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PROJECT REPORT

Real-Time River Water Quality Monitoring and Control System

TEAM ID: **PNT2022TMID00376**

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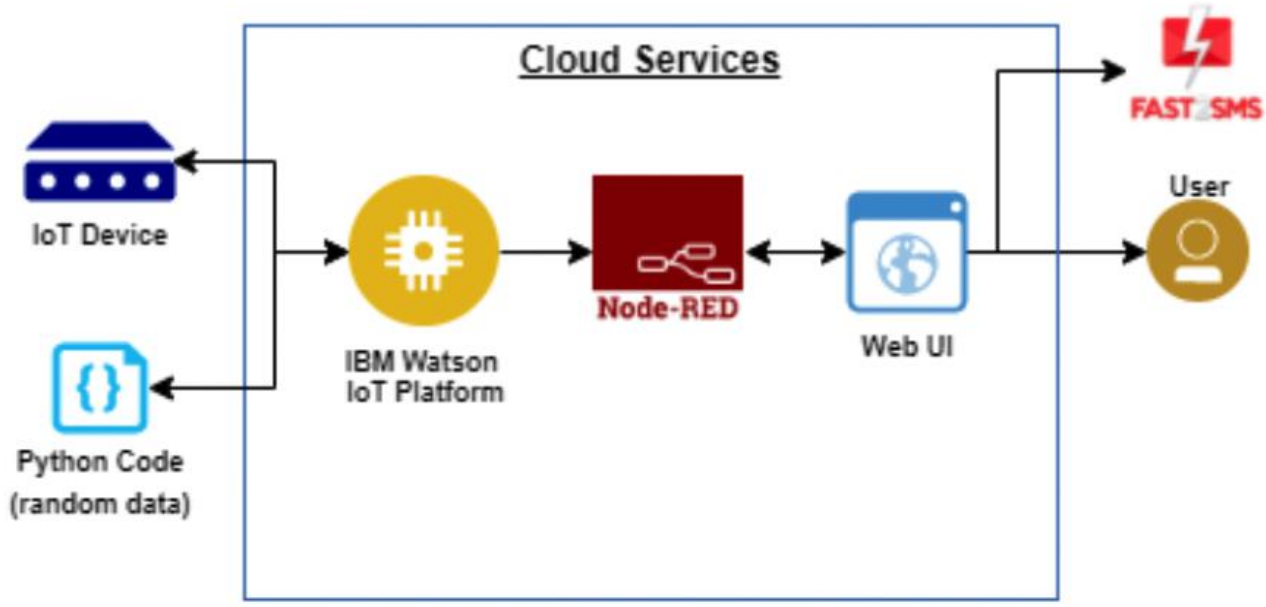


1. INTRODUCTION

1.1 PROJECT OVERVIEW:

As we speak on water quality, there are many issues arising continuously. Water is a very important natural resource as we depend on it every day. Water quality constantly degrades as it gets contaminated with toxicants. Water pollution affects the health of people significantly, and contamination is the second biggest water quality problem after water depletion. According to report from UNICEF and World Health Organization, and the consumption of impure water causes around 12% of deaths around the world.
The elderly people feel the need of knowing the information regarding the water quality on a regular basis, as they are the one who consume water regularly. The fisherman needs to know the quality of river water, so that he can get the idea if the fisheries are good to consume or not.
Water quality and scarcity will be one of the vital upcoming global problems. The necessity to solve these issues is so urgent that many experiments are being done to preserve the water quality. IoT-based innovative water quality management can identify toxicants present in the water.

1.2 PURPOSE

The main purpose behind making of this project is to alert the authorities in charge regarding to the water quality of the river continuously.
The periodic measurement of river parameters, such as pH, temperature and turbidity is done with the help of sensors that is coupled to the micro controller. They sensed River parameter values are therefore integrated with the mobile application that is developed by us as a part of this project. Therefore, the authorities in charge can look at the river quality status periodically.

2. LITERATURE SURVEY

2.1 Existing Problem

The existing problem lies in the fact that the authorities in charge are not able to accurately compute the oceanic parameter such as pH, temperature, turbidity on a periodic basis.

