periods.	The customer can pay for their water usage via online and offline mode	High	Jayapal
	Catch online customer	USN-13	As a water supplier, I want to provide customers with online access to their billing information. The system should offer a user-friendly customer portal where customers can view their consumption history, current balance, and download invoices. It should also send automated email or SMS notifications when bills are generated or payments are due.	It is necessary to catch the online customers as well as Offline customer.	High	Arun prasad
	Utilize the offline customer efficiently	USN-14	As a water supplier, I want to efficiently utilize the customer those who are not have a knowledge about internet access.		High	Dhanush
Customer Care executive	**Work of customer care executive**	USN-15	As a customer care execute, I want the smart billing system to handle billing disputes efficiently, providing a	If any errors may occur in water billing software or any doubts/ issues regarding to access the software, the executive should	Medium	Jayapal

			mechanism for customers to raise concerns or discrepancies and initiate a resolution process, ensuring timely and satisfactory resolutions.	work to clarify the customer issues.		
Employee	**Employee's Work**	USN-16	As an employee, I want the smart billing system to support automated meter reading data collection from remote locations, allowing for data retrieval even in areas with poor network connectivity and ensuring accurate billing for all customers.	The employee should work back on the billing software	Medium	Gowri shankar
Sociologist	**Opinion**	USN-17	As a sociologist, I want to understand the socio-economic factors that influence water usage patterns and behaviours. I need access to data that includes demographic information, household income levels, education, and cultural factors to study how these variables impact water consumption and conservation practices.	The sociologist could have the curiosity to save the water. So that the water billing system provides the awareness to save water. Because if anyone could pay for water, they becomes very conscious to use and save it.	Medium	Jayapal

These user stories address the various functionalities and requirements of a smart billing system for water suppliers, including automated meter reading, accurate billing, customer self-service, payment options, notifications, dispute resolution, reporting, integration, security, scalability, personalized billing plans, API capabilities, meter management, and compliance.

5. CODING AND SOLUTIONING:

It refers to the process of creating a solution to a problem or task using programming languages and tools. This involves writing codes, testing and debugging, and optimizing the solution for performance and efficiency.

Parameters:

The important parameters of the code are as follows. Such as

- No. of Functional features included in the solution
- Code-layout, Readability and Reusability
- Utilization of algorithms
- Debugging and Traceability
- Exception Handling

Let us see, how these parameters are implemented in my project.

5.1. No. of Functional features included in the solution:

The number of functional features included in a solution for a smart billing system for water suppliers can vary depending on the specific requirements and complexity of the system. However, here are some common four Functional features that I have developed for this project is listed below.

- Accessing the IBM platform.
- Wifi and mqtt connection.
- Calculating Payload (motorbill) by using random function generator.
- Publishing these payload to Node-RED Platform (web UI).

5.2. Code-layout, Readability and Reusability:

When developing a smart billing system for water suppliers, it is essential to consider code layout, readability, and reusability. These factors contribute to the overall quality and maintainability of the codebase.

Code- Layout:

Code layouting refers to the organization and formatting of code in a consistent and visually pleasing manner. Proper code layouting improves readability, maintainability, and collaboration among developers.

Readability:

It refers to Write code that is easy to understand and follow. Use meaningful variable and function names that reflect their purpose and intention. Write concise and self-explanatory comments. Explain the purpose of the code, its expected behavior, and any potential caveats or limitations.

Reusability:

Aim to write modular code that can be easily reused in different parts of the system or in future projects. Implement a clear and consistent API for interacting with your smart billing system. This allows other developers to easily integrate or extend its functionality.

So, with reference to these criteria, I have developed my project with ease of code-layouting, read as well as reuse ability. The Layout of this system is

- Accessing the IBM Platform by providing the credentials

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

#define ORG "4566ei"//IBM ORGANITION ID
#define DEVICE_TYPE "abcd"//Device type mentioned in ibm watson IOT Platform
#define DEVICE_ID "1234" //Device ID mentioned in ibm watson IOT Platform
#define TOKEN "12345678"
```

- Customize these credentials

```
//-------- 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
```

- Setting up the system

```
void setup(){
//statement
}
```

- Mqtt connection

```
void mqttconnect(){
//statement
}
```

- Wifi connection

```
void wificonnect(){
//statement
}
```

- Managing the device

```
void initManagedDevice(){
//statement
}
```

- Callback function

```
void callback(char* subscribetopic, byte* payload, unsigned int
payloadLength){
//statement
}
```

- Receiving information from node-red

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

      data3 += (char)payload[i];
}
```

- Calculating the payload (Motorbill) using random function

```
motorbill=random(60,200);

motorbill=motorbill*5;
delay(1000);
PublishData(motorbill);
```

- Publishing the payload to Web UI

```
void PublishData(float motorbill){
//statement
}
```

- Generating the local time

```
void printLocalTime(){
//statement
}
```

These are the outline of my source code. So, it should be readable and the functions are used for reusability.

5.3. Utilization of algorithm:

Utilizing resources efficiently is crucial in a smart billing system for water suppliers to ensure optimal performance and cost-effectiveness. The major utilizations are like

- Data storage - recent events in IBM
- Network communication- mqtt() and wifi()
- Connecting hardware with software – Internet of things (IOT)
- User Interface – Node-RED (Web UI)

By focusing on efficient resource utilization, a smart billing system for water suppliers can maximize performance, minimize costs, and ensure sustainable operation. Regular monitoring, analysis, and optimization are key to maintaining an optimized system throughout its lifecycle. Implement monitoring tools to track resource usage and identify bottlenecks or areas for optimization. Continuously analyze resource utilization data and optimize system components based on the findings. Employ predictive analytics or machine learning algorithms to forecast resource requirements and optimize resource allocation.

5.4. Debugging and Traceability:

Debugging and traceability are crucial aspects of a smart billing system for water suppliers. They help in identifying and resolving issues, tracking system behaviour, and ensuring accurate billing processes. the major debugging properties are

- Logging and Error Handling

- Debugging Tools and Techniques
- Error Reporting and Monitoring
- Traceability and Audit Trail
- Test and Debug in Realistic Environments

By incorporating effective debugging and traceability practices in your smart billing system, you can enhance its reliability, ensure accurate billing, and efficiently resolve issues that may arise.

Here, for debugging parameters I use the GDB Debugger website.

https://docs.wokwi.com/gdb-debugging

5.5. Exception handling:

Exception handling is an important aspect of any software system, including a smart billing system for water suppliers. It helps ensure that your application can gracefully handle unexpected or exceptional situations that may arise during runtime. Here in my project I use different types of handling an exception using if-else conditional statement. such as

a) Check for publishing a data:

```
// To check if it is published or not
  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");
  }
```

b) Check for subscription:

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

```
    Serial.println("subscribe to cmd FAILED");
  }
}
```

c) While client is not connected:

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

The exception handling should be a part of my system's overall error handling and recovery strategy. It is crucial to handle exceptions in a way that provides meaningful feedback to users and administrators, ensures the integrity of the billing process, and maintains the stability and availability of the system.

