RMK ENGINEERING COLLEGE

(An Autonomous Institution)

R.S.M. Nagar, Kavaraipettai-601 206, Gummidipoondi Taluk,
Thiruvallur District.

PROJECT

Real-Time River Water Quality Monitoring and Control System

DONE BY

TEAM ID - PNT2022TMID15687

BRINDA A – 111719104028
DHEEKSHITHA S – 111719104043
DIVYA PRIYA MS - 111719104048
GEJASHREE T – 111917104055

1. INTRODUCTION

1.1. Project Overview

The environment around consists of five key elements e.g., soil, water, climate, natural vegetation, and landforms. Among these water is the utmost crucial element for human life. It is also vital for the persistence of other living habitats . Whether it is used for drinking, domestic use, and food production or recreational purposes, safe and readily available water is the need for public health . So it is highly imperative for us to maintain water quality balance. our project detects the pH value temperature value,and turbity value of the water and send SMS to an authorized person routinely when water quality detected does not match the preset standards, so that, necessary actions can be taken.. we used MIT App Inventor for user's login and shows the water quality range. We have used node-Red ,IBM Watson and IBM cloud.

1.2. Purpose

Nowadays water is the is the most valuable for all the human beings drinking water utilities faces challenges in realtime 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. To reduce the water related diseases and prevent water population World health Organization (WHO) has also stated this crisis as "the largest mass poisoning of a population in history". The main goal of this project to build a Water Quality Monitoring System.

2. LITERATURE SURVEY

2.1. Existing System

Detection on water pollution and water management using smart sensors IoT To ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things)

based water quality monitoring has been proposed. This system consists some sensors. Which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature. The measured values from the sensors are processed by microcontroller and these processed values are transmitted remotely to the core controller thatis raspberry pi using Zigbee protocol. Based on a study of existing water quality monitoring systemand scenario of water we can say that proposed system is more suitable to monitor water quality parameters in real time. Based on a study of existing water quality monitoring system and scenario of water we can say that proposed system is more suitable to monitor water quality parameters inreal time.

Author: J.Navarajan

This research paper focuses on Sensor Web for River Water Pollution Monitoring and Alert System Sensor Web has provided infrastructure for collecting and processing data from distributed and heterogeneous sensors. This set of technologies has found various implementations, especially in the area of environmental monitoring. The

Sensor Web architecture for crisis management, described in this paper, provides active monitoring of measuring parameters and timely responses in cases of environmental disasters. The River Water Management and Alert System built on this architecture enable access, control and management of river water pollution.

Author: NatasaMarkovic

Advantages:

- Pure water in healthcare facilities. A healthy water supply made possible.
- Aquatic life preservation practical, Achieve sustainability through LEED and/or WELL certifications.

Disadvantages:

- The waters in many supply systems have to be allocated based on past availability or existing consumer demand. The practice does not necessarily mean the allocation is proper. In fact, some supply systems can get overly crowded.
- There are no specific management plans or

sanctions on water extractions in many areas, such as pumping groundwater or rivers. These have caused less water to be soluble and even led to the mining of that resource in some respects. This hampers the water levels and increases the risk of contaminated water.

2.2. References

[1] . K. Khurana, R. Singh, A. Prakash, R. Chhabra, “An IoT Based Water Health Monitoring System”, International Journal of Computer Technology and Applications (IJCTA), 9(21), pp. 07-13, 2016.

[2] Guidelines for Water Quality Monitoring Central”, Central Pollution Control Board, 2008

[3] A.S. Rao, S. Marshall, J. Gubbi, M. Palaniswami, R. Sinnott, V. Pettigrove, “Design of Low-cost Autonomous Water Quality Monitoring System”, International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2013.

[4] ISO 7027, Water Quality, International Standard,

1990.

[5] WQA Glossary of Terms, by the Water Quality Association, Illinois 60532 USA, 3rd Edition, 1997. [6] V. S. Hart, C. E. Johnson, and R. D. Letterman, An Analysis of LowLevel Turbidity measurements

2.3. Problem Statement Definition

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.

