

# **REAL-TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEMS**

**Team-Id: PNT2022TMID00265**

## **PROJECT REPORT**

### **INTRODUCTION:**

#### **1.1 Project Overview**

When detection of water quality is conventionally performed, water samples will be obtained and sent for laboratory examinations which costs for time, financial aid and human resources. Such techniques do not provide data in real-time. The proposed water quality monitoring system is consisting of a microcontroller and basic sensors, which is compact and very useful for pH, turbidity, water level detection, temperature and humidity of the atmosphere, continuous and real-time data sending via wireless technology to the monitoring station. This projected the water quality observation interface sensors with quality observation with IOT setting. WQM selects parameters of water like temperature, pH level, water level and CO<sub>2</sub> by multiple different device nodes. This methodology sends the information to the web server. The data updated at intervals within the server may be retrieved or accessed from anyplace within the world. If the sensors do not work or get into abnormal conditions, then a buzzer will go ON. So for this project we are going to effectively analyze the two components involved in a real time quality monitoring system. For the hardware part we are going to take sensors to analyze the river water and a ping it to a controller used to control the sensor nodes. For the software part we are going to use Node RED in IOT Watson platform. So after we develop the software code we are going to load in the hardware component and a bigger data storage is needed for all those temperature, turbidity, and pH values of river water. An IOT Watson platform inter-connected to Node RED acts as a directive to Web UI forming the cloud services and storage. Python language which is Simple in nature, Highly Compatible and Object-Oriented it performs easy compilation and Increases Speed and Productivity employing Lots of Libraries and Built-in Data Structures for which it greatly accounts for our data storage issue. In our project we use WSN technology to perform a low and consistent energy management for wireless connection of sensor nodes. Thus creating a much efficient product that we present to people which is beneficial and both Safe and Affordable.

#### **1.2 Purpose**

Our culture being centered around the prominence of water being manifested in many forms. Our project is yet another step in conservation and preservation of the water bodies.

Due to rapid urbanization and increase in population, water resources are exploited. Not only depleting in the attempt of acquisition also contaminating while doing so. One of the ways of the quality being degraded is "Eutrophication".

Where a water body develops a surplus amount of nutrients and phosphorus from pollutants allowing for the rapid growth of algae and plankton. It takes minimum of a year to regain the old nature of the lake

Though the eutrophication caused by enteromopha prolifera does not affect humans or animals directly, due to oxygen meant for aquatic life forms being consumed, the ecosystem is disturbed

## **2. LITERATURE SURVEY**

### **2.1 Existing problem**

In "Smart Water Quality Monitoring System" by Mr. Kumar K explains that Water is one of the major compounds that profoundly influence ecosystem. But, nowadays it is been exploited heavily due to rapid industrialization, human waste and random use of pesticides and chemical fertilizers in agriculture, which leads to water contamination. Thus, a water monitoring system is necessary to observe the water quality in a large area such as lake, river, and aquaculture. As per the current world situation, Internet of Things (IoT) and remote sensing techniques are used in heterogeneous areas of research for supervising, congregate and analyzing data from the remote locations. In this paper, the suggested system is a minimal price real time water quality monitoring system in IoT environment. This system comprise of numerous sensors for assessing the physical and chemical parameter. The factors of water that can be assessed using these sensors are pH, turbidity, conductivity, dissolved oxygen. Using this system the real time quality of water bodies can be determined and the data uploaded over the Internet are analyzed.

Jayti Bhatt, Jignesh Patoliya entitled "Real Time Water Quality Monitoring System". This paper describes 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. In this paper, we present the design of IOT based water quality monitoring system that monitor the quality of water in real time. This system consists some sensors which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature and total dissolved solids (TDS). The measured values from the sensors are processed by microcontroller and this processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Finally, sensors data can view on internet browser application using cloud computing.

Nikhil Kedia entitled "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project." Published in 2015 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India. This paper highlights the entire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator and villagers in ensuring proper information dissipation. It also explores the Sensor Cloud domain. While automatically improving the

water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people.

## **2.2 References**

1. "Smart Water Quality Monitoring System" authored by Mr. Kumar K International Journal of Innovations in Engineering and Science, Vol. 3, No.3, 2018.
2. Jayti Bhatt, Jignesh Patoliya, "IoT Based Water Quality Monitoring System" IRFIC, 21 feb, 2016.
3. Nikhil Kedia, "Water Quality Monitoring for Rural Areas- A Sensor Cloud Based Economical Project" in 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India, 4-5 September 2015. 978-1-4673-6809-4/15©2015 IEEE.
4. B. Anuradha, R. Chaitra, D. Pooja "IoT based low cost system for monitoring of water quality in real time" Int. Res. J. Eng. Technol. (IRJET) Volume : 05 (Issue : 05) (2018) May-2018.
5. Michal lom, ondrej priby & miroslav svitek, "Internet 4.0 as a part of smart cities" 978-1-5090-1116-2/16 ©2016 IEEE.

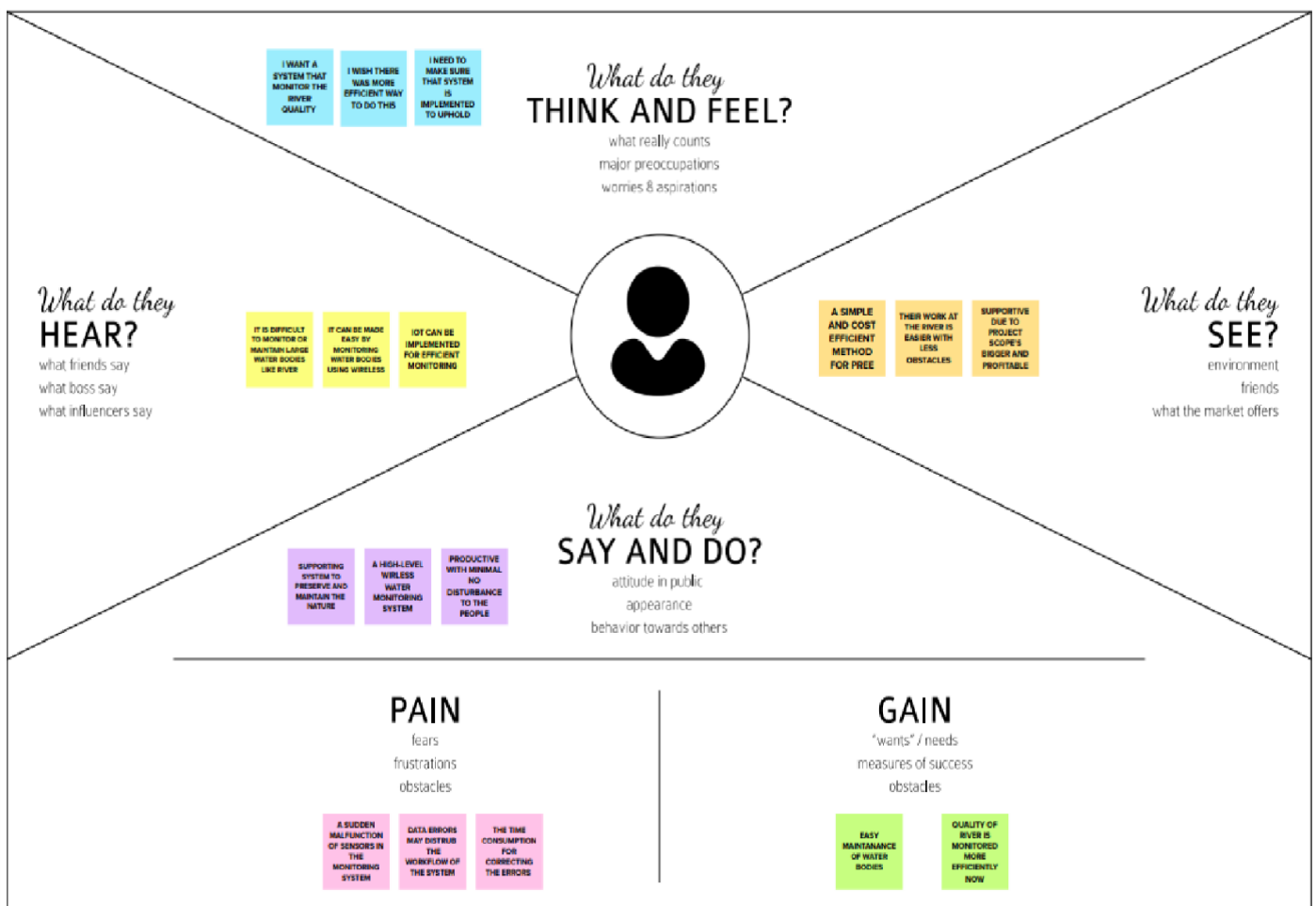
## **2.3 Problem Statement Definition**

Generally in accordance with the referred papers published regarding the issue is centered with a concern of ignorance to the extent of human intervention directly or indirectly leading to greater fluctuations in the characteristics of the water bodies affecting the livelihood of people who are dependent.

## IDEATION & PROPOSED SOLUTION

### 3.1 Empathy Map Canvas

As an attempt to provide the approach of the project towards the Target customer, an Empathy map for the project is provided and discussed. Empathy map-which is collaborative tool used **to gain a deeper insight into their customers**. Much like a user persona, an empathy map can represent a group of users, such as a customer segment.



## 3.2 Ideation & Brainstorming

**Brainstorm & idea prioritization**

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare  
1 hour to collaborate  
24 people recommended

Show template feedback

**Before you collaborate**

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

1. Team gathering: Define who should participate in the session and send an invite. Share relevant information or previous ideas.

2. Set the goal: Think about the problem you'll be focusing on during the brainstorming session.

3. Learn how to use the facilitation tools: Use the facilitation suggestions to run a happy and productive session.

Open article

**Define your problem statement**

What problem are you trying to solve? Frame your problem as a how might we statement. This will be the focus of your brainstorm.

5 minutes

HOW MIGHT WE  
IMPROVE THE  
WATER MONITORING  
AND  
PREDICTION WITH  
REAL TIME DATA AND  
ALERT

**Key rules of brainstorming**

To run an unbreakable and productive session

Stay in topic  
Defer judgment  
Welcome wild ideas  
Encourage risk taking  
Use lots of words  
If possible, be visual

**Brainstorm**

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

10 minutes

**GOKUL KS**

Easy to accommodate  
Cost Efficient  
Profitable  
Eco friendly

**HEMANAND J**

Continuous monitoring achieved through Web UI  
Quick access through the interface  
Storage is flexible  
Results monitored via cloud service

**ANAND E**

Operated via online  
New users can use it with ease  
Low power consumption  
A powerful equipment that maintains clean river

**CHITHART HNK**

Boosts confidence among people using River source.  
Has Great user interface and is trustworthy to use.  
Sensors used to detect water quality.