5.6. DATABASE SCHEMA:

For managing the datas, here we use **IBM Watson IOT Platform**. The major software that we are used for implementing this project are listed below.

a) **IBM Watson IoT Platform:** it provides a secure and scalable infrastructure for connecting and managing Internet of Things (IoT) devices. It enables businesses to collect, analyze, and derive insights from IoT data, facilitating IoT-based solutions in industries like manufacturing, healthcare, and transportation.

b) **Wokwi Stimulator:** Wokwi is an online platform that provides a virtual hardware simulation environment for electronics and microcontroller-based projects. It allows users to design, simulate, and test their circuits and code in a web browser without the need for physical components.

c) **Node-RED:** Node-RED is an open-source flow-based programming tool that allows users to visually connect hardware devices, APIs, and online services to build applications and automation flows. It provides a browser-based

interface that enables users to drag and drop nodes and create flows by connecting them together

6. RESULT:

Performance testing is a non-functional software testing technique that determines how the stability, speed, scalability, and responsiveness of an application holds up under a given workload. It's a key step in ensuring software quality, but unfortunately, is often seen as an afterthought, in isolation, and to begin once functional testing is completed in most cases, after the code is ready to release.

6.1. PERFORMANCE TESTING-XLSX:

NFT: (Non-Fungible Token)
It is a type of digital asset that represents ownership or proof of authenticity of a unique item or piece of content, typically using blockchain technology. Unlike cryptocurrencies such as Bitcoin or Ethereum, which are fungible and can be exchanged on a one-to-one basis, NFTs are distinct and cannot be exchanged on a like-for-like basis because they each have unique attributes or properties.

- Uniqueness
- Digital Assets
- Ownership and Authenticity
- Smart Contracts
- Marketplaces and Trading
- Interoperability
- Royalties and Secondary Sales
- Potential Applications

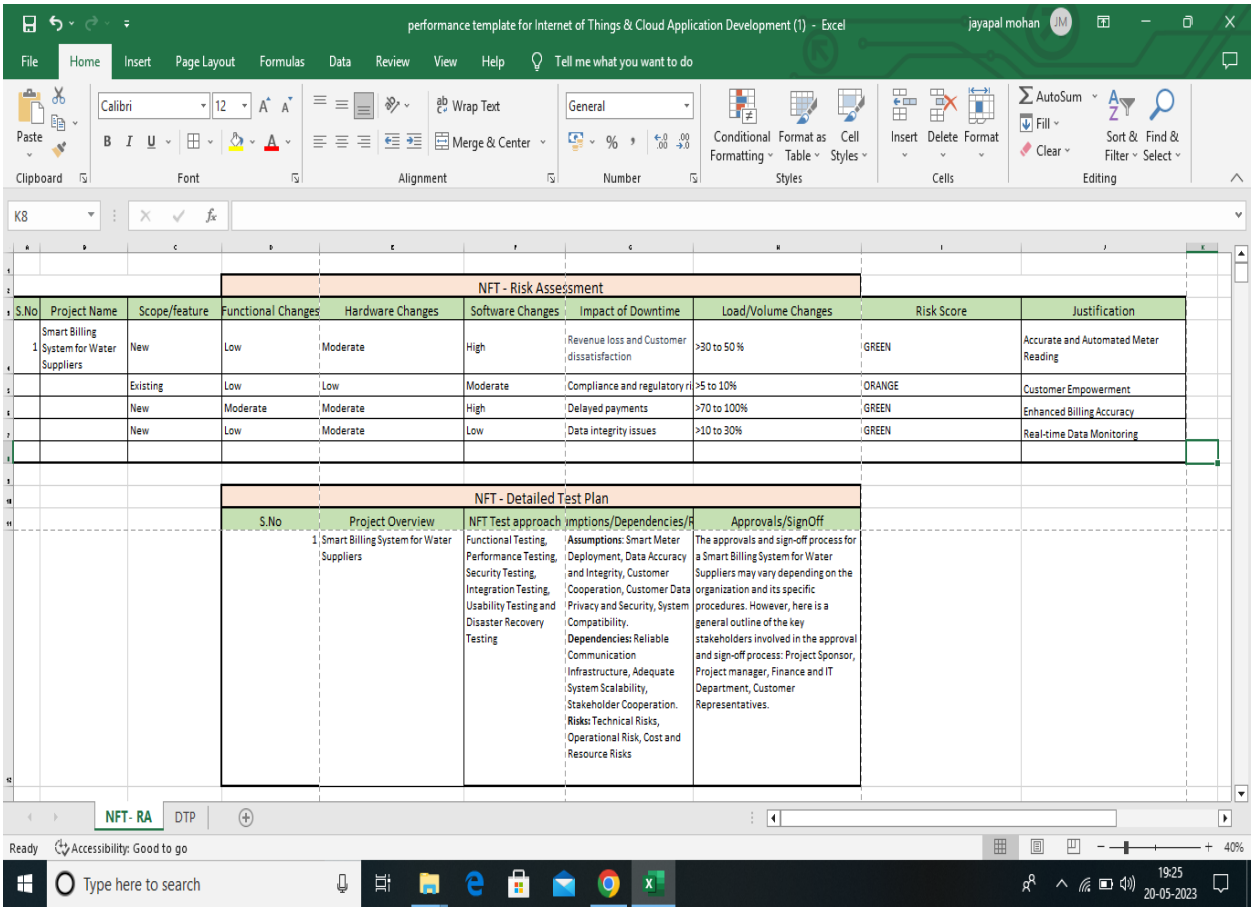
Here, I have created the various NFT parameters for our project like
1. NFT Risk Assessment
2. NFT Detailed Test Plan

3. End of Test Report which includes Test Approaches, NFR (Non- Functional Requirements) MET, Test outcome, GO / NO-GO Decisions as well as Recommendations, Identified Defects in which the defect is detected, closed or opened condition and Approval, sign OFF Credentials as shown below.

The various NFT Criteria are tabulated below.