The periodic measurement of the oceanic parameter requires use of large number of sensors and actuators, and maintaining them is a tedious task.

Manually going and checking the recorded values from sensors is another headache for them and therefore they rely on an IOT solution where they can get the values and get the values uploaded to a cloud platform and from the cloud platform they extract the required data on to a portable application.

Therefore, as a whole they require an IOT solution by which they can efficiently monitor the oceanic parameters at all times, and therefore conclude the quality of the river water. if necessary take out some safety operation plans on the river.

In **"IoT based Smart Water Quality Monitoring System"** authored by Varsha Lakshmikantha et la [16]. Water pollution ensues when lethal materials move into water sources like ponds, rivers, lakes, seas and oceans, gets dissolved and suspends in water or gets deposited on the bed. Pollution will degrade the quality and purity of water.

The consequences of water pollution or poor water quality are:
● Destruction of biodiversity: Pollution of water reduces aquatic ecosystems and initiates
unrestrained increase of phytoplankton in water resources.

● Food chain contamination: Fishing carried out in polluted water resources and utilization

of waste water for agriculture and livestock husbandry may lead to addition of toxins or
contaminants into foods that are injurious to the health after consumption.
● Scarcity of drinkable water: If pollution of water increases or quality of drinking water is not maintained, then there will be no clean water for drinking or public health or
sanitization, in rural as well as urban areas.

● Disease: According to WHO (World Health Organization) information, roughly 2 billion
people across the world do not have any option for pure water resources, but they have
to drink water polluted by excrement, which exposes them to many ailments.

● Infant mortality: As per WHO, diarrhoeal diseases associated with lacking of hygiene
results in death of nearly 1,000 children per day across the world.

In **"Iot based Smart Water Quality Monitoring System"** authoured by Monira Mukta et al [11]. This paper represents an IoT (Internet of things) based smart water quality monitoring (SWQM) system that aids in continuous measurement of water condition based on four physical parameters i.e., temperature, pH, electric conductivity and turbidity properties.

In **"Managing High pH in Freshwater Ponds"** authored by Craig S. Tucker et al [7]. The term “pH” is a mathematical transformation of the hydrogen ion (H+)concentration; it conveniently expresses the acidity or basicity of water.

There are no precise guidelines for high pH tolerance, but pH values above 9.5 or 10 are generally considered undesirable in aquaculture ponds.

In **"Sending Messages Using Arduino and GSM Module"** authored by Bryan Amper, Max Angelo, it is evident that already the idea of sending SMS when there is any emergency, has been proven to work effectively. therefore, we are going to implement the same using FastSMS Software.

2.2 References

[1] Varsha Lakshmikantha, Anjitha Hiriyannagowda, Akshay Manjunath, Aruna Patted Jagadeesh Basavaiah, Audre Arlene Anthony **"IoT based Smart Water Quality Monitoring System"** keaipublishing journals global-transitions. Vol: 2, PP 181-187, Nov 2021.

[2] Monira Mukta, Samia Islam, Surajit Das Barman, Ahmad Wasif Reza **"Iot based Smart Water Quality Monitoring System"** 2019 IEEE 4th International Conference on Computer and Communication Systems (ICCCS), Feb 2019.

[3] Craig S. Tucker, Louis R. D'Abramo **"Managing High pH in Freshwater Ponds"** Southern Regional Aquaculture centre SRAC Publication No.4604, July 2008.

[4] Paul Bokingkito & Orven Ebarle Llantos **"Design and Implementation of Real-Time Mobile- based Water Temperature Monitoring System"** 4th Information Systems International Conference, ISICO, November 2017.
[5] Bryan Amper, Max Angelo **"Sending Messages Using Arduino and GSM Module"** Research Gate **,**June 15 2022.