COULD BE WITH  
GOKUL KS &  
ANAND E

Read some suggestions! See a list of ideas of how to improve the brainstorming session.

Open article

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Show template feedback

**Group Ideas**

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

10 minutes

**Technology**

It uses its potential to develop solutions to many physical and cognitive problems with river water to promote safer river water consumption on sustainable and daily basis.

**Quality Management of Water**

Monitoring and control over river water helps preventing presence and make of polluted water with hazardous chemicals thereby improving people health and life.

**Model Analogy**

Careful analysis is taken to develop an high performance river water monitoring technology which is trained with an perfect platform its sustainability and safe.

Decisions and analyze the data

**Prioritize**

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

10 minutes

Analysis and results handled safely.  
Less complications and complexities  
IOT  
PST SMS  
Cloud services  
Public facilitated  
DBMS  
Advanced optimization and quick reports  
Friendly User interface  
Feedback and support

Importance  
Feasibility

Regulation of IOT operations, which takes care more than other (SMS, cloud, PST, simplicity, etc.)

**After you collaborate**

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick additions

1. Share the mural: Share a link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

2. Export the mural: Export a copy of the mural as a PNG or PDF to allow to easily integrate it into your work.

Keep moving forward

1. Strategy blueprint: Define the components of a new idea or strategy. Open the template

2. Customer experience journey map: Prioritize customer needs, motivations, and emotions to strategize. Open the template

3. Strengths, weaknesses, opportunities & threats: Identify strengths, weaknesses, opportunities and threats (SWOT) to generate a plan. Open the template

Show template feedback

Read some suggestions! See a list of ideas of how to improve the brainstorming session.

Open article

10 minutes to prepare  
1 hour to collaborate  
24 people recommended

Show template feedback

### 3.3 Proposed Solution

River water quality can be monitored by the web application. It can be able to know if there are any dust particles in the river water. The PH level of the river water can be monitored. Water temperature can be monitored. Alerting the authorities if the water quality is not good so that they can go and announce the localities not to drink that river water.

Exhibited in the form of Water monitoring and control model.

This system uses different sensors for monitoring the water quality by determining pH, turbidity, conductivity and temperature. The Arduino controller used will access the sensor data. With the use of IoT, the collected data is analyzed and the pollution of water can be investigated by a stringent mechanism.

### 3.4 Problem Solution fit

#### Problem-Solution fit canvas 2.0

Project Design Phase - I

Team ID: PNT2022TMD00265

Define CS, fit into CC	<b>1. CUSTOMER SEGMENT(S)</b> Who is your customer? * Municipal Corporation * Industries * Local people	<b>6. CUSTOMER</b> What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices. - traditional monitoring is a time consuming method - budget problem - requirement of maintenance service - tedious job - Network issue	<b>5. AVAILABLE SOLUTIONS</b> Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking - discharge only treated water - proper wastewater management - water treatment plants - traditional monitoring system - smart sensing monitoring systems
	<b>2. JOBS-TO-BE-DONE / PROBLEMS</b> Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides. - to provide portable water - water quality data for the purpose of treatment of water - to support aquatic life forms	<b>9. PROBLEM ROOT CAUSE</b> What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations. - River water get contaminated by runoff of the solid debris, untreated water and farmland wastes. Algal bloom due to nutrient enriched water leads to Eutrophication	<b>7. BEHAVIOUR</b> What does your customer do to address the problem and get the job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace) - Local people approaches the government for monitoring and controlling the river water quality - Industries analyses the outlet treated water - Municipality performs the water treatment process
Focus on J&P, tap into BE, understand RC	<b>3. TRIGGERS</b> What triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news. - Water scarcity, Eutrophication, Death of fishes	<b>10. YOUR SOLUTION</b> If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour. - IoT based smart monitoring and controlling water quality system through the web or mobile app	<b>8. CHANNELS of BEHAVIOUR</b> <b>8.1 ONLINE</b> What kind of actions do customers take online? Extract online channels from #7 - water quality parameters data are collected and analyzed <b>8.2 OFFLINE</b> What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development. - from the data collected proper control measures are taken
	<b>4. EMOTIONS: BEFORE / AFTER</b> How do customers feel when they face a problem or a job and afterwards? i.e. lost, insecure > confident, in control - use it in your communication strategy & design. - suffers from water toxicity, soil infertility - poor vegetation		