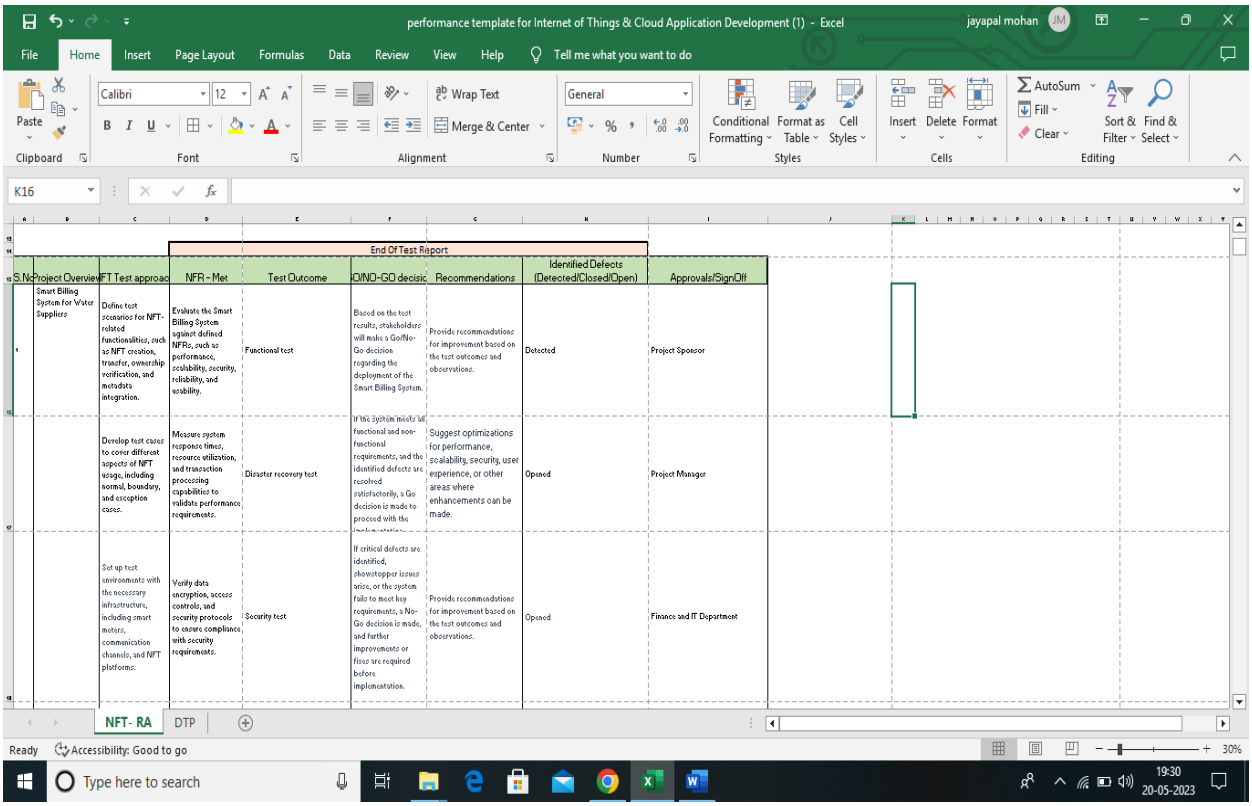
Step-1:

The NFT- Risk Assessments and detailed Test Plans are mapped.



Step-2:

The **End of NFT Test Report** is determined for our project.