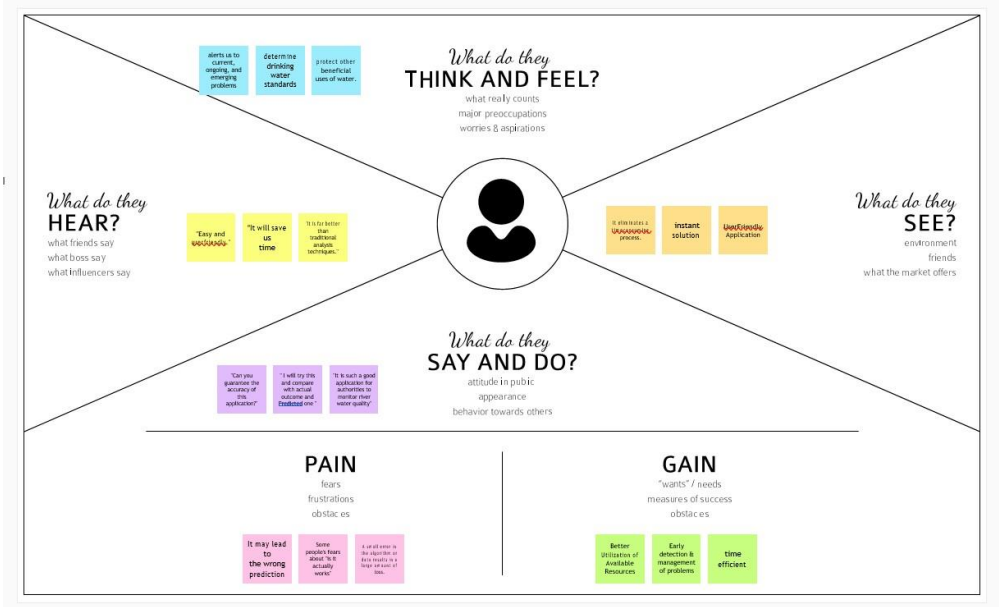
3. IDEATION & PROPOSED SOLUTION

3.1. Empathy Map Canvas

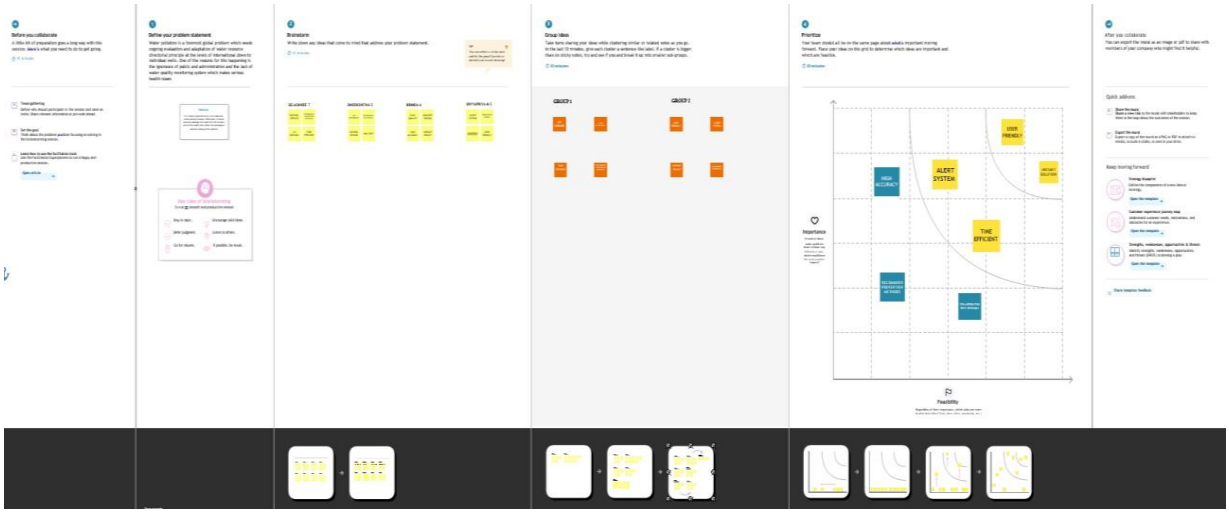
River water is the major source for civilization. Due to rapid industrialization and increasing population the amount of sewage disposal into river is greatly increased lea

ding to

Real-Time River Water Quality Monitoring and Control Systemthe pollution of water. Our proposed system will immensely help people to become conscious against contaminated water as well as to stop polluting the water.



3.2. Ideation & Brainstorming



3.3. Proposed Solution

S. No.	Parameter	Description
1.	Problem Statement (Problem to besolved)	Many rivers and streams are significantly polluted all around the world. A primary reason for this is that all three major sources of pollution (industry, agriculture and domestic) are concentrated along the rivers. Industries and cities have historically been located along rivers because the rivers provide transportation and have traditionally been a convenient place to discharge waste. Agricultural activities have tended to be concentrated near rivers,

		because river floodplains are exceptionally fertile due to the many nutrients that are deposited in the soil whenthe river overflows. Hence it is highly necessary for us to monitor the quality of river water. Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming.
2.	Idea / Solution description	This project proposes a sensor-based water quality monitoring system. The main aim isto develop a system for continuous monitoring of river water quality at remote places using wireless sensor networks with low power consumption, low-cost and