Identify strong TR & EM

TR

SL

CH

EM

## 4. REQUIREMENT ANALYSIS

### 4.1 Functional requirement

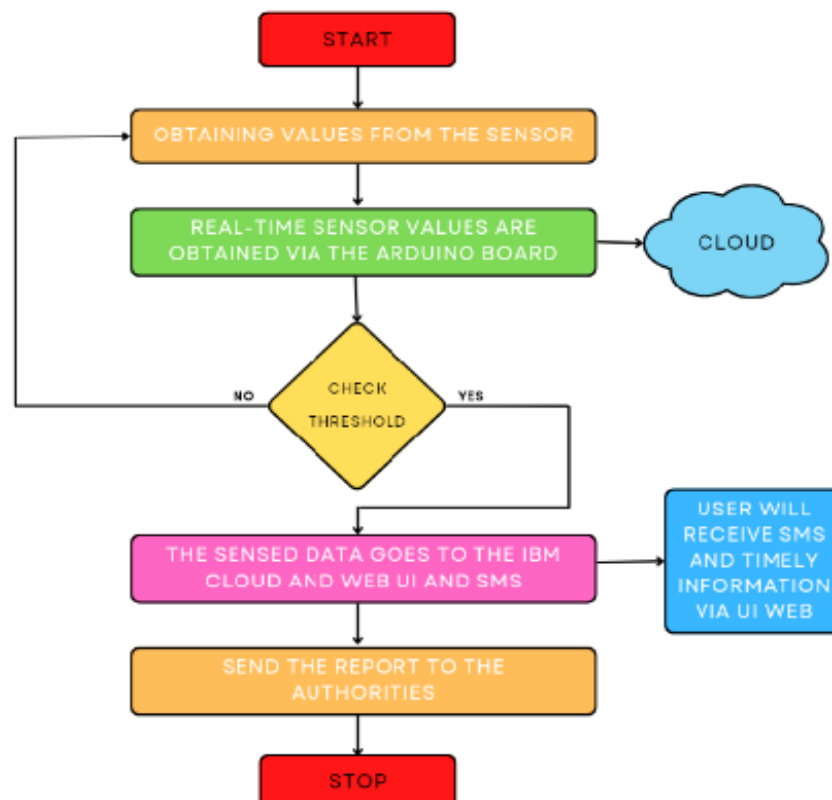
Functional requirements of the model will include the need of a cloud platform to serve as an integration point in the operation, periodic maintenance to ensure the seamless working of the model, proper power backup. Components needed to an atleast to physically represent the model to an extent which require the use of different sensors for monitoring the water quality by determining pH, turbidity, conductivity and temperature. The Arduino controller used will access the sensor data. With the use of IoT, the collected data is analyzed and the pollution of water can be investigated by a stringent mechanism.

### 4.2 Non-Functional requirements

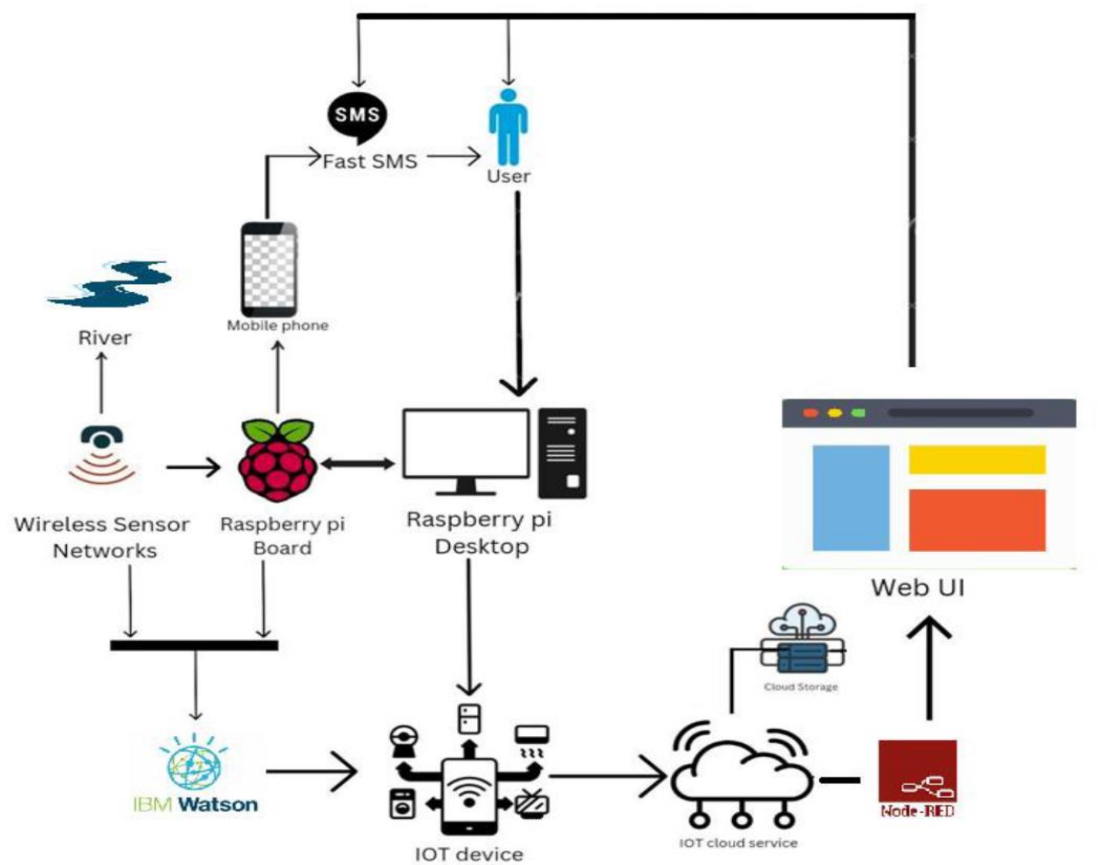
With the option provided to choose to opt the model for the water body monitoring, prior knowledge behind the working mechanism of the model should be known by the user. Utilizing the human resource to properly to scheduling the usage of the model.

## 5. PROJECT DESIGN PROJECT DESIGN

### 5.1 Data Flow Diagram



## 5.2 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 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-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Google	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	can register through the mail	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password	I can receive login credentials	High	Sprint-1
Customer (Web user)	Dashboard	USN-6	As a user, I can access the specific info(ph value, turbidity).	I can able to know the quality of the water	High	Sprint-1
Customer Care Executive		USN-7	24/7 Service can be provided by company	I can clear my doubts.	Medium	Sprint-2
Administrator	Risk tolerant	USN-8	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

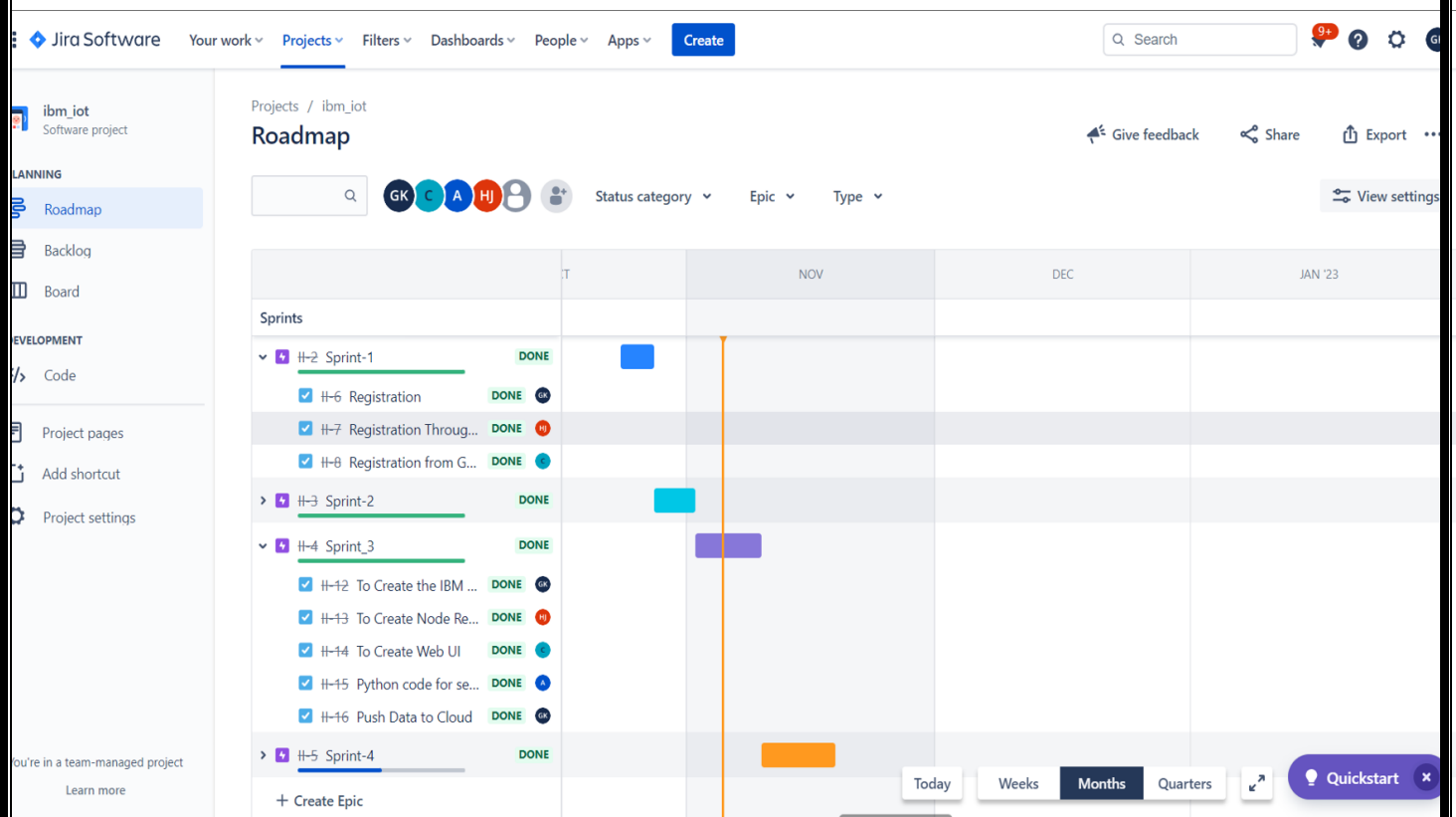
### 6.1 Sprint Planning & Estimation

Sprint	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	4 Days	24 Oct 2022	27 Oct 2022	20	29 Oct 2022
Sprint-2	20	5 Days	28 Oct 2022	01 Nov 2022	20	04 Nov 2022
Sprint-3	20	8 Days	02 Nov 2022	09 Nov 2022	20	11 Nov 2022
Sprint-4	20	9 Days	10 Nov 2022	18 Nov 2022	20	19 Nov 2022

## 6.2 Sprint Delivery Schedule

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	Gokul Anand
	Registration via Facebook	USN-3	As a user, I can register for the application through Facebook	2	Low	Hemanand
	Registration via Mail ID	USN-4	As a user, I can register for the application through Gmail	2	Medium	Chitharthik
Sprint-2	Confirmation	USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	Anand
	Login	USN-5	As a user, I can log into the application by entering email & password	1	High	Hemanand
	IBM Cloud service Access		Get access to IBM cloud services.	2	High	Chitharthik
Sprint-3	Create the IBM Watson IoT and device Settings	USN-6	To create the IBM Watson IoT Platform and integrate the microcontroller with it, to send the sensed data on Cloud	2	High	Gokul
	Create a node red service	USN-7	To create a node red service to integrate the IBM Watson along with the Web UI	2	medium	Hemanad
	Create a Web UI	USN-8	To create a Web UI, to access the data from the cloud And display all parameters.	2	Medium	Chitharthik
	To develop a Python code	USN-9	Create a python code to sense the physical quantity And store data.	2	Medium	Anand
	Publish Data to cloud.	USN-10	Publish Data that is sensed by the microcontroller to the Cloud	3	High	Gokul
Sprint-4	Fast-SMS Service	USN-11	Use Fast SMS to send alert messages once the parameters like pH, Turbidity and temperature goes beyond the threshold	3	High	Gokul Anand
	Testing	USN-12	Testing of project and final deliverables	3	Medium	Hemanand Chitharthik

## 6.3 Reports from JIRA



## 7. CODING & SOLUTIONING

### 7.1 Python Code:

```
import random
import time
import sys
import ibmIoTf.application
import ibmIoTf.device
from twilio.rest import Client

#IBM Watson Device Credentials

organization = "uwujz1" # repalce it with organization ID      uwujz1
deviceType = "ibm_IoT" # replace it with device type
deviceId = "Python_IoT" # repalce with device id
authMethod = "token"
authToken = "1234asdf" # repalce with token
```

```

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

    status = cmd.data['command']
    if status == "Motor ON":
        print("MOTOR ON")
    else:
        print("MOTOR OFF")

#connecting with IoT device
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()

#twilio sms service
account_sid = 'AC7d3677f934bbdf90eb5aef3459939e4a'
auth_token = 'c83c527d7037201cbfa631e6ea99dbc1'
client = Client(account_sid, auth_token)

message = client.messages .create(
                        body="High Temperature - ALERT !",
                        from_='+13465455379',
                        to='+919943562883'
                    )

while True:
    temp = random.randint(90,100)
    humidity = random.randint(0,100)
    pH=random.randint(0,100)
    # Send Temperature & Humidity to IBM Watson
    data = {'temperature':temp, 'humidity':humidity,'pH':pH}    #output

    def myOnPublishCallback():

        print("Data publish ",data, "to IBM Watson\n")

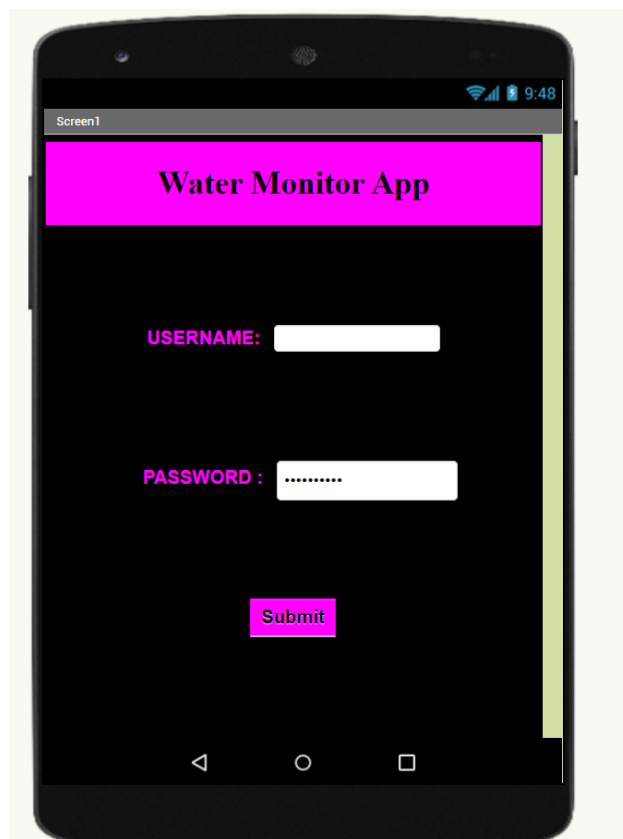
```

```
if(temp>95):
    print("Temp alert -sms sent successful")
    print(message.sid)

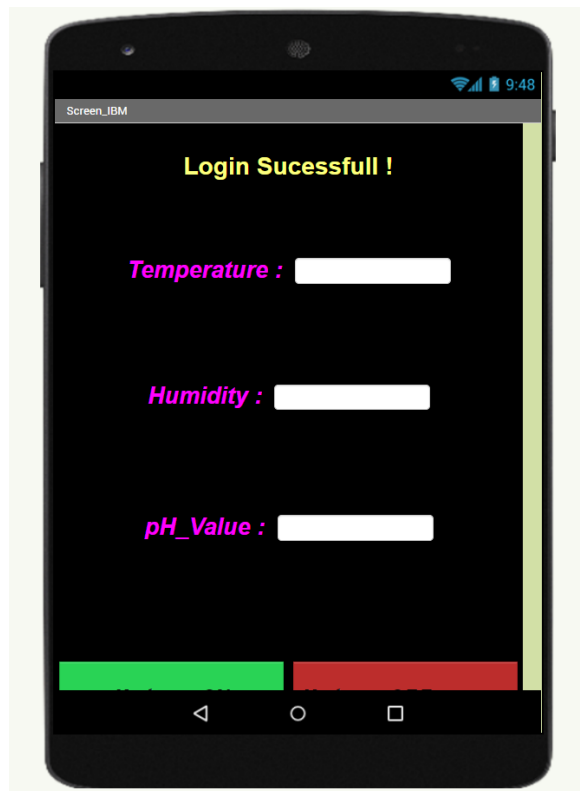
    success = deviceCli.publishEvent("event", "json", data, 0,
myOnPublishCallback)
    if not success:
        print("Not connected to IoT")
        time.sleep(2)

    deviceCli.commandCallback = myCommandCallback
deviceCli.disconnect()
```

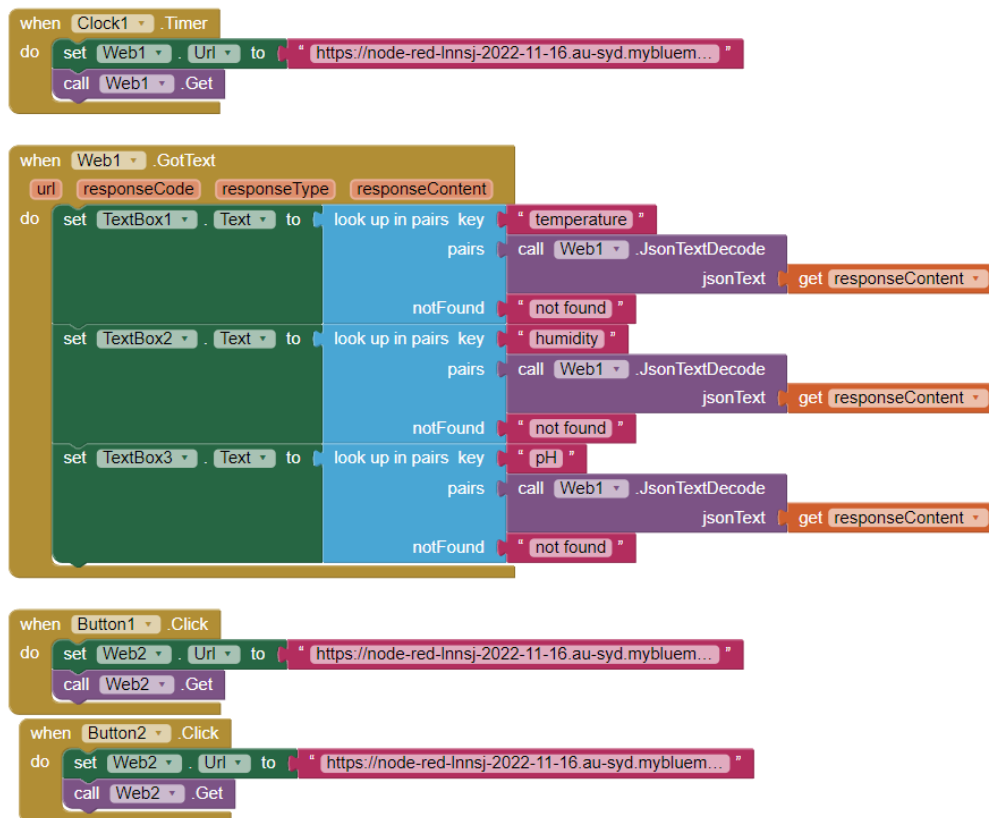
### 7.2.1 Feature 2 –Login security:



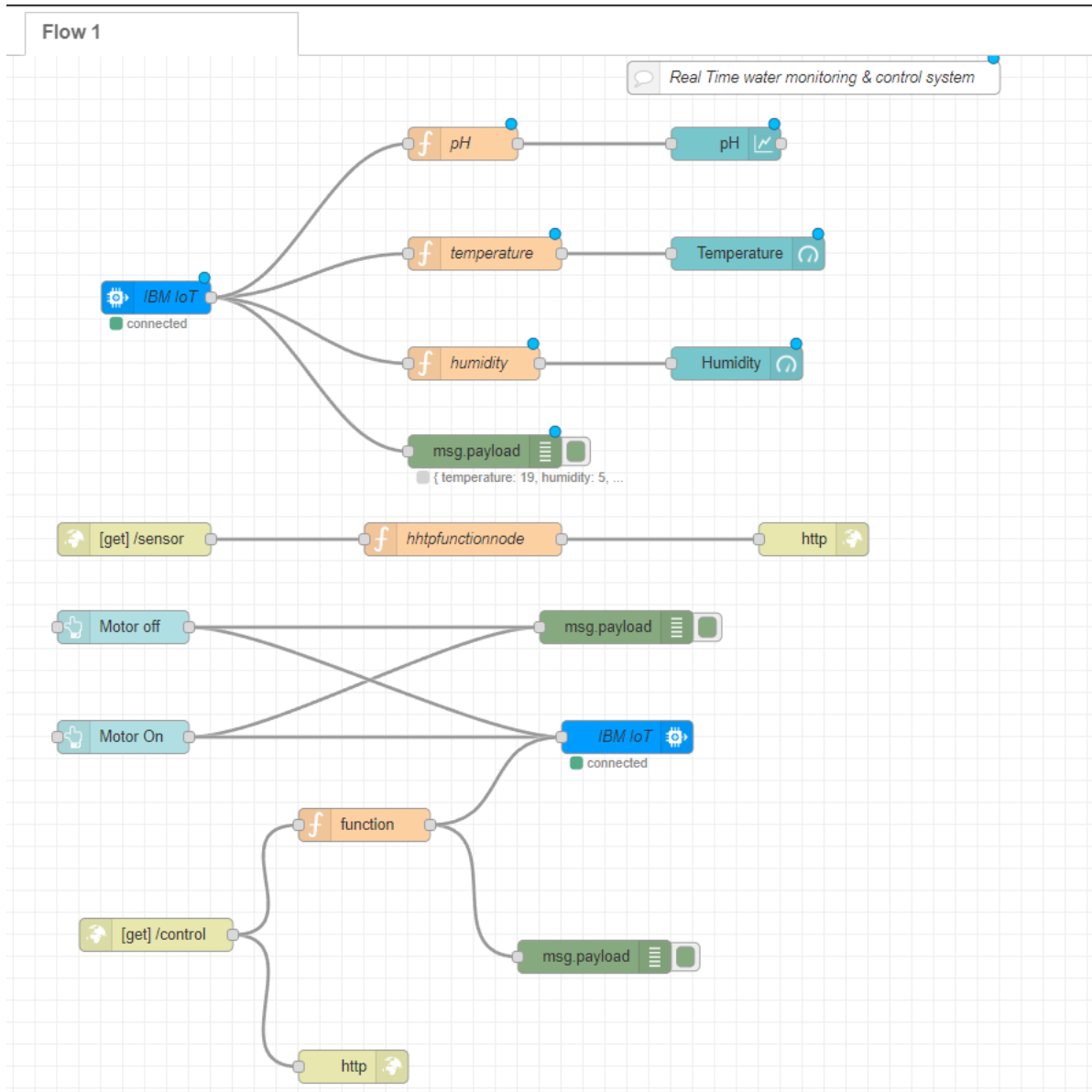
### 7.2.2 Home Page :



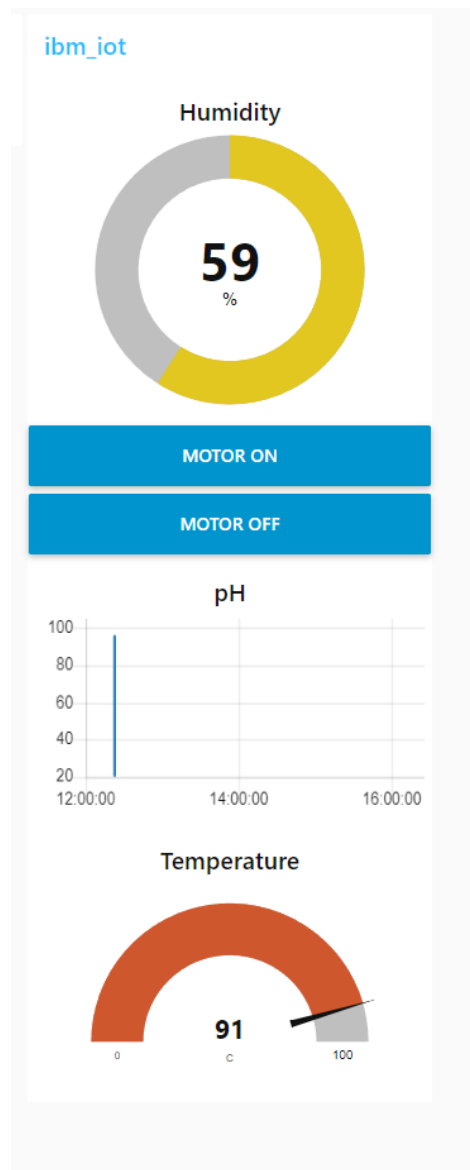
### 7.2.3 Blocks:



### 7.3 Node-Red Flows:

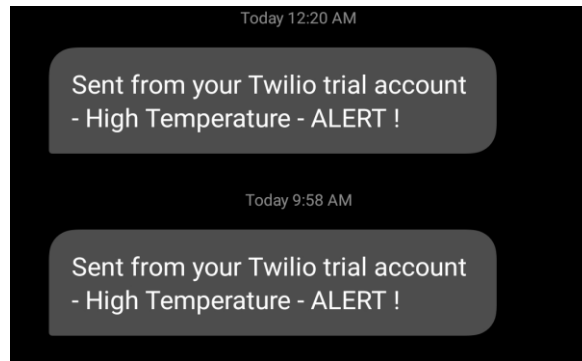


### 7.3.1 Web UI:





## 8. SMS Alert



## 9. ADVANTAGES & DISADVANTAGES

Like every system is use, which constitutes utilization of it and be fundamentally segregated or used based on knowing its edge over similar entities and its disadvantages. Similarly for the water monitoring model, acknowledging the same ultimately renders the users to know when and when not to rely on the system.

### 9.1 Pros:

- Offers Flexibility over conventional water preservation methods.
- Scalable based on the use case
- Reliable with almost least human intervention

### 9.2 Cons:

- Though, understanding the working of system comes with benefit since every member in team uses the model requires knowledge, making it redundant for many.
- Establishing a new method takes time to implement.
- Relaying of misinterpreted data in any phase makes it useless.

## 10. CONCLUSION

The IoT aided water monitoring system will improve the standards of preserving the target water bodies with much ease over the conventional methods which rely much on human resource or manual human intervention.

Compared with typical means of measurement once acclimating to the adopted model comes with knowledge behind to assist the operation and patience to see greater yields and

once familiarized with the working, the improvement and efficiency in performance will be greater than the latter.

## **12. FUTURE SCOPE**

With the growing demand and need to preserve water bodies, the model can further be developed to fully be automated, with only maintenance a real concern also making it more affordable to people of all backgrounds with less to no complex knowledge needed beforehand to work with the model.

## **13. APPENDIX**

Source Code GitHub : [github.com/IBM-EPBL/IBM-Project-12947-1659501329](https://github.com/IBM-EPBL/IBM-Project-12947-1659501329)

Project Demo Link : [IBM IoT - Google Drive](#)