performance template for Internet of Things & Cloud Application Development (1) - Excel
jayapal mohan
File Home Insert Page Layout Formulas Data Review View Help Tell me what you want to do
Paste Calibri 12 Wrap Text General
Merge & Center
Conditional Formatting Format as Table Cell Styles
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K16
End Of Test Report
S.No Project Overview FT Test approac NFR - Met Test Outcome O/NO-GO decisic Recommendations Identified Defects (Detected/Closed/Open) Approvals/SignOff
Smart Billing System for Water Suppliers
Define test scenarios for NFT-related functionalities, such as NFT creation, transfer, ownership verification, and metadata integration.
Evaluate the Smart Billing System against defined NFRs, such as performance, scalability, security, reliability, and usability.
Functional test
Based on the test results, stakeholders will make a Go/No-Go decision regarding the deployment of the Smart Billing System.
Provide recommendations for improvement based on the test outcomes and observations.
Detected
Project Sponsor
Develop test cases to cover different aspects of NFT usage, including normal, boundary, and exception cases.
Measure system response times, resource utilization, and transaction processing capabilities to validate performance requirements.
Disaster recovery test
If the system meets all functional and non-functional requirements, and the identified defects are resolved satisfactorily, a Go decision is made to proceed with the
Suggest optimizations for performance, scalability, security, user experience, or other areas where enhancements can be made.
Opened
Project Manager
Set up test environments with the necessary infrastructure, including smart meters, communication channels, and NFT platforms.
Verify data encryption, access controls, and security protocols to ensure compliance with security requirements.
Security test
If critical defects are identified, showstopper issues arise, or the system fails to meet key requirements, a No-Go decision is made, and further improvements or fixes are required before implementation.
Provide recommendations for improvement based on the test outcomes and observations.
Opened
Finance and IT Department
NFT- RA DTP
Ready Accessibility: Good to go
30%
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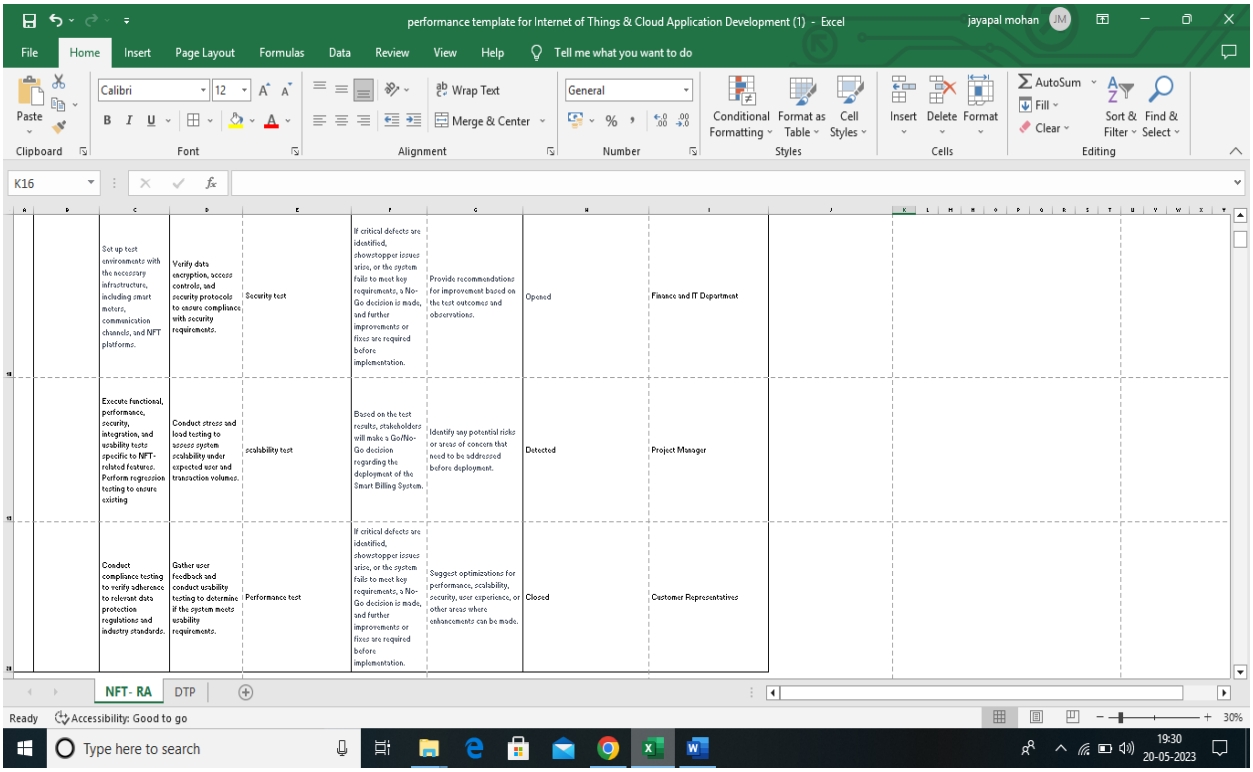
20-05-2023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Paste Calibri 12 Wrap Text General
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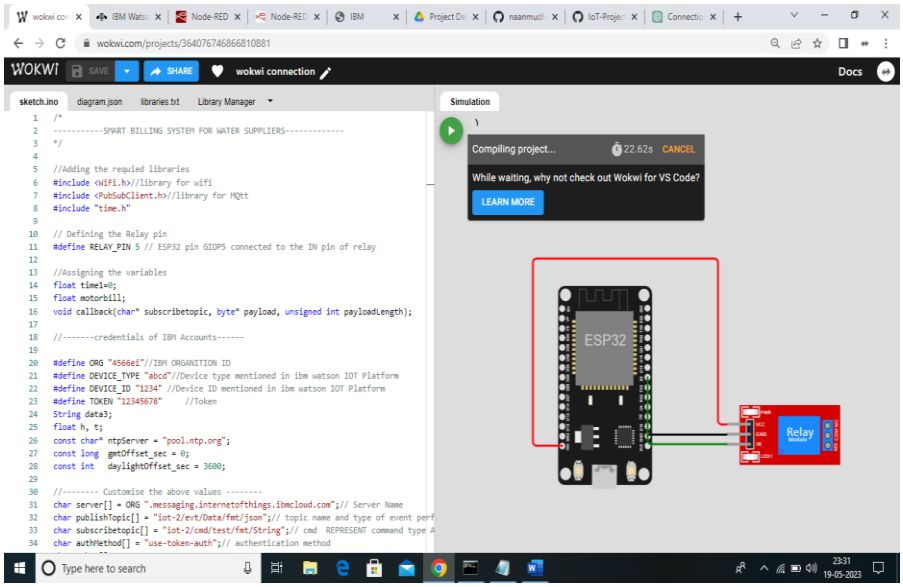
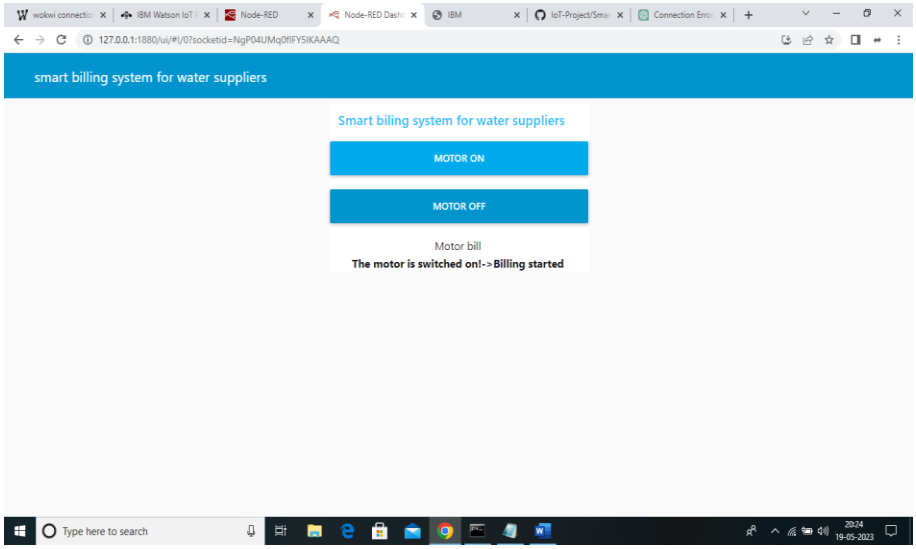
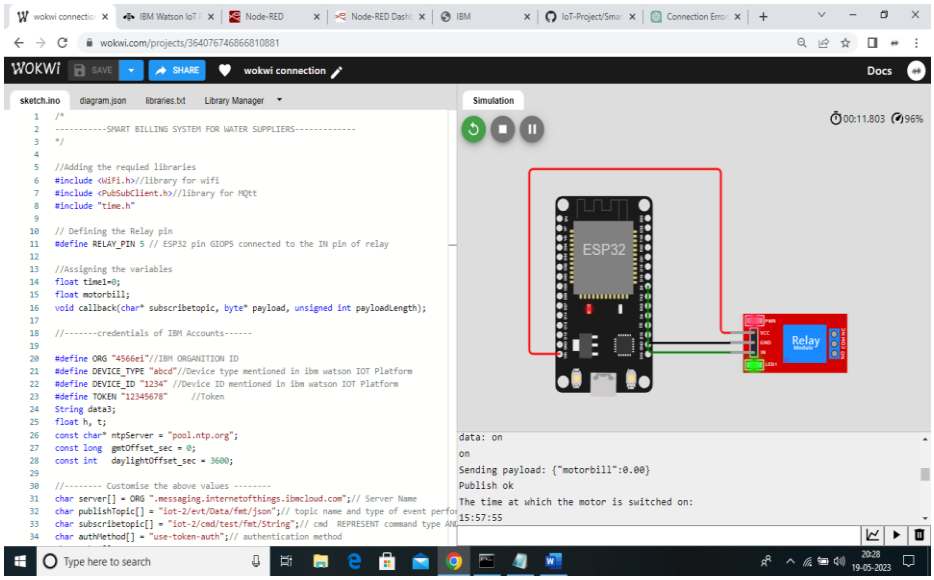
Conditional Formatting Format as Table Cell Styles
Insert Delete Format
AutoSum Fill Clear
Sort & Filter Find & Select
Clipboard Font Alignment Number Styles Cells Editing
K16
Set up test environments with the necessary infrastructure, including smart meters, communication channels, and NFT platforms.
Verify data encryption, access controls, and security protocols to ensure compliance with security requirements.
Security test
If critical defects are identified, showstopper issues arise, or the system fails to meet key requirements, a No-Go decision is made, and further improvements or fixes are required before implementation.
Provide recommendations for improvement based on the test outcomes and observations.
Opened
Finance and IT Department
Execute functional, performance, security, integration, and usability tests specific to NFT-related features. Perform regression testing to ensure existing
Conduct stress and load testing to assess system scalability under expected user and transaction volumes.
scalability test
Based on the test results, stakeholders will make a Go/No-Go decision regarding the deployment of the Smart Billing System.
Identify any potential risks or areas of concern that need to be addressed before deployment.
Detected
Project Manager
Conduct compliance testing to verify adherence to relevant data protection regulations and industry standards.
Gather user feedback and conduct usability testing to determine if the system meets usability requirements.
Performance test
If critical defects are identified, showstopper issues arise, or the system fails to meet key requirements, a No-Go decision is made, and further improvements or fixes are required before implementation.
Suggest optimizations for performance, scalability, security, user experience, or other areas where enhancements can be made.
Closed
Customer Representatives
NFT- RA DTP
Ready Accessibility: Good to go
30%
Type here to search
19:30
20-05-2023

Here, we developed the NFT Algorithm for this water systems. It's important to note that while NFTs have gained considerable attention and popularity, they have also raised discussions around environmental impact, intellectual property rights, and the sustainability of the market. As with any emerging technology, the long-term implications and adoption of NFTs continue to evolve.