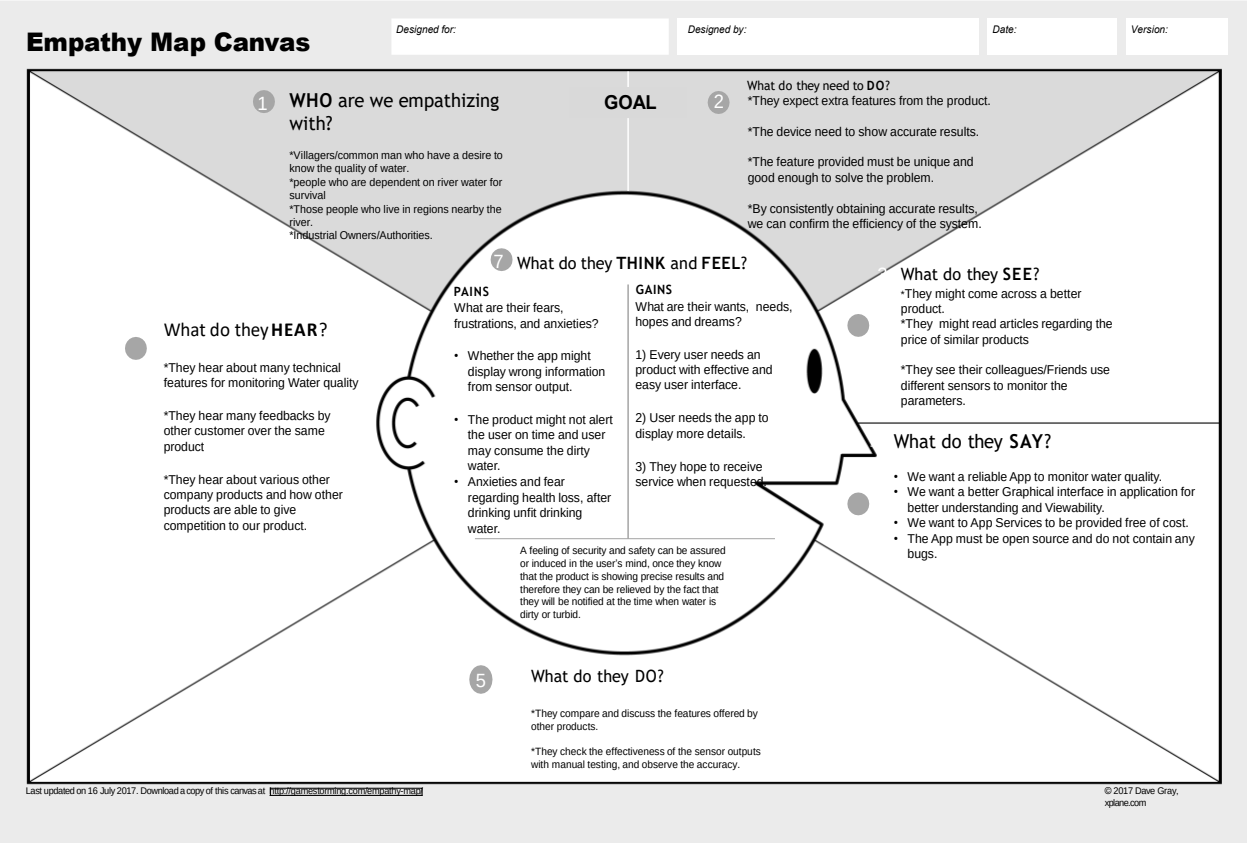
2.3 Problem Statement

Problem addressed:

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

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

IoT-based innovative water quality management can identify toxicants present in the water. So we have decided to implement a system using IBM Watson IoT Platform and Node-Red Cloud software. The IBM IoT Platform is used to test for salinity, acidity or alkalinity, total dissolved solids

and turbidity to ensure levels are safe for human use. After the check is complete the data is sensed and sent to user via the Node-Red cloud platform.

The User gets the sensed data through a fast SMS service which is used to push the Alert message when the water quality levels fall below the estimated quality level and periodic data on the water quality is also being stored in cloud and can also be monitored by the user.

We are going to be using multiple sensors, such as temperature sensor to continuously monitor the temperature of the river water. This is an essential step, as the sea creature's may die out due to extensive water temperature. We are going to be connecting it to the raspberry pi microcontroller, with the aid of GPIO pins.

The other sensors include the turbidity sensor, which checks for dirt and dust in the water , and therefore if the sensed value is lower than the threshold, them the microcontroller will use the sensed, after which the further process of sending SMS to the user is made. Ph level can also be monitored with the help of sensors available in the market and be placed in line with the microcontroller's GPIO pin. The code is written for all the three sensor, which are all together connected with the microcontroller.

Brainstorming:

Real Time Water Quality Monitoring and Control System- Top 3 Idea of Focus:

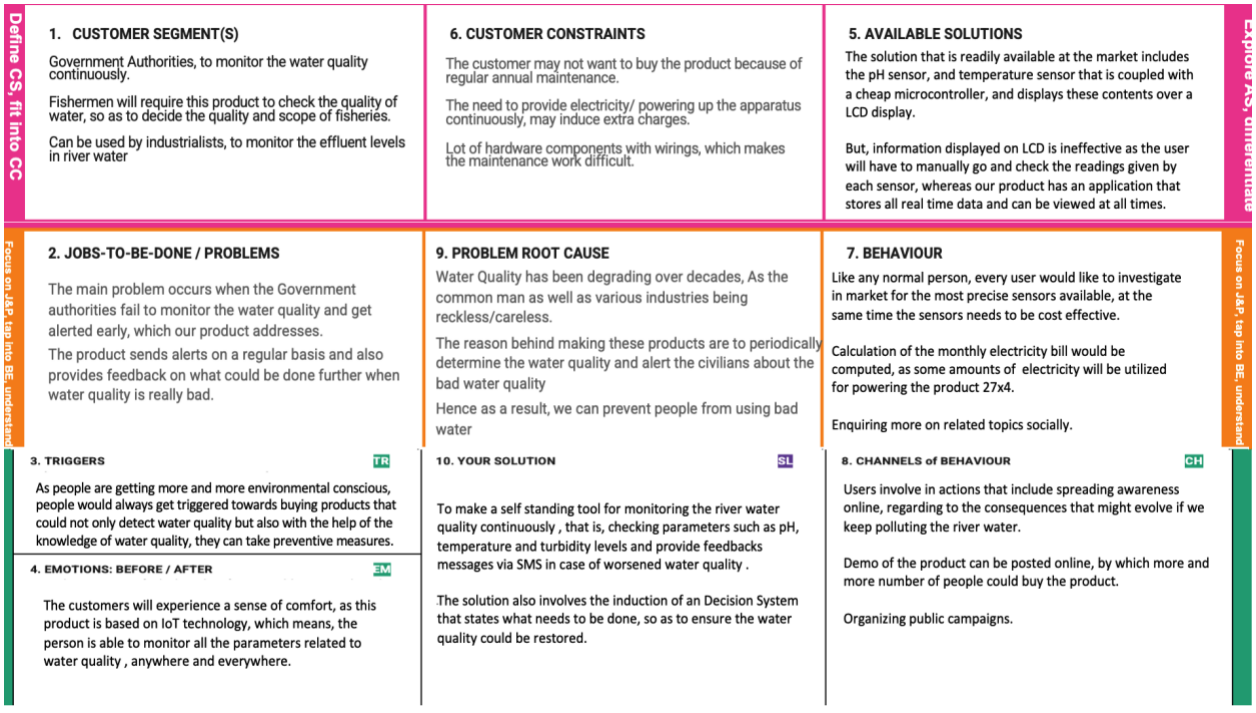
1. Implement the pH level monitoring and temperature monitoring systems first, and then check the efficiency of measuring systems.
2. Project should be cost efficient and accessible to all.
3. The product prototype. when implemented as a complete product, the product must be able to detect the qualities of water as accurate as possible.

3.3 Proposed Solution

The proposed solution is having the following features:

1. Continuous monitoring of oceanic quality parameters such as pH, Turbidity, Temperature using sensors.
2. Publishing the data that is measured by the electronic sensors to the IBM cloud platform and to access the data from there.
3. An phone application is been created for the user to continuously see the values that is got from the sensors on the mobile phone application so that he can easily monitor the status of water quality of the river.
4. An alert message is pushed to the user's mobile phone in case if the water quality is degraded through SMS.

3.4 Proposed Solution Fit:



4. REQUIREMENT ANALYSIS

4.1 Functional Requirement:

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration-Email	Registration through the application with the help of any email address.
FR-2	User Confirmation-Email	Confirmation is received in the email through which , the user have created account
FR-3	Sensors and actuators	Sensor for sensing physical quantities from the environment.
FR-4	Cloud Account-Access	Cloud technology to append all the sensed data on the internet.
FR-5	Mobile phone- with internet connectivity	As cloud requires internet connectivity, therefore it's a must to have internet connection for receiving updates regularly.

4.2 Non-Functional requirements:

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The usability must be easy and self understandable to use by old people and the illiterate.The project contains a interactive UI application specially made for the elderly for easy access. Monitoring of the pH , turbidity of water and acidity level in the water has now been made easy, as every data is

		sensed and is sent to the cloud platform , which is again interlinked with the app.
NFR-2	**Security**	There should be no compromise in security.The application is secure enough, and will not ask for any personal sensitive details or will not even try to portray ads. The application offers dual authentication entry.
NFR-3	**Reliability**	The system should not be in a condition of breakdown during sensing the physical quantities from the environment. The system is reliable, as we are going to make sure of quality sensors and actuators for developing the prototype, and we can expect an efficacy rate of 85-90% from the product.
NFR-4	**Performance**	Performance should be top tier. Our product should be in a position to outsmart other products available in the market, so as to sell the products in high numbers.
NFR-5	**Availability**	The product needs to be available in most of the regions (nationwide). The product should be even accessible by the village authorities, therefore must be available readily in all parts of the village as well.
NFR-6	**Scalability**	Scalability is defined as how long the item can be relevant in the market, or in other words, what all change scan be made to the project in the future ,so that it can be more and more attracted towards wider range of audiences.

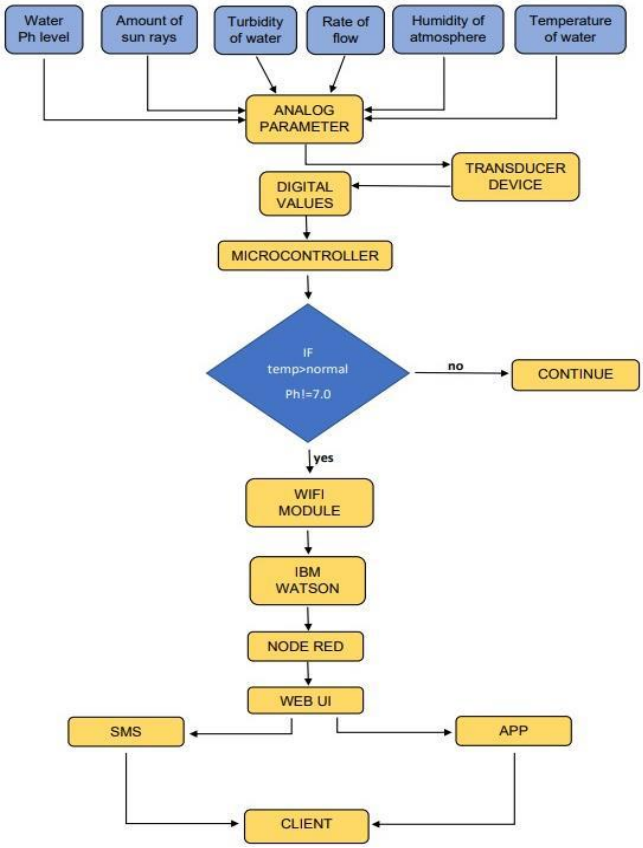
5. PROJECT DESIGN

5.1 Data Flow Diagrams:

