PROJECT REPORT

REAL-TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM

TEAM ID:

PNT2022TMID19330

TEAM MEMBERS:

PRAKATHI V

RIVEKA M S

SUPRIYA E

VANITHA M

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1. INTRODUCTION

1.1 PROJECT OVERVIEW

Water is the primary need of all living beings and living without water is impossible. With the advancement of technology and industrialization, environmental pollutions have become a major concern. Water pollution is one of the most serious types of this environmental pollution. Our lives depend on the quality of water that we consume in different ways, from juices, which are produced by the industries. Any imbalance in the quality of water would severely affect the humans' health and at the same time, it would affect the ecological balance among all species. Water quality refers to the chemical, biological, radiological, and biological parameters of the water. The essential parameters of the water quality vary based on the application of water. For example, for aquariums, it is necessary to maintain the temperature, pH level, dissolved oxygen level, turbidity, and the level of the water in a certain normal range in order to ensure the safety of the fish inside the aquarium. For the industrial and household applications, however, some parameters of the water are more essential to be monitored frequently than the others, depending on the usage of the water. This project proposes a River water quality Monitoring and control system that is a sensor-based water quality monitoring system which will help to know if there are any dust particles present in the water. PH level and Water temperature of the water is monitored continuously. If there are any abnormalities found or if the water quality is not good, it will alert the authorities, so that they can go and announce the localities not to drink that water.

1.2 PURPOSE

The main purpose of this project is to build a Sensor- based Real-Time River water quality monitoring system. Monitoring water quality is clearly important: in our seas, our rivers, on the surface and in our ports, for both companies and the public. It enables us to assess how they are changing, analyze trends and to inform plans and strategies that improve water quality and ensures that water meets its designated use. There are several indicators determining water quality. These include dissolved oxygen, turbidity, bio indicators, nitrates, pH scale and water temperature. Monitoring water quality helps to identify specific pollutants, a certain chemical, and the source of the pollution. So, in this project, we depicted the design of Wireless Sensor Network (WSN) along with IOT technology that assists to monitor the quality of river water with the support of information sensed by the sensors dipped in water. Using different sensors, this system can collect various parameters from water, such as pH, dissolved oxygen, turbidity, conductivity, temperature, and so on. The rapid development of Wireless Sensor Network (WSN) technology provides a novel approach to real-time data acquisition, transmission, and processing. The clients can get ongoing water quality information from far away.

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM

Existing system has a mechanism, which are semi-automated, or manually controlled devices, which are to be handled by a person responsible for monitoring the water quality. There is need to have human intervention in taking various reading of the water parameters. The instruments or tools are used by either putting/inserting a water sensing part into water or seeing the result on small display device or by directly inserting a portable device in water and watching the output on the display. Central Water Commission (CWC) monitors water quality, by collecting samples from representative locations within the processing and distribution system. These samples are analyzed at the well-equipped laboratories. At these laboratories, samples of raw water, filter water and treated water are taken for analysis, this analysis can be performed by human intervention which for specific period only. The disadvantage of this system is, water is not monitoring seamlessly, and it always needs a human intervention.

2.2 REFERENCES

1. Menon, KA Unnikrishna, P. Divya, and Maneesha V. Ramesh. "Wireless sensor network for river water quality monitoring in India." 2012 Third International Conference on Computing, Communication and Networking Technologies (ICCCNT'12). IEEE, 2012.
2. Pradeepkumar M, Monisha J, Pravenisha R “The Real Time Monitoring of Water Quality in IoT Environment.”, ISSN:2347-6710, DOI:10.15680/IJIRSET.2016.0503246.