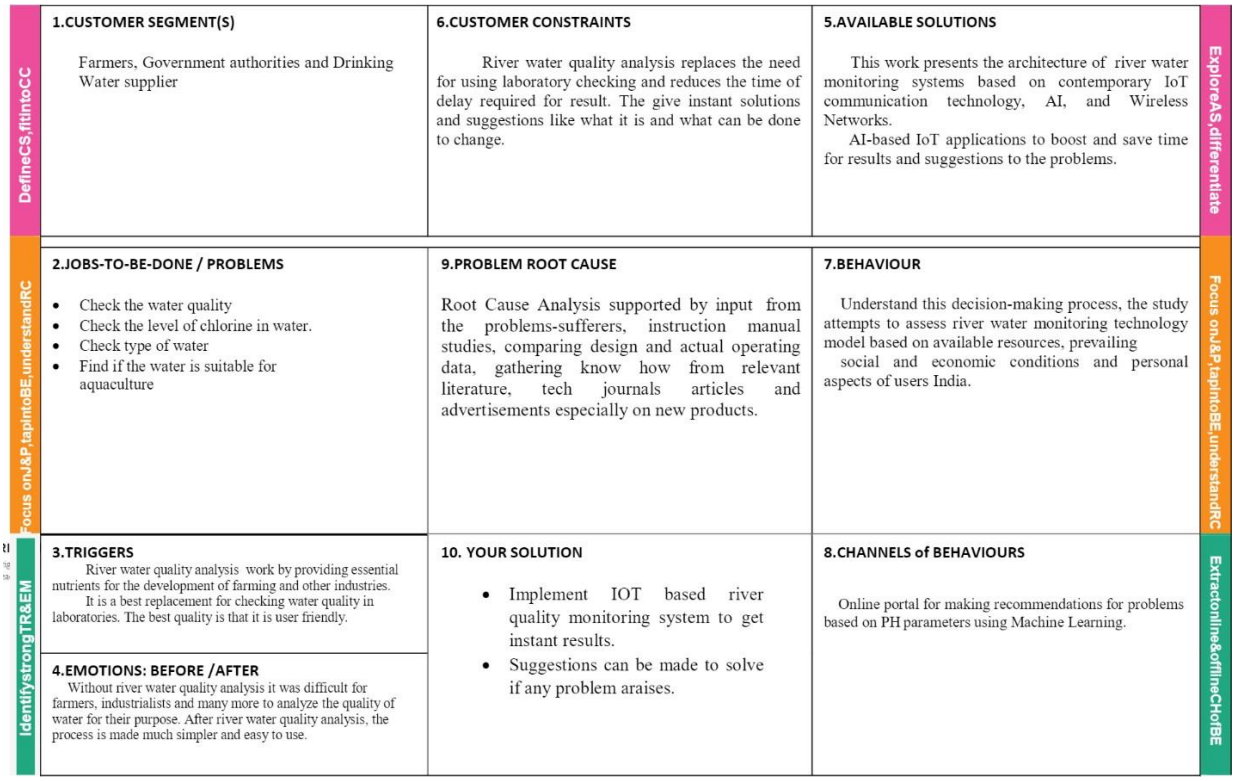
		high detection accuracy. pH, conductivity, turbidity level, etc. are the limits that are analyzed to improve the water quality. Following are the aims of idea implementation (a) To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, etc. using availablesensors at a remote place. (b) To assemble data from various sensor nodes and send itto the base station by the wireless channel. (c) To simulate and evaluate quality

		parameters for quality control. (d) To send SMS to an authorized person routinely when water quality detected does not match the pre-set standards, so that, necessary actions can be taken.
3.	Novelty / Uniqueness	This project not only monitors the quality ofwater but also suggests methods to prevent pollution caused by various factors.
4.	Social Impact / Customer Satisfaction	Real-time monitoring of water quality by using IoT integrated Big Data Analytics willimmensely 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.
5.	Business Model (Revenue Model)	A low cost, less complex water quality monitoring system is proposed. The implementation enables sensor to provide online data to consumers. We plan to collaborate with authorities and market our product to them to generate revenue.
6.	Scalability of the Solution	This project focusses 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 wasn't the scope of this project such as total dissolved solid, chemical oxygen demand and dissolved oxygen can also be quantified.

3.4. Problem Solution fit



4. REQUIREMENT ANALYSIS

4.1. Functional requirement

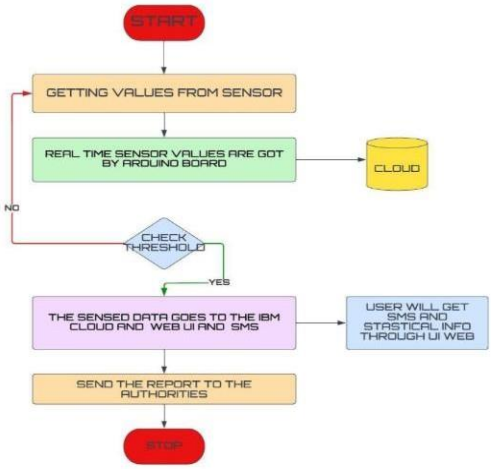
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Control system(Arduino)	Arduino is connected to sensors, and it periodically gathers measurement data from the sensors.
FR-2	WSN Sensor	For the monitoring of pH, temperature, dust particles, and turbidity, several sensor nodes have been installed.
FR-3	Software Design Requirements	In order to categorize water quality as Good or Bad, WSN requires an IoT platform that requires a neural network model. IoT has big data analytics integrated to store data in the cloud and continuously analyze it.
FR-4	Display	Displays the resulting sensed pH, temperature, turbidity. If ,acquired value > Threshold value, then comment=BAD. If, acquired value < Threshold value, then comment=GOOD.