6.2. PERFORMANCE TESTING- METRICS:

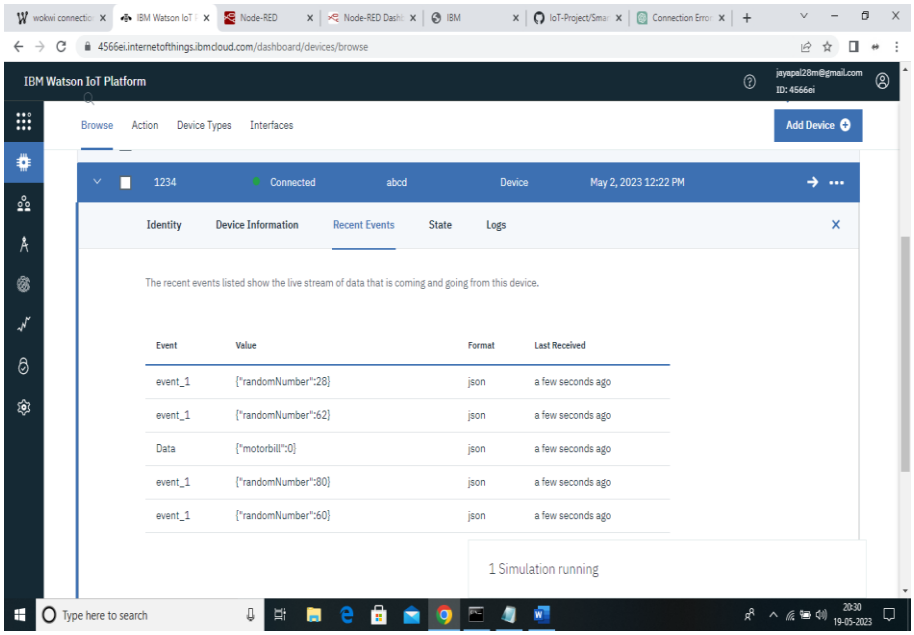
Application performance metrics are used to measure and evaluate the performance and efficiency of an application. They provide insights into how well an application is performing and help identify areas for improvement.so for this system, let us see the Execution Time and its output efficiency.

Parameters	Values	Screenshots
Metrics	Wowki Execution time	The Execution time of wokwi stimulator for our project is 22.62 seconds. 

	Output screenshot	There are many steps involved in the output process. Here I attached screenshots for every steps below. **Step 1:** Turn ON the motor in Web UI (Node-RED)  **Step 2:** In wokwi, the relay will be switched ON and starts monitoring 

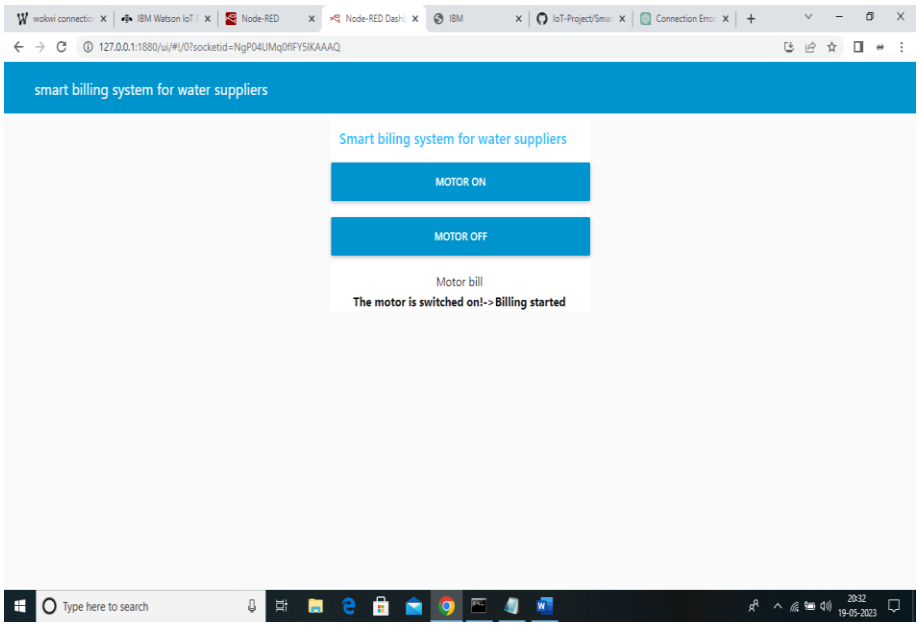
Step 3:

Publishing the data to IBM recent events



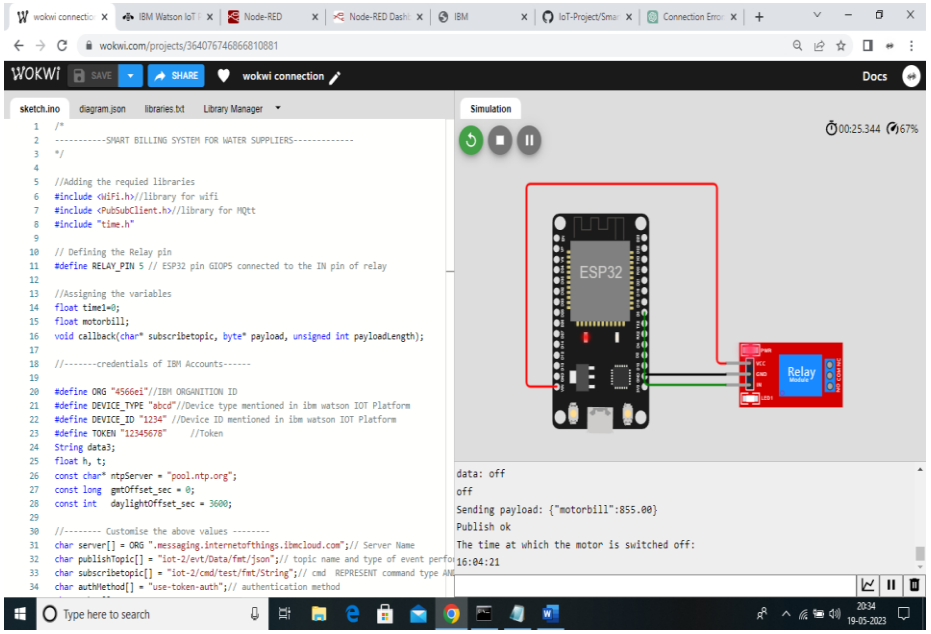
Step 4:

After few moments, the motor is directed to turn OFF in Node-RED



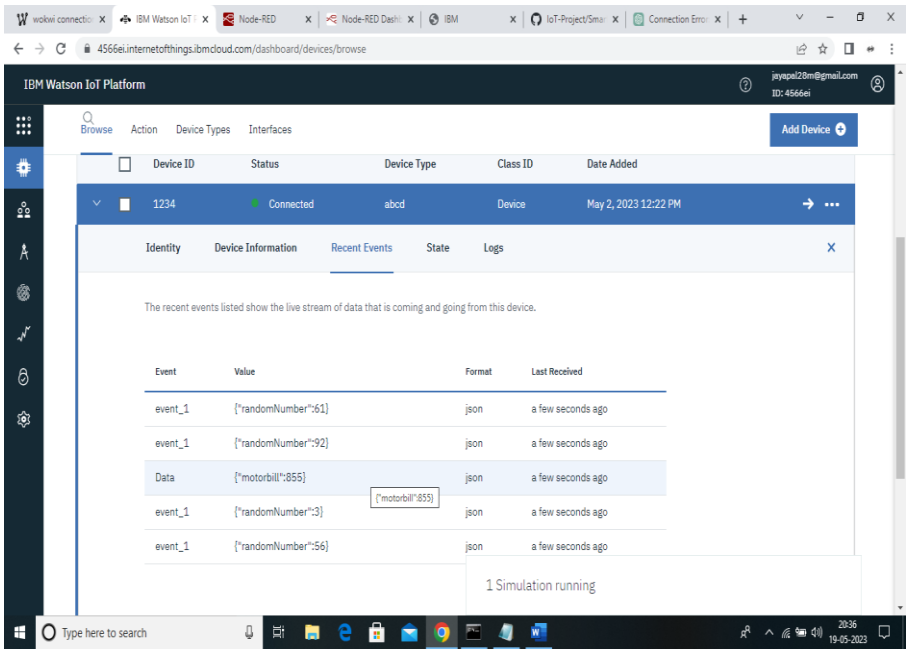
Step 5:

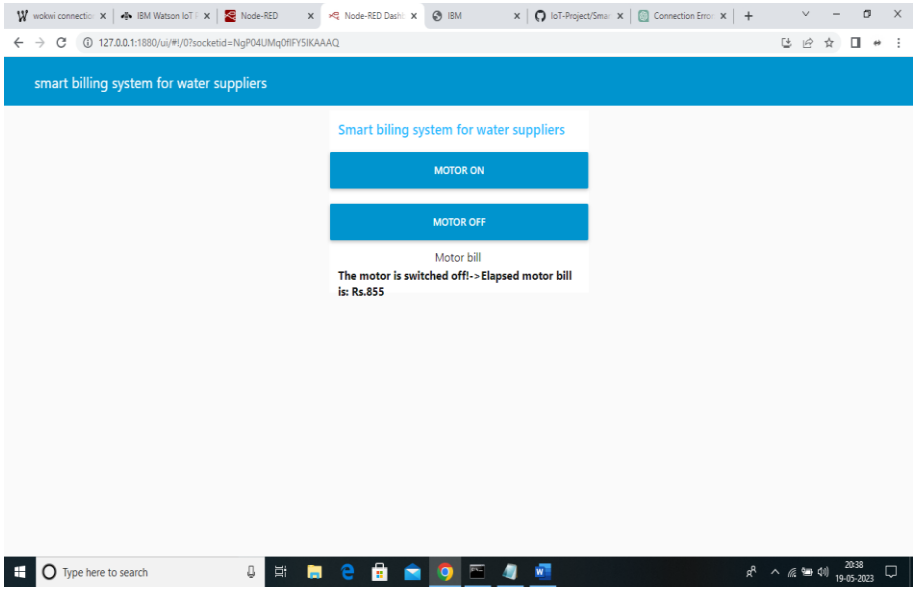
In wokwi, the relay will be switched OFF and generate a bill by using random function generator.



Step 6:

Publishing the motorbill to IBM recent events



		Step 7: Finally got the motorbill in Web UI 

These performance testing can be done by using the steps as follows.

- Identifying the Test Environment and tools
- Define acceptable Performance criteria
- Plan and Design Tests
- Prepare Test Environment and tools
- Run the Performance Tests
- Resolve and Retest

To make sure that the Performance testing is an iterative process, and it should be conducted at different stages of development and deployment to ensure consistent performance and reliability of the smart billing system for water suppliers.

7. ADVANTAGES AND DISADVANTAGES:

The major advantages and disadvantages of Smart billing system for water Supplier are discussed below.

7.1. ADVANTAGES:

- **Accuracy and Efficiency:**
  A smart billing system enables accurate and automated meter reading, eliminating human errors and ensuring precise billing calculations. It streamlines the billing process, saving time and effort for water suppliers.
- **Real-Time Data:**
  Smart meters capture water consumption data in real-time, allowing water suppliers to have up-to-date and accurate information about usage patterns. This data can help in detecting leaks, identifying abnormal consumption, and improving overall water management.
- **Fair and Transparent Billing:**
  With real-time data, smart billing systems provide customers with transparent and detailed bills based on their actual usage. This fosters trust and fairness in billing practices and reduces disputes between water suppliers and customers.
- **Cost Savings:**
  By accurately measuring water consumption, smart billing systems can help customers identify and reduce wasteful usage patterns. This can lead to water conservation and cost savings for both customers and water suppliers.
- **Improved Customer Experience:**
  Smart billing systems often come with customer portals or mobile apps that allow customers to access their billing information, consumption history, and payment options. This self-service capability enhances the customer experience and empowers customers to monitor and manage their water usage.

7.2. DISADVANTAGES:

- **Implementation Costs:**
  Implementing a smart billing system requires an upfront investment in smart meters, communication infrastructure, software, and integration with existing systems. These initial costs can be a barrier for smaller water suppliers or those with limited budgets.
- **Technical Challenges:**
  Deploying and maintaining a smart billing system involves dealing with complex technologies, such as IoT devices, communication networks, and data management. This may require specialized technical expertise and ongoing support.
- **Privacy and Security Concerns:**
  Smart billing systems collect and transmit sensitive customer data, including consumption patterns and personal information. Protecting this data from unauthorized access and ensuring compliance with privacy regulations is crucial and requires robust security measures.
- **Customer Adoption and Education:**
  Introducing new technologies and billing methods may require customers to adapt and understand the changes. Some customers may have concerns about privacy, data security, or the accuracy of the new system. Proper customer education and support are essential to ensure smooth adoption.
- **System Reliability:**
  Dependence on technology and communication networks means that system outages or failures can impact the operation of a smart billing system. Backup systems and contingency plans should be in place to ensure uninterrupted service.

It's important to note that the advantages and disadvantages of a smart billing system can vary depending on the specific implementation, scale of operations, and the needs of water suppliers and customers. Careful consideration of these factors is necessary to assess the suitability and potential challenges of implementing a smart billing system.

8. CONCLUSION:

In conclusion, implementing a smart billing system for water suppliers offers numerous benefits and opportunities for improvement. It enables accurate and efficient billing processes, provides real-time data for better water management, ensures fair and transparent billing practices, promotes cost savings and water conservation, and enhances the overall customer experience. By leveraging smart meters and IoT technologies, water suppliers can automate meter reading, eliminate human errors, and streamline the billing process. The availability of real-time data empowers water suppliers to detect leaks, identify abnormal consumption patterns, and make informed decisions for efficient water management.

However, there are challenges to consider, such as the initial implementation costs, technical complexities, privacy and security concerns, customer adoption, and system reliability. These challenges require careful planning, technical expertise, customer education, and robust security measures to ensure a successful and seamless transition to a smart billing system.

Despite the challenges, the benefits of a smart billing system, including accurate billing, cost savings, improved water management, and enhanced customer satisfaction, make it a compelling solution for water suppliers. With proper planning, implementation, and ongoing support, a smart billing system can revolutionize the way water suppliers operate and interact with their customers, leading to more efficient and sustainable water management practices.

9. FUTURE SCOPE:

The future scope of smart billing systems for water suppliers is promising, with several potential advancements and opportunities for growth. Here are some key areas that could shape the future of smart billing systems:

- Advanced Metering Infrastructure (AMI)
- Data Analytics and Predictive Analytics
- Demand Response and Time-of-Use Billing
- Integration with Smart Home Technologies
- Blockchain and Smart Contracts
- Water Conservation and Sustainability
- Integration with Smart City Initiatives

It's important to note that the future scope of smart billing systems will also be influenced by advancements in technology, regulatory frameworks, customer expectations, and sustainability goals. Water suppliers and technology providers will need to collaborate and adapt to these changes to unlock the full potential of smart billing systems and drive positive impacts in water management and customer engagement.

PROJECT FLOW:

The project flow of this system is written in simple steps for your reference,

- Create and configure IBM Cloud Services
- Create IBM Watson IoT Platform and Device
- Develop the Device Script
- Develop the Web application using Node-RED
- Testing the Web UI by giving the required inputs

By completing all these steps one-by-one with reference to the above explained phenomena, you will surely develop this Smart Billing system for Water Suppliers.

MORAL:

"With a Smart Billing System, water suppliers can proactively identify and address issues such as leaks, unauthorized consumption, and inefficient usage, leading to cost savings, operational optimization, and enhanced customer experiences.

10.APPENDIX:

This appendix provides additional information and resources related to the smart billing system for water suppliers.

1. **Smart Metering Technology:**

- Smart meters: Devices that measure water consumption and provide real-time data.
- Internet of Things (IoT): The network of interconnected devices and sensors used in smart metering systems.
- Wireless communication technologies: Such as Wi-Fi, cellular networks, or LPWAN (Low Power Wide Area Network), used for transmitting data from smart meters to the billing system.

2. **Data Management and Analysis:**

- Data analytics: Techniques and tools used to analyze consumption patterns, identify anomalies, and derive insights from water consumption data.
- Predictive analytics: Using historical data to forecast future water consumption and optimize billing processes.
- Data security and privacy: Measures to ensure the confidentiality, integrity, and protection of customer data.

3. **Billing and Payment Systems:**

- Automated billing: The generation of accurate and timely bills based on real-time consumption data.
- Billing cycles: Different billing cycles for various customer segments, allowing flexibility and customization.
- Online payment portals: Providing customers with convenient options for paying bills electronically.
- Integration with existing billing systems: Ensuring compatibility and smooth data flow between the smart billing system and existing infrastructure.

4. **Customer Engagement and Self-Service:**

- Customer portals and mobile apps: Allowing customers to access their billing information, consumption history, and payment options.
- Real-time usage monitoring: Enabling customers to track their water consumption and identify areas for conservation.
- Customer support and education: Providing resources, FAQs, and assistance to address customer inquiries and promote understanding of the smart billing system.

5. **Regulatory Compliance and Standards:**

- Compliance with regulatory requirements: Ensuring adherence to local, regional, and national regulations governing water billing practices, data privacy, and security.
- Standards and interoperability: Adhering to industry standards for smart metering, data exchange, and communication protocols to facilitate compatibility and interoperability among different systems and vendors.

Case Studies and Success Stories:

Examples of water suppliers that have implemented smart billing systems and their outcomes in terms of accuracy, efficiency, customer satisfaction, and water conservation.
Lessons learned and best practices from successful smart billing system implementations.

10.1. SOURCE CODE:

By considering and using all these above parameters, the source code of our project is implemented as

```
/*
----------SMART BILLING SYSTEM FOR WATER SUPPLIERS-------------
*/

//Adding the requied libraries
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#include "time.h"

// Defining the Relay pin
#define RELAY_PIN 5 // ESP32 pin GIOP5 connected to the IN pin of relay

//Assigning the variables
float time1=0;
float motorbill;
void callback(char* subscribetopic, byte* payload, unsigned int payloadLength);

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

#define ORG "4566ei"//IBM ORGANITION ID
#define DEVICE_TYPE "abcd"//Device type mentioned in ibm watson IOT Platform
#define DEVICE_ID "1234" //Device ID mentioned in ibm watson IOT Platform
#define TOKEN "12345678"     //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() {

  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);

  // To check if it is published or not
```

```
  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 {
```

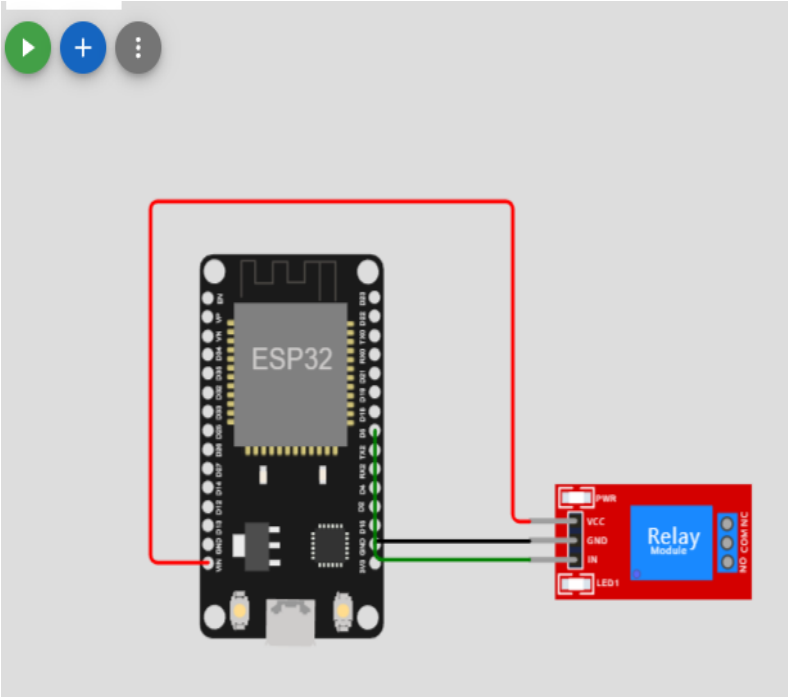
```
    Serial.println("subscribe to cmd FAILED");
  }
}

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++) {
    data3 += (char)payload[i];
  }

  Serial.println("data: "+ data3);

  // when motor is switched ON
  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;

  }

// when motor is switched OFF
  else if(data3=="off")
  {

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

  }
```

```
data3="";

}

//Function for print the time
void printLocalTime(){
  struct tm* timeinfo;
  time_t now;
  time(&now);

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

This is the Major source code of our project “Smart billing system for water suppliers” developed in Wokwi Stimulator.

WOKWI CONNECTION:

The Connections that we made for this project are shown below.



These connections are made up of by using ESP32 (Micro controller) and Relay. Here, the relay is acts as a switch for motor (ON & OFF).

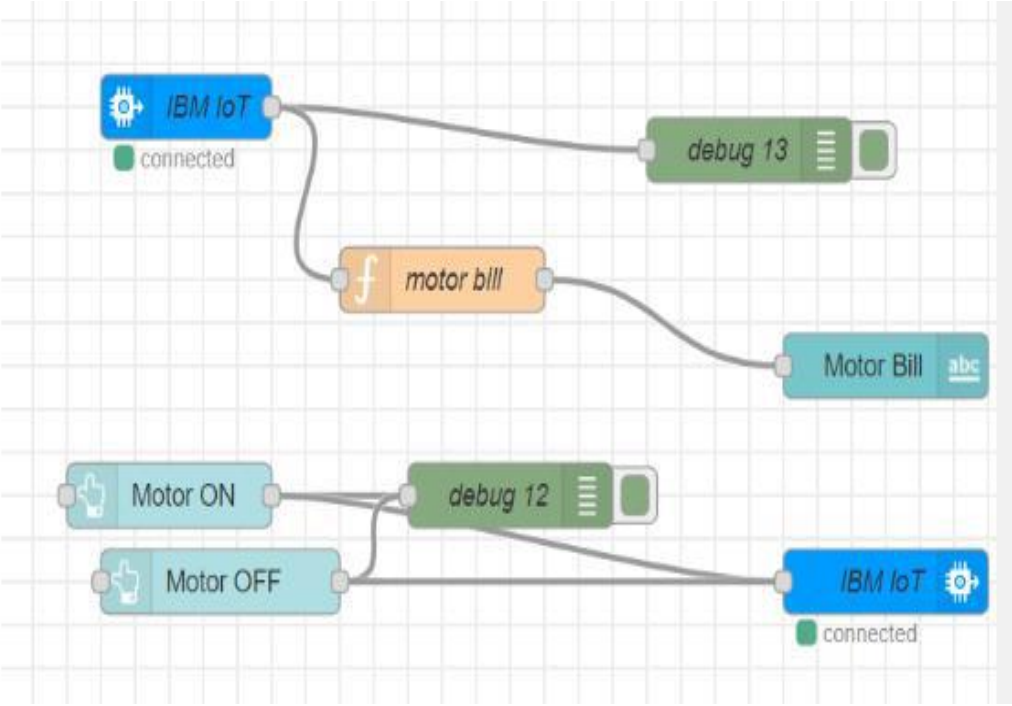
- Ground of relay is connected to ground of ESP32
- Vcc of relay is connected to vin of ESP32 and
- IN of relay is connected to ESP32 D5 pin.

Reference link:

For your reference, I attached the link here
https://wokwi.com/projects/364076746866810881

NODE- RED CONNECTION:

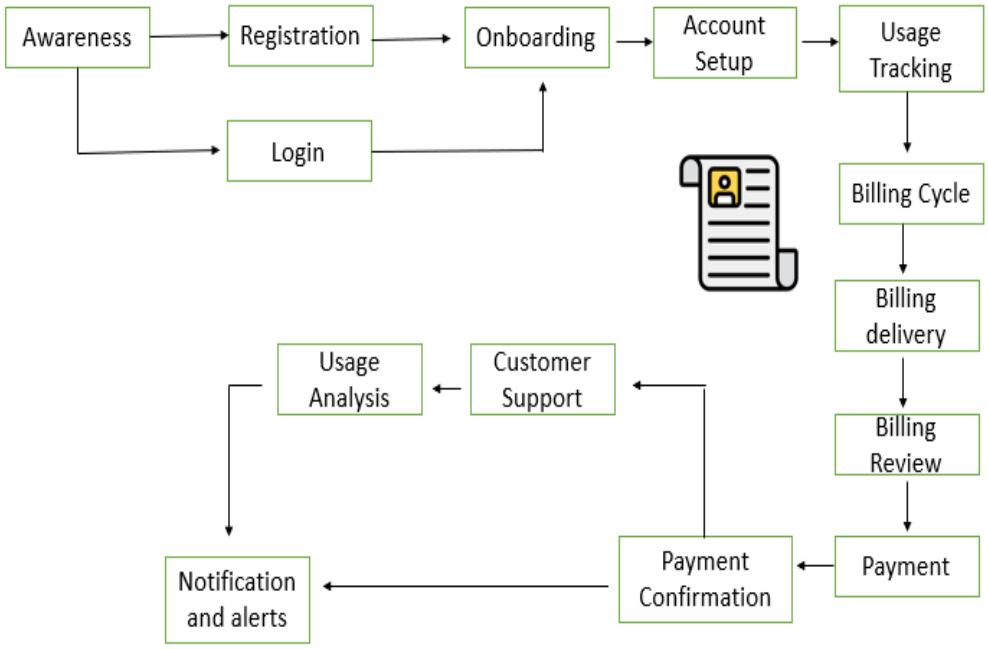
The connection of node- red with IBM IOT Platform is configured below.



By making these connections properly which ensures water suppliers can streamline their operations, improve billing accuracy, enhance customer experiences, and foster sustainable practices.

CUSTOMER JOURNEY MAP:

Customer journey maps are valuable tools for understanding the customer's perspective and designing strategies to deliver a seamless and satisfying experience. They provide a holistic view of the customer's interactions and allow organizations to identify opportunities for enhancement and build stronger customer relationships.



10.2. MAJOR REFERENCE LINKS:

For your reference, I attached the links for accessing major the sources.

GitHub Link: https://github.com/naanmudhalvan-SI/PBL-NT-GP-8997-1682679215

Project Demonstration link: https://youtu.be/Vx151clgdUg

In Conclusion, This adoption of a Smart Billing System is a significant step towards a more efficient, transparent, and environmentally conscious water supply industry.