3. Jayti Bhatt, Jignesh Patoliya, “IOT Based Water Quality Monitoring System”, IRFIC, 21feb, 2016

2.3 PROBLEM STATEMENT DEFINITION

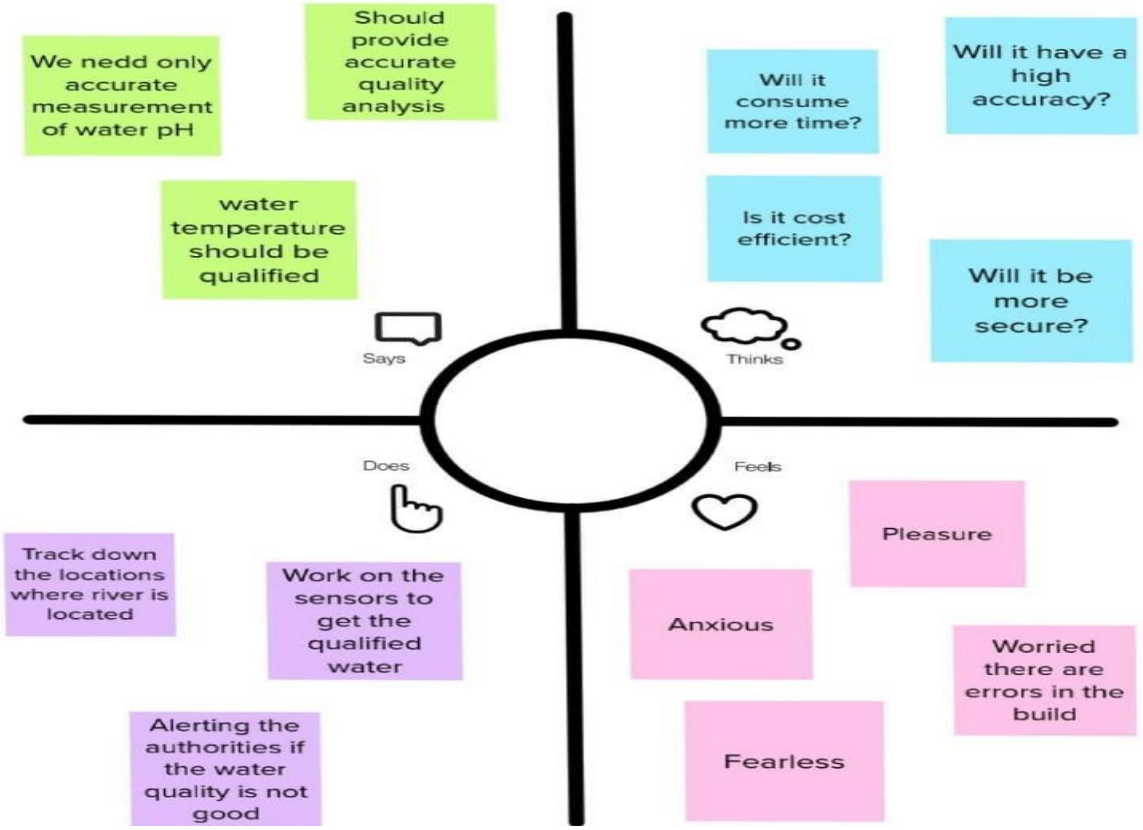
Water is the is the most valuable for all the human beings drinking water utilities faces challenges in real-time operation. These challenges occurred because of growing population, limited water resources, ageing infrastructure etc. Hence, there is a need of better methodologies for monitoring the water quality.

Problem Statement (PS)	**I am (Customer)**	**I am trying to**	**But**	**Because**	**Which makes me feel**
PS-1	As a Cold drinks manufacturer,I struggle with the problems caused by the river that served as my source of water.	I am trying to increase the water filtration process by getting clear and quality river water formy products.	But I am not able tofilter the water resource due to lackof knowledg eand resources.	Because the filtration process is not much easier and more time-consuming with poor water quality, we are not able to produce the best quality product.	It is one of the obstacles to the success of my firm and makes me responsible for customer happiness.
PS-2	I’m a villager	To make safe drinking water for my family and for my village.	Water in our locality causing many health issues andskin diseases.	We are not having much purifiers for water purification.	More Anxious about our future.

3. IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

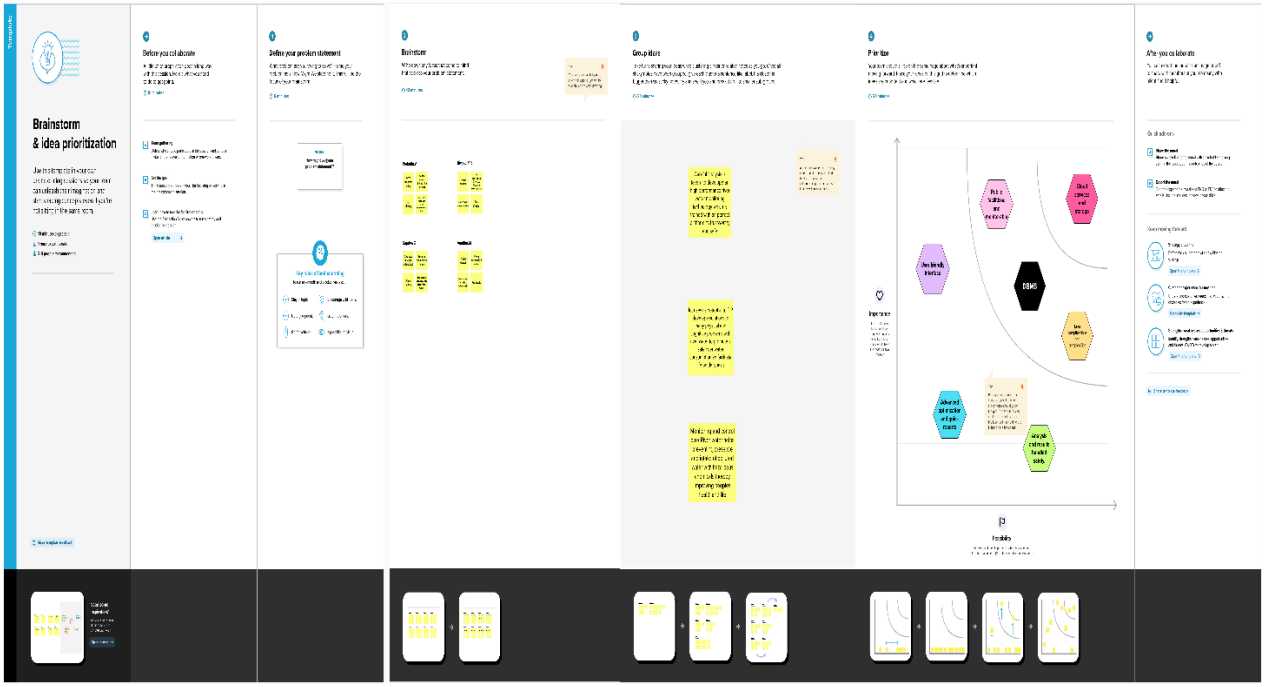
An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviors and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.



3.2 IDEATION & BRAINSTORMING

Brainstorming provides a free and open environment that encourages everyone within a team 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 participants are encouraged to collaborate, helping each other develop a rich number of creative solutions.

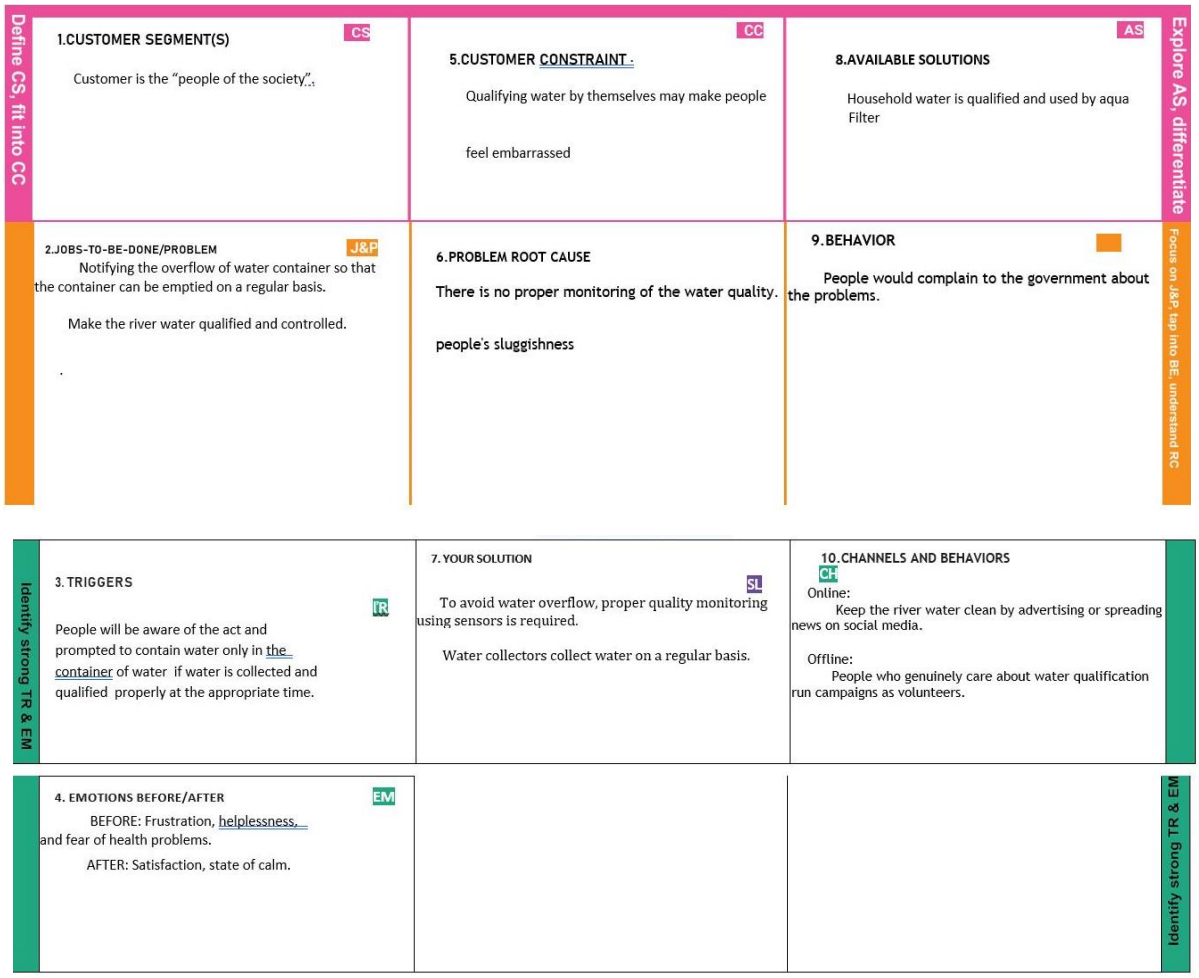


3.3 PROPOSED SOLUTION

S.NO	PARAMETER	DESCRIPTION
1.	Problem statement	The main issue with river water quality monitoring is that water is not qualified on a regular basis because water containers are unaware of the overflow of aqua containers.
2.	Idea / solution description	The main aim is to develop a system for continuous monitoring of river water quality at remote places using wireless sensor networks with low power consumption, low-cost and high detection accuracy
3.	Novelty / Uniqueness	River water quality can be monitored by web application. Quality parameter will track continuously with standard measurements

4.	Social Impact / Customer Satisfaction	Localities will not get suffered by poor quality of water by alerting them when the water quality is not good.
5.	Business Model	Real-Time Quality Monitoring system generates revenue by providing residential, commercial, industrial, and municipal clients with a variety of quality monitoring services and recycling solutions.
6.	Scalability of the Solution	Measuring of real time values and continuous monitoring helps in maintaining the quality of water.

3.4 PROBLEM SOLUTION FIT



4. REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through Product Mobile UI
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Ph level Detection	Ph sensor is used to monitor the water quality and the detected signals are sent to Arduino.
FR-4	Turbidity Detection	Turbidity sensor measures the clarity of element or muddiness utter in the water and the signals are send to Arduino.
FR-5	Ultrasonic Generator	The waves are generated at the regular interval times to clear algae 25%,50%, 100%

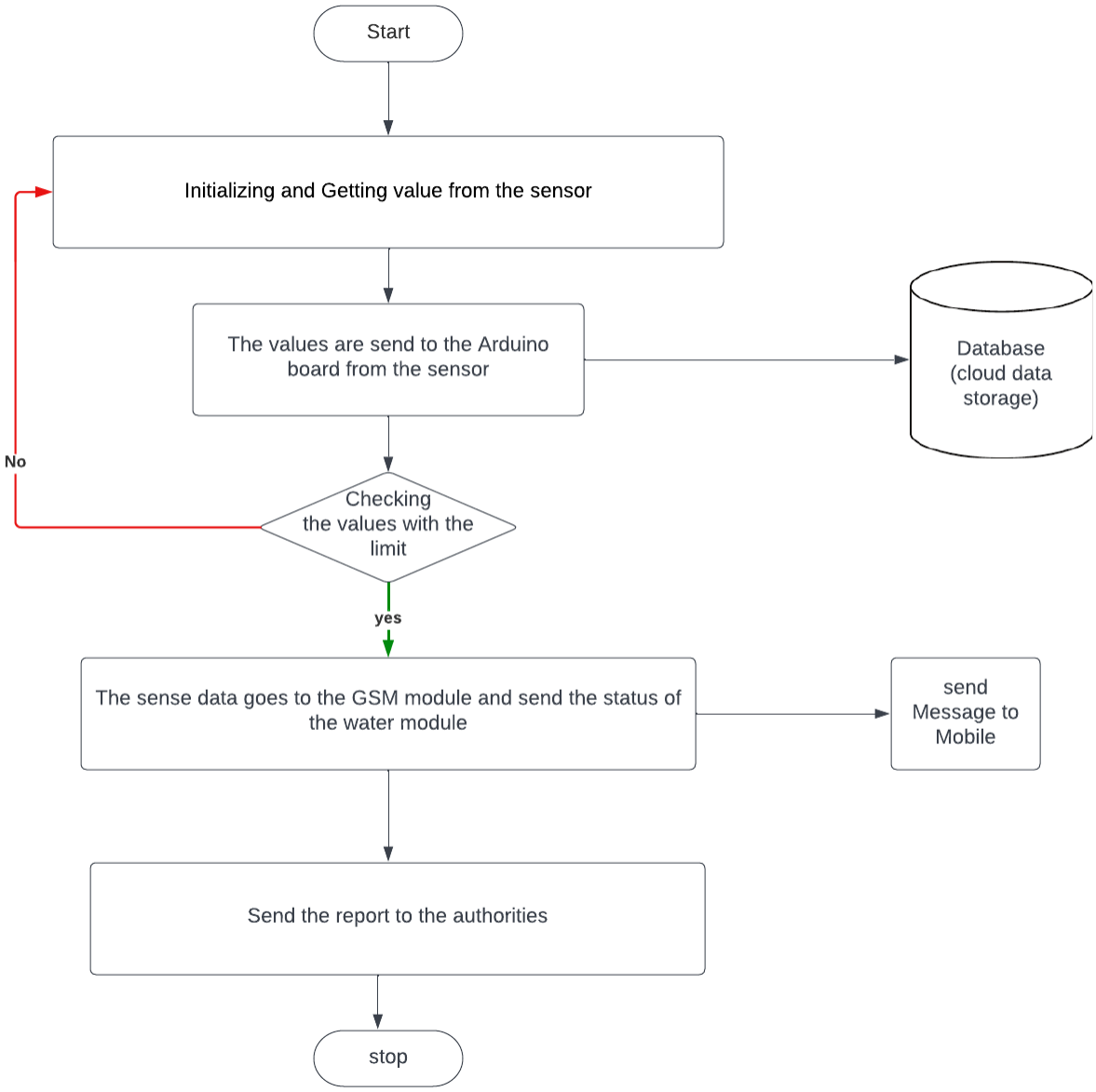
4.2 NON-FUNCTIONAL REQUIREMENTS

NFR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	It has simple monitoring system and efficient to use.
NFR-2	**Security**	Mobile application is secured with firewalls protection.
NFR-3	**Reliability**	Real time sensor output values with future predicted data storage. 98% efficient monitoring output. It also gives assurance for aquaculture safety.
NFR-4	**Performance**	It has greater performance and environmentally safe model.
NFR-5	**Availability**	In the form of mobile UI 24 x 7 monitoring System.
NFR-6	**Scalability**	Highly Scalable. It is capable to produce a best final output.
NFR-7	**Stability**	It has high Stability.
NFR-8	**Efficiency**	It is highly efficient, high mobility and low powered.

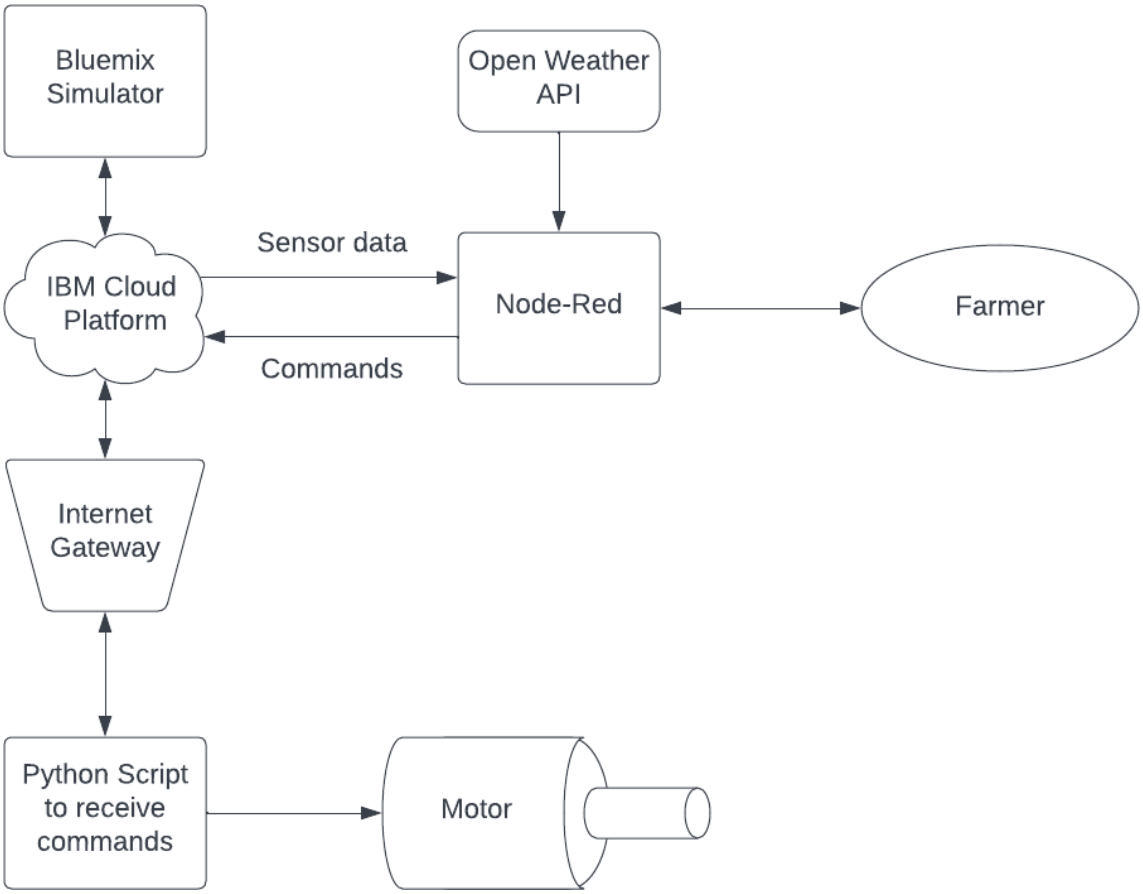
5. PROJECT DESIGN

5.1 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 details stored.



5.2 SOLUTION & TECHNICAL ARCHITECTURE



Component & Technologies:

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g., Web UI, Mobile App, Chatbot etc.	HTML, CSS, JavaScript / Angular Js / React Js etc.
2.	Application Logic-1	Logic for a process in the application	Java / Python
3.	Application Logic-2	Logic for a process in the application	IBM Watson STT service
4.	Application Logic-3	Logic for a process in the application	IBM Watson Assistant

5.	Database	Data Type, Configurations etc.	MySQL, NoSQL, etc.
6.	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant etc.
7.	File Storage	File storage requirements	IBM Block Storage or Other Storage Service or Local Filesystem
8.	External API-1	Purpose of External API used in the application	IBM Weather API, etc.
9.	External API-2	Purpose of External API used in the application	Aadhar API, etc.
10.	Machine Learning Model	Purpose of Machine Learning Model	Object Recognition Model, etc.
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System / CloudLocal Server Configuration: Cloud Server Configuration:	Local, Cloud Foundry, Kubernetes, etc.

Application Characteristics:

S. No	Characteristics	Description	Technology
1.	PH level Monitoring	The PH level of river water can be monitored via placing sensors in rivers.	PH-sensor
2.	Air Quality Monitoring	The clarity and purity of river water can be monitored	Surface Mount Sensor
3.	Temperature Monitoring	The temperature of river water can be monitored	Temperature sensor

4.	Water Treatment	can be used as both a safetydevice in the water purification process as carbon dioxide, methane, and carbon monoxide are some of the key gases produced during the treatment process	NDIR gas sensors

5.3 USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile 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	Sprint-1
		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	Sprint-2
		USN-3	As a user, I can register for the application through Google	I can register & access the dashboard with Google Login	High	Sprint-1
		USN-4	As a user, I can register for the application through Gmail	I can register through the mail.	Medium	Sprint-2
	Login	USN-5	As a user, I can log into the application by entering email & password	I can receive login credentials.	High	Sprint-1
	Interface	USN-6	As a user, the interface should be user-friendly manner	I can able to access easily.	Medium	Sprint-1
Customer (Web user)	Dashboard	USN-7	As a user, I can access the specific info (ph.	I can able to knowthe	High	Sprint-1

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
			value, temp, humidity, quality).	quality of the water.		
Customer Care Executive		USN-8	As a user, I can view data in visual representation manner(graph)	I can easily understand by visuals.	High	Sprint-1
	Taste	USN-9	As a user, I can able to view the quality(salty) of the water	I can easily know Whether it is salty or not	High	Sprint-1
	Colour visibility	USN-10	As a user, I can ably predict the water colour	I can easily know the condition by colour	High	Sprint-1
Administrator	Risk tolerant	USN-11	An administrator who Is handling the system should update and take care of the application.	Admin should monitor the records properly.	Medium	Sprint-2

6. PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	Prakathi, Supriya
Sprint-1	Registration through google	USN-2	As a user, I can register for the application through Google	2	Low	Prakathi, Supriya
Sprint-1	Registration through gmail	USN-3	As a user, I can register for the application through Gmail	2	Medium	Prakathi, Supriya
Sprint-2	Confirmation	USN-4	As a user, I will receive confirmation email once I have registered for the application	3	High	Supriya, Vanitha
Sprint-2	Login	USN-5	As a user, I can log into the application by entering email & password	2	High	Supriya, Vanitha
Sprint-2	IBM cloud service	USN-6	Get access to IBM cloud services	3	High	Vanitha, Riveka
Sprint-3	Create IBM Watson and device settings	USN-7	To create the IBM Watson IOT platform and Integrate the microcontroller with it to send sensed data to cloud	3	High	Riveka, Prakathi

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	Create node red service	USN-8	To create a node red service to integrate the IBM Watson along with Web UI	1	Low	Riveka, Prakathi
Sprint-3	Create Web UI	USN-9	To create Web UI to access the data from cloud And display all parameters	3	High	Vanitha, Riveka
Sprint-3	To develop a python code	USN-10	Create python code to sense the physical quantity and store data	2	Medium	Vanitha, Riveka
Sprint-4	Publish data to cloud	USN-11	Publish data that is sensed by the microcontroller to the cloud	3	High	Vanitha Riveka

6.2 SPRINT DELIVERY SCHEDULE

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	10	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	10	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	10	19 Nov 2022

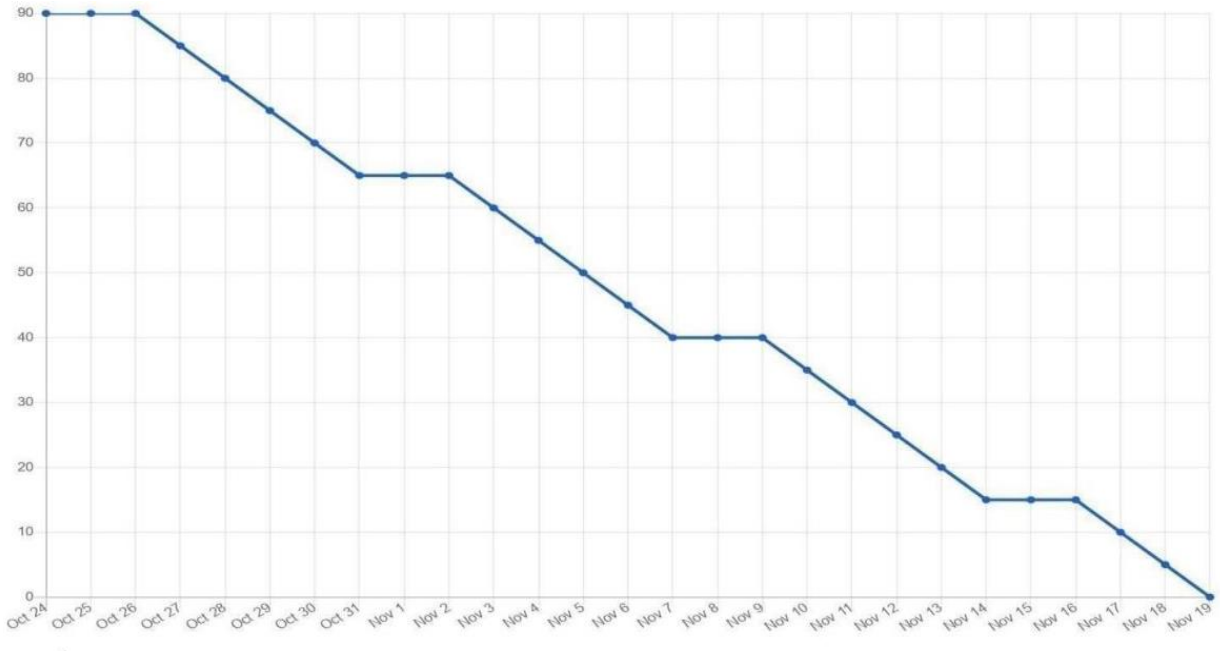
Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let us calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

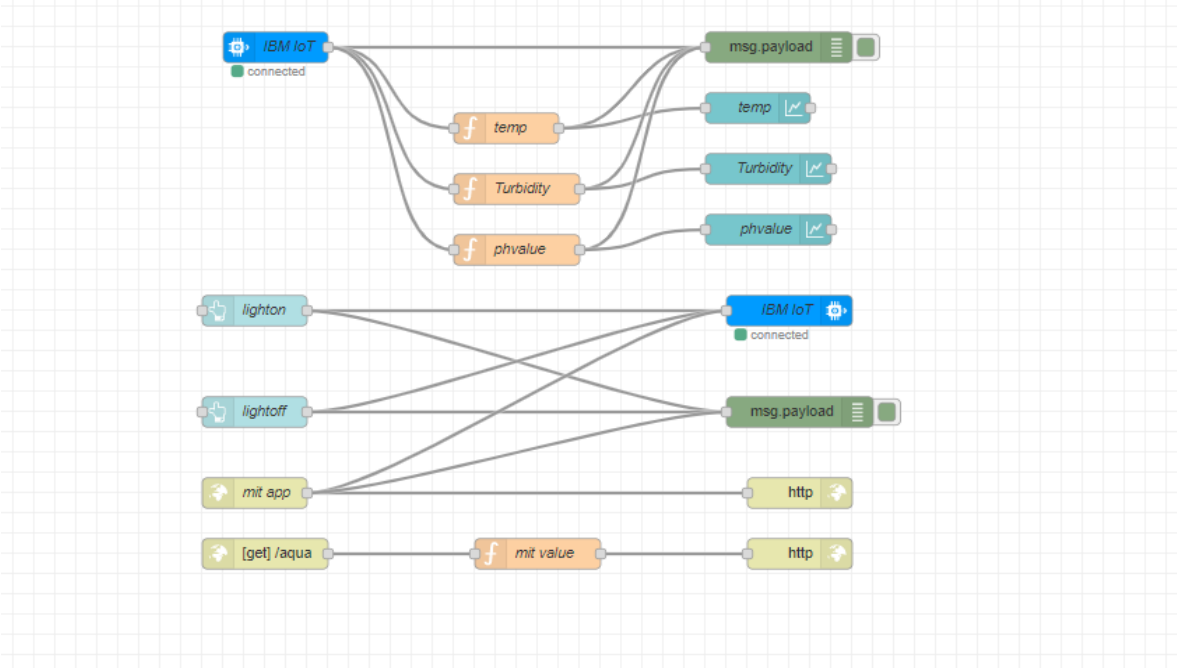
Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

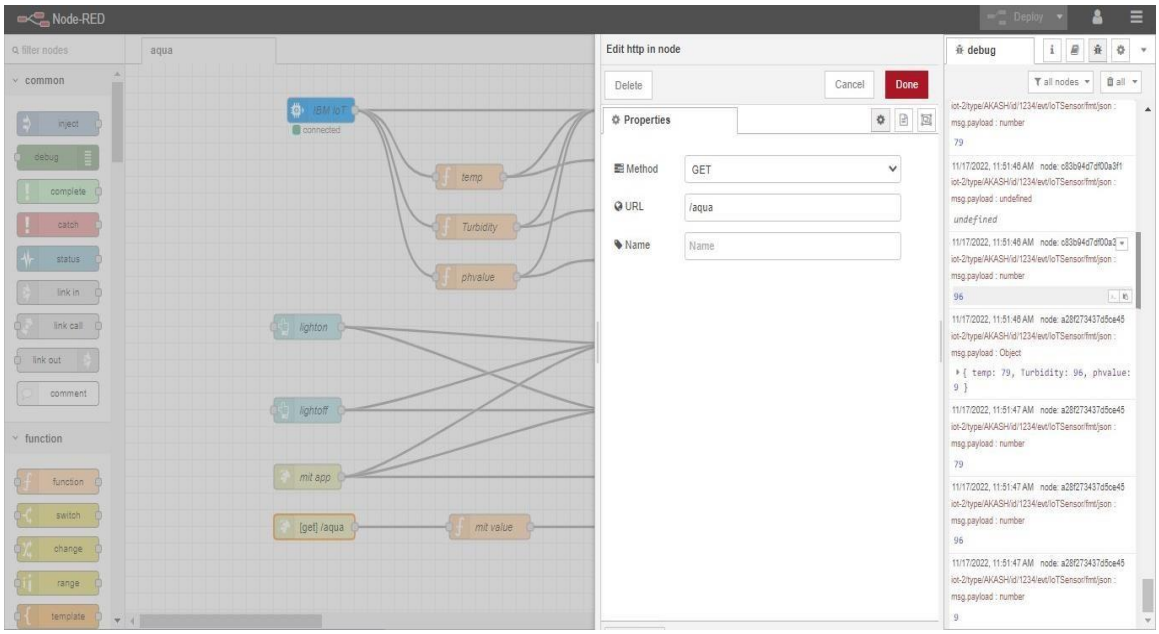


7. CODING & SOLUTIONING

7.1 FEATURE 1



7.2 FEATURE 2



8. TESTING

Testing is more important in every project because we need to know the performance such that the value of product is depend up on the performance

8.1TEST CASES

This report shows the number of test cases that have passed, failed, and untested.

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	15	0	0	15
Client Application	45	0	0	45
Security	1	0	0	1
Outsource Shipping	2	0	0	2
Exception Reporting	10	0	0	10
Final Report Output	4	0	0	4
Version Control	3	0	0	3

8.2 USER ACCEPTANCE TESTING

Test caseid	Feature	Component	Test Scenario	Steps to Execute	Test Data	Actual Result	Status
Login page	Functional	Home page	Verify user can see the Given app	1.Download the given APK File 2. Click on download button3. Verify login popup displayedor not"	APK File	Working as expected	Pass

Login page	Functional	Home page	Verify user can see the Login/Signup popup when user open the Aqua Meter	1. Download the given APK File 2. Click on download button 3. Verify login popup displayed or not"	APK File	Working as expected	Pass
Login page	Functional	Home page	Verify the UI elements in Login/Signup popup	1. Download the given APK File 2. Click on download button 3. Verify login popup with below UI elements: A .Username textbox A .password textbox B .Submit button	APK File	Workingas Expected	Pass
Login Page	Functional	Home page	Verify user is able to log into application with Valid credentials	1 Download thegiven APK File 2. Click on download button3. Enter Valid Given username inUsername text box 4. Enter valid password in password text box5. Click on Submit button"	Userna me: Userna me Passw ord: Passw ord	Workingas Expected	Pass
Login Page	Functional	Home page	Verify user is able to see the output	1.output displayed	APK File	Workingas Expected	Pass

9. RESULTS

9.1 PERFORMANCE METRICS

			NFT - Risk Assessment						
S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Voluem Changes	Risk Score	Justification
1	REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM	New	Low	No Changes	Moderate	3days	>5 to 10%	ORANGE	As we have seen the changes

PERFORMANCE TABLE

PARAMETER	PERFORMANCE	DESCRIPTION
ADMIN TESTING	95%-100%	THE TESTING DONE BEFORE IT IS DEPLOYED AS AN APP
CUSTOMER SATISFACTION	75-85%	THE CUSTOMER NEED TO BE SATISFIED WITHTHE MOBILE APPLICATION
USER INTERFACE	65-85%	THE APP CAN USED BYANYONE (EASE OF ACCESS)
SEVER RESPONSE	50-75%	URL - response
DATA VALIDATION WITHNO. OF TEST CASE	60-80% (15-30 TESTCASE)	VALID DATA FROMTHE APP
ERROR	3-5%	REAL-TIME DELAYMAY OCCUR

10.ADVANTAGES & DISADVANTAGES

ADVANTAGES

- The system gathers the water turbidity and pH characteristics on a real-time basis from numerous distinct sensor nodes at a high rate.
- The automation of this water monitoring, cleaning and control process removes the need of manual labor and thus saves time and money.

DISADVANTAGES

- Maintenance such as a dysfunctional battery power source must be replaced on a regular basis.
- Other sensors need to be added to the system to test more parameters of water quality for some applications.
- It is difficult to collect the water samples from all the area of the water body.

11.CONCLUSION

Real-time monitoring of water quality by using IoT will immensely help people to become conscious against using contaminated water as well as to stop polluting the water. The research is conducted focusing on monitoring river water quality in real-time. Due to the limitation of the budget, we only focus on measuring the quality of river water parameters. This project can be extended into an efficient water management system of a local area. Moreover, other parameters which was not the scope of this project such as total dissolved solid, chemical oxygen demand and dissolved oxygen can also be quantified. So, the additional budget is required for further improvement of the overall system. Thus, our project is used to Monitoring of Turbidity, PH & Temperature of Water makes use of water detection sensor with unique advantage and existing GSM network. The system can monitor water quality automatically, and it is low in cost and does not require people on duty. So, the water quality testing is likely to be more economical, convenient, and fast. The system has good flexibility. Only by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters.

12.FUTURE SCOPE

We use water detection sensor has unique advantage. I t consumes less time to monitor than a manual method for checking polluted levels, and notifies immediately to reduce affected rate of pollution in water. People who are living in rural areas near to the river will be very satisfied with our idea. It will be useful to monitor water pollution in specific area. So, this system prevent people from water pollution. It will be used for farming purpose to check quality water, temperature, and PH level. Our Impact of this project is also creating a social satisfaction for farmers too. The scalability of this project gives the addition of more different type of sensors. By interfacing the relay, we can control the supply of water. We can also implement as a revenue model. This system could also be implemented in various industrial processes. The system can be modified according to the needs of the user and can be implemented along with lab view to monitor data on computers.

13.APPENDIX

SOURCE CODE

```
import time

import sys

import ibmiotf.application

import ibmiotf.device

import random


#Provide your IBM Watson Device Credentials

organization = "uo60re"

deviceType = "AKASH"

deviceId = "1234"

authMethod = "token"

authToken = "12345678"


# Initialize GPIO

def myCommandCallback(cmd):

    print("Command received: %s" % cmd.data['command'])
```

```
    status=cmd.data['command']
    if status=="lighton":
        print ("led is on")
    else:
        print ("led is off")


try:
    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}
    deviceCli = ibmiotf.device.Client(deviceOptions)


except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()


# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times
deviceCli.connect()
```

```
while True:
        #Get Sensor Data from DHT11
        temp=random.randint(60,100)
        Turbidity=random.randint(0,100)
        phvalue=random.randint(2,14)
        data = { 'temp' : temp, 'Turbidity': Turbidity,'phvalue': phvalue}
        #print data
        def myOnPublishCallback():
           print ("Published temp = %s 'C" % temp, "Turbidity = %s %%" Turbidity,"phvalue = %s %%" % phvalue, "to IBM Watson")
        success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback)
        if not success:
           print("Not connected to IoTF")
        time.sleep(10)
        deviceCli.commandCallback = myCommandCallback


# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

GITHUB & PROJECT DEMO LINK

GITHUB LINK:

https://github.com/IBM-EPBL/IBM-Project-38862-1660386140

PROJECT DEMO LINK:

https://youtu.be/wHK2kSpRXJY