4.2. Non-Functional requirements

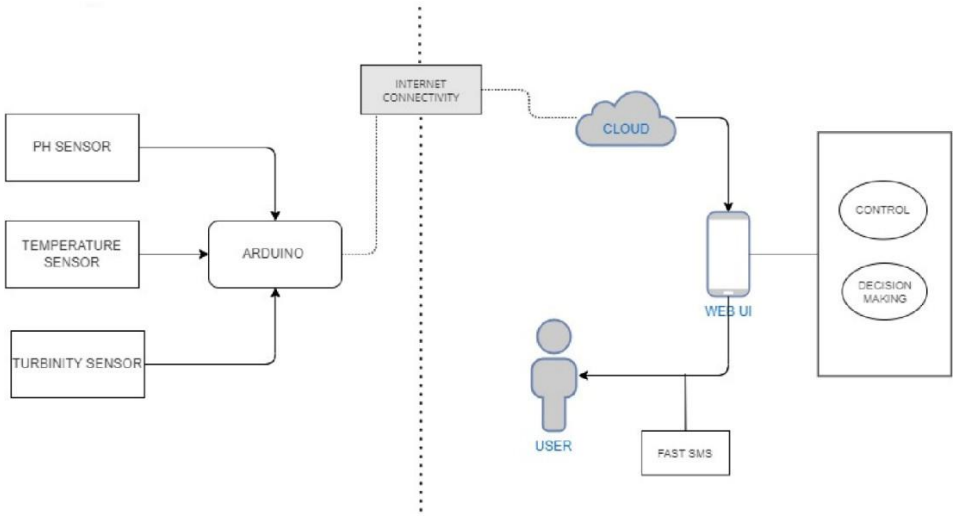
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Monitoring water quality is crucial to ensuring that it is safe for people to drink as well as for wildlife and marine life, to understand how it affects the ecosystem, and to prevent harm to marine life.
NFR-2	**Security**	The IoT networks have excellent connection speeds and are highly safe. All of the problems are comfortably solved by technology.
NFR-3	**Reliability**	The method for monitoring the quality of the water is dependable, and its results can be trusted. Considering that standardised hardware and software architectures are employed.
NFR-4	**Performance**	Water quality monitoring is done in real time, and if the quality is poor, the authorities are notified.

5. PROJECT DESIGN

5.1. Data Flow Diagrams



5.2. Solution & Technical Architecture



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 email, password, and confirming my password.	I can access my account/dashboard	High	Sprint-1
		USN-2	As a user, I will receive a confirmation email once I have registered for the application	I can receive e 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	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 & captcha	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	WUSN-1	As a web user, I can access the specific info (ph value, temp, humidity, quality).	I can able to know the quality of the water.	High	Sprint-1
Customer Care Executive (input)	View manner	CCE-1	As a customer care, I can view data in visual representation manner(graph)	I can easily understand by visuals.	High	Sprint-1
	Taste	CCE-2	As a customer care , I can able to view the quality(salty) of the water	I can easily know whether it is salty or not	High	Sprint-1
	Color visibility	CCE-3	As a customer care , I can able predict the water color	I can easily know the condition by color	High	Sprint-1
Administrator	Risk tolerant	ADMIN-1	An administrator who Is handling the system should update and take care of the application.	Admin should monitor the records properly.	High	Sprint-2

6. PROJECT PLANNING & SCHEDULING

6.1. Sprint Planning

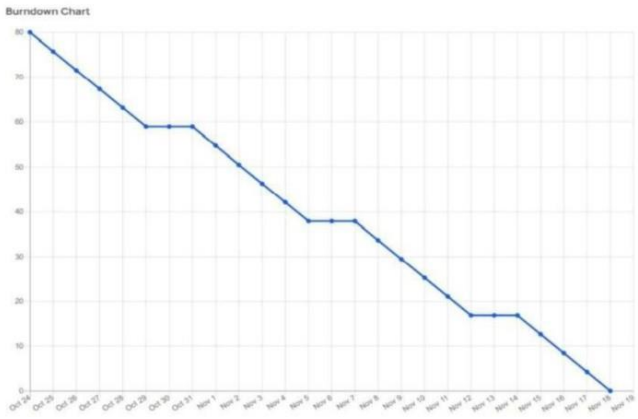
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Create IBM Cloud Services	USN-1	Creation of an IBM Cloud account and registering a device.	2	High	Dheekshitha S, Divya Priya MS, Brinda A, Gejashree T
Sprint-1	Configure the IoT devicein IBM Cloud.	USN-2	Creation and registering of a device	2	High	Dheekshitha S, Divya Priya MS, Brinda A, Gejashree T
Sprint-1	Mobile UI	USN-3	As a user,I can study the river water quality by registering into Mobile app	1	Medium	Brinda A, Divya priya MS
Sprint-1	Secure Login	USN-4	As a user, I can login into App securely and my login credentials are securely stored in database	2	High	Gejashree T, Dheekshitha S
Sprint-1	Alerting Authority	USN-5	As a user, I can alert the authority by sending mail or SMS	2	Medium	Dheekshitha S, Divya Priya MS, Brinda A
Sprint-2	Quick delivery of sensor values	USN-6	As a user, I can get the data values without any latency	3	Medium	Gejashree T, Dheekshitha S
Sprint-3	Create a Node Red Service	USN-7	To create a node red service to integrate the IBMWatson along with the Web UI	2	Low	Brinda A, Divya priya MS

Sprint-3	Create a Web UI	USN-8	To create a Web UI, to access the data from the cloud and display all parameters.	2	Low	Gejashree T, Dheekshitha S
Sprint-3	Generate a link to Interface the node red service with the Web UI/Mobile app	USN-9	Generate Link to interface the services.	3		Dheekshitha S
Sprint-4	Design a Mobile App, todisplay pH, Temperatureand turbidity values	USN-10	To design a Android App using MIT App inventor, todisplay pH, Temperature and turbidity values.	2	Medium	Dheekshitha S, Divya Priya MS, Brinda A, Gejashree T
Sprint-4	Fast-SMS Service	USN-11	For real-time quality monitoring, we use Fast SMS to send alert messages once the parameters like pH, Turbidity and temperature goes beyond the threshold	3	High	Gejashree T, Brinda A
Sprint-4	Product Testing	USN-12	Testing of project and final deliverables	3	High	Dheekshitha S, Divya Priya MS, Brinda A, Gejashree T

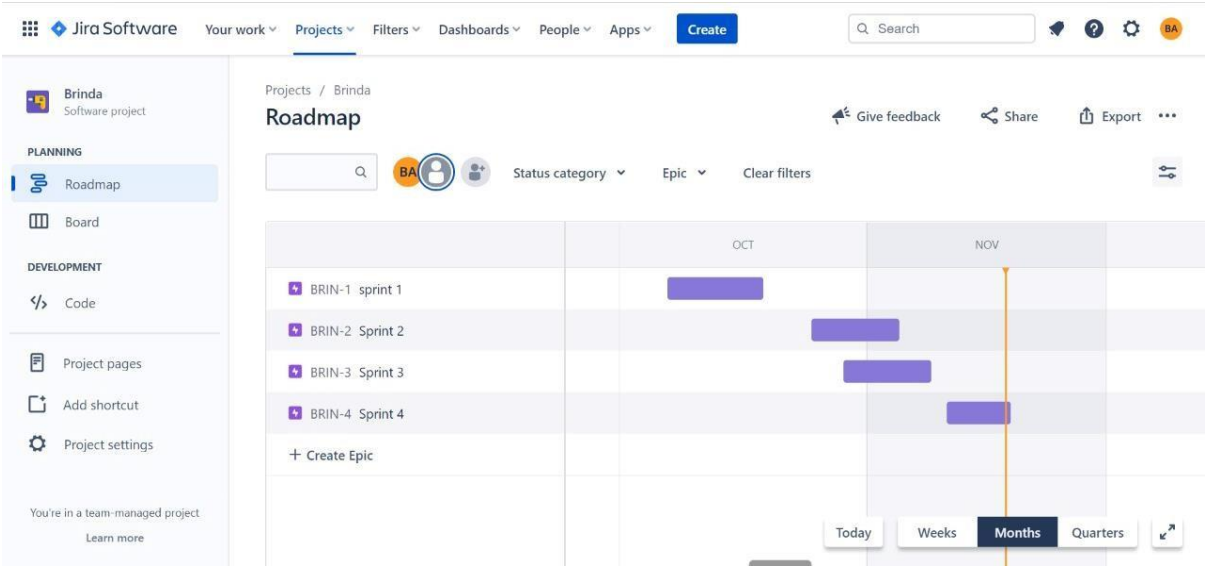
6.2. Sprint Delivery Schedule & Estimation

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	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Burndown Chart:

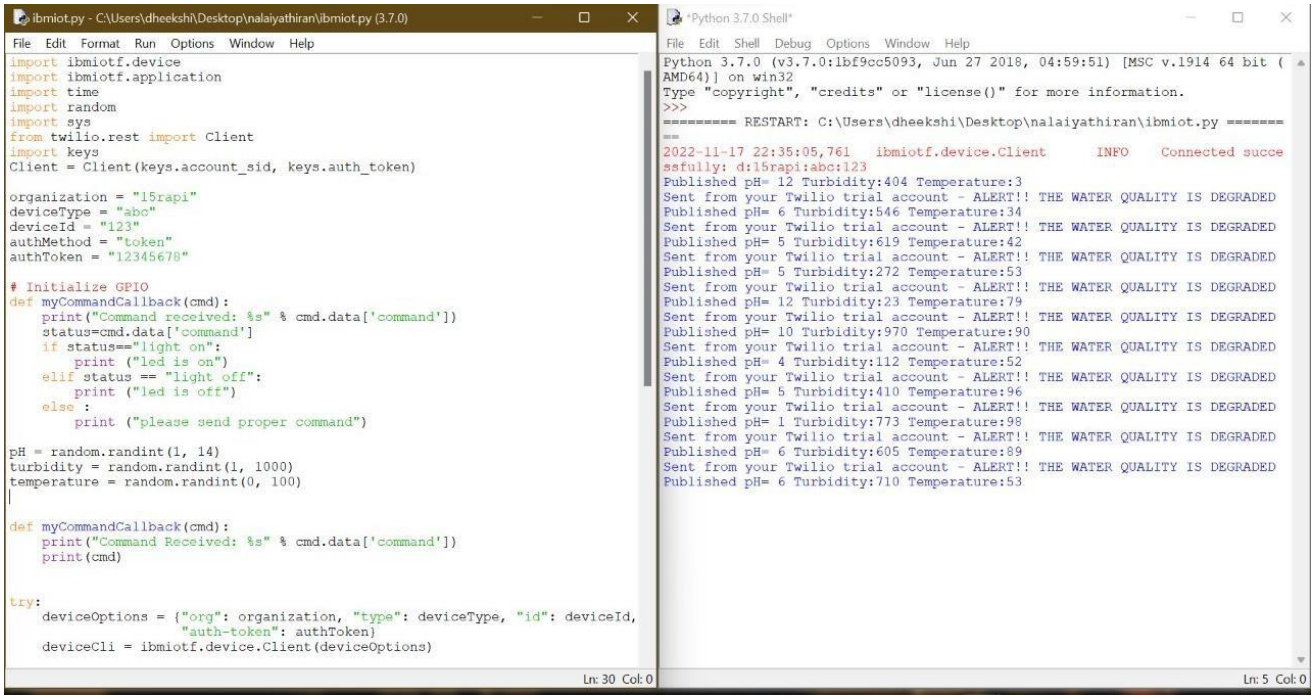


6.3. Reports from JIRA



7. CODING & SOLUTIONING

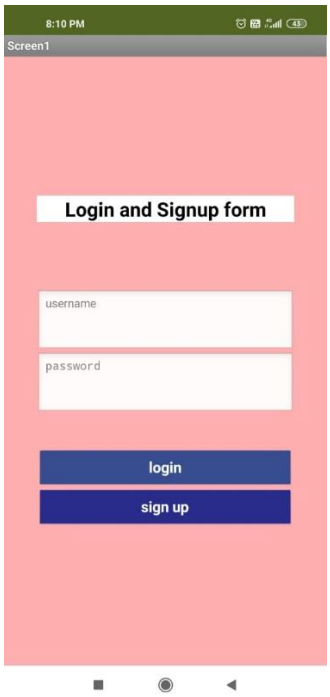
CODE



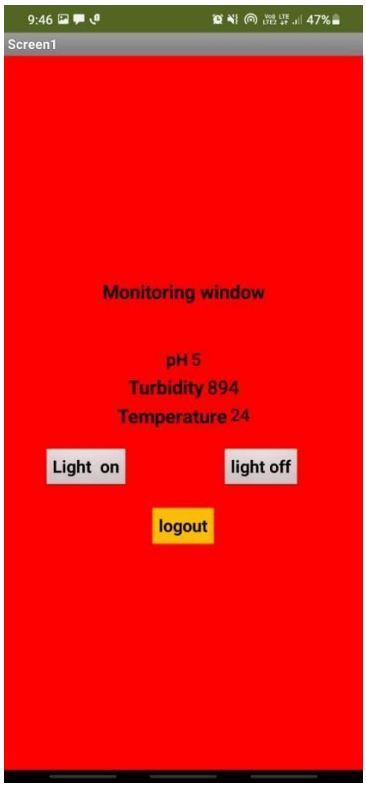
```
import ibmiotf.device
import ibmiotf.application
import time
import random
import sys
from twilio.rest import Client
import keys
Client = Client(keys.account_sid, keys.auth_token)

organization = "15rapi"
deviceType = "abc"
deviceId = "123"
authMethod = "token"
authToken = "12345678"

# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="light on":
        print ("led is on")
    elif status == "light off":
        print ("led is off")
    else :
        print ("please send proper command")

pH = random.randint(1, 14)
turbidity = random.randint(1, 1000)
temperature = random.randint(0, 100)

def myCommandCallback(cmd):
    print("Command Received: %s" % cmd.data['command'])
    print(cmd)


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

```
Python 3.7.0 (v3.7.0:1bf9cc5093, Jun 27 2018, 04:59:51) [MSC v.1914 64 bit (
AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
========= RESTART: C:\Users\dheekshi\Desktop\nalaiyathiran\ibmiot.py =======
==
2022-11-17 22:35:05,761   ibmiotf.device.Client      INFO    Connected succe
ssfully: d:15rapi:abc:123
Published pH= 12 Turbidity:404 Temperature:3
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 6 Turbidity:546 Temperature:34
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 5 Turbidity:619 Temperature:42
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 5 Turbidity:272 Temperature:53
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 12 Turbidity:23 Temperature:79
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 10 Turbidity:970 Temperature:90
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 4 Turbidity:112 Temperature:52
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 5 Turbidity:410 Temperature:96
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 1 Turbidity:773 Temperature:98
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 6 Turbidity:605 Temperature:89
Sent from your Twilio trial account - ALERT!! THE WATER QUALITY IS DEGRADED
Published pH= 6 Turbidity:710 Temperature:53
```

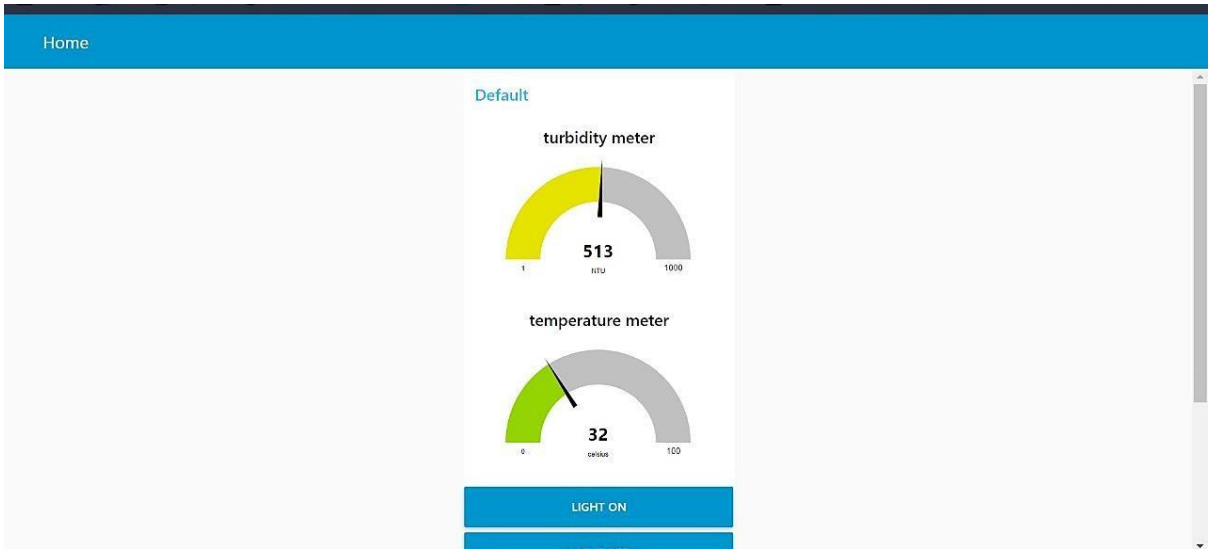
Login Page



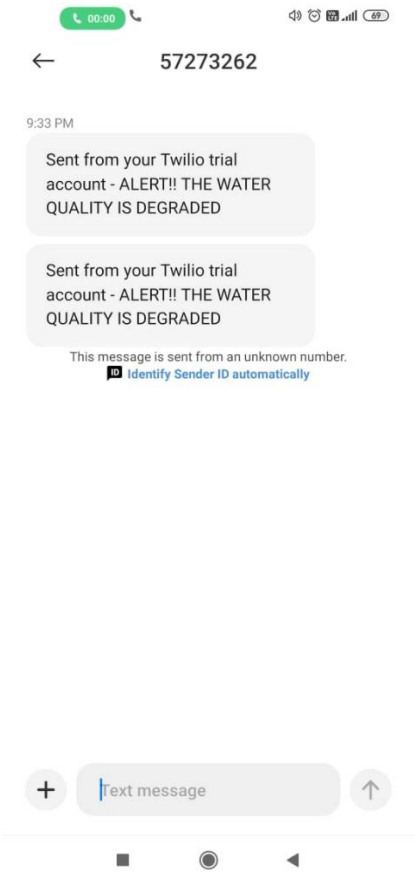
Monitoring window



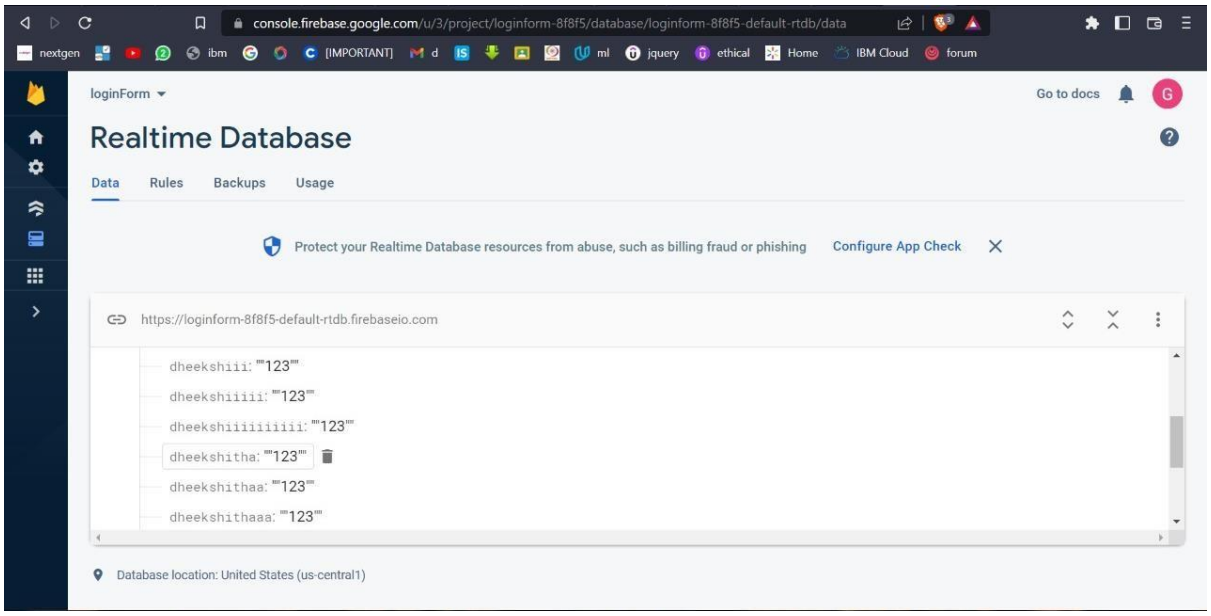
Web UI



Alert & Notification page



Database Schema (FireBase)



8. TESTING & RESULTS

8.1. Test Cases

Test case ID	Test case	Input	Output	Status
1	When the values of the parameters	Temperature=3,pH=3,Turbidity=404	ALERT!! THE WATER QUALITY IS DEGRA	Pass

	are above the threshold value		DED	
2	When the values of the parameters are within the range	Temperature=45,pH=7,Turbidity=350	(no alert message is sent)	Pass

8.2. User Acceptance Testing

Defect Analysis

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20

Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

Test Case Analysis

Section	Total Cases	Not Tested	Fail	Pass
Client Application	51	0	0	51
Security	2	0	0	2

Exception Reporting	9	0	0	9
Final ReportOutput	4	0	0	4
Version Control	2	0	0	2

8.3 Performance Testing

PARAMETER	PERFORMANCE	DESCRIPTION
Admin testing	95%-100%	The testing is done before the app is deployed
Customer satisfaction	75%-85%	The customer needs to be satisfied with the mobile application
User Interface	65%-85%	The app can be used by anyone
Server response	50%-75%	URL response
Data validation with no.of test case	60%-80%	Valid data from the app
Error	3%-5%	Real-time delay may occur

9. ADVANTAGES

- Pure water in healthcare facilities, A healthy water supply made possible.
- Aquatic life preservation practical.
- Wireless sensor Network which aids in River Water Quality Monitoring. This paper also proposes a novel technique for the design of a water quality sensor node

which can be used for monitoringthe pH of water.

- Based on a study of existing water quality monitoring system and scenario of water we can say that proposed system is more suitable to monitor water quality parameters in real time.
- The River Water Management and Alert System built

on this architecture enable access, control and management of river water pollution.

- The water quality parameters such as pH, Temperature, Turbidity can be monitored.

DISADVANTAGES

- There are no specific management plans or sanctions on water extractionsin many areas, such as pumping groundwater or rivers. These have caused less water to be

  soluble and even led to the mining of that resource in some respects. This hampers the water levels and increases the risk of contaminated water.
- This paper focuses only on the pH, turbidigity, temperature of river water here the other parameters such as conductivity is not considered.
- The disadvantage of this system is, water is not monitoring seamlessly, and it always needs a human intervention.

10. CONCLUSION

Real-time monitoring of water quality by using IoT integrated 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. Therefore, IoT integrated big data analytics is appeared to be a better solution as reliability, scalability, speed, and persistence can be provided.

11. FUTURE SCOPE

In this proposed system 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 wasn't the scope of this project such as total dissolved solid, chemical oxygen demand and dissolved oxygen can also be quantified.

12. APPENDIX

Source Code:

```
import ibmiotf.device
import ibmiotf.application
import time
import random
import sys
from twilio.rest import Client
import keys
Client = Client(keys.account_sid, keys.auth_token)

organization = "15rapi"
deviceType = "abc"
deviceId = "123"
authMethod = "token"
authToken = "12345678"

pH = random.randint(1, 14)
turbidity = random.randint(1, 1000)
temperature = random.randint(0, 100)
```

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


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()
deviceCli.connect()


while True:
```

```
pH = random.randint(1, 14)
turbidity = random.randint(1, 1000)
temperature = random.randint(0, 100)
data = {'pH': pH, 'turbid': turbidity, 'temp': temperature}

def SMS():
    message = Client.messages.create(
        body="ALERT!! THE WATER QUALITY IS DEGRADED",
        from_=keys.twilio_number,
         to = keys.target_number)
    print(message.body)

if temperature>70 or pH<6 or turbidity>500:
    SMS()

def myOnPublishCallback():
    print("Published pH= %s" % pH, "Turbidity:%s" %
```

```
turbidity, "Temperature:%s" % temperature)

success = deviceCli.publishEvent("demo", "json",
data, qos=0, on_publish=myOnPublishCallback)
if not success:
    print("Not Connected to ibmiot")
time.sleep(5)
deviceCli.commandCallback = myCommandCallback

deviceCli.disconnect()
```

GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-25699-1659971050

Project Demo Link:

https://drive.google.com/drive/folders/1s_iIWyfj3--TQxQzOZQkk_pp3wJClwBm?usp=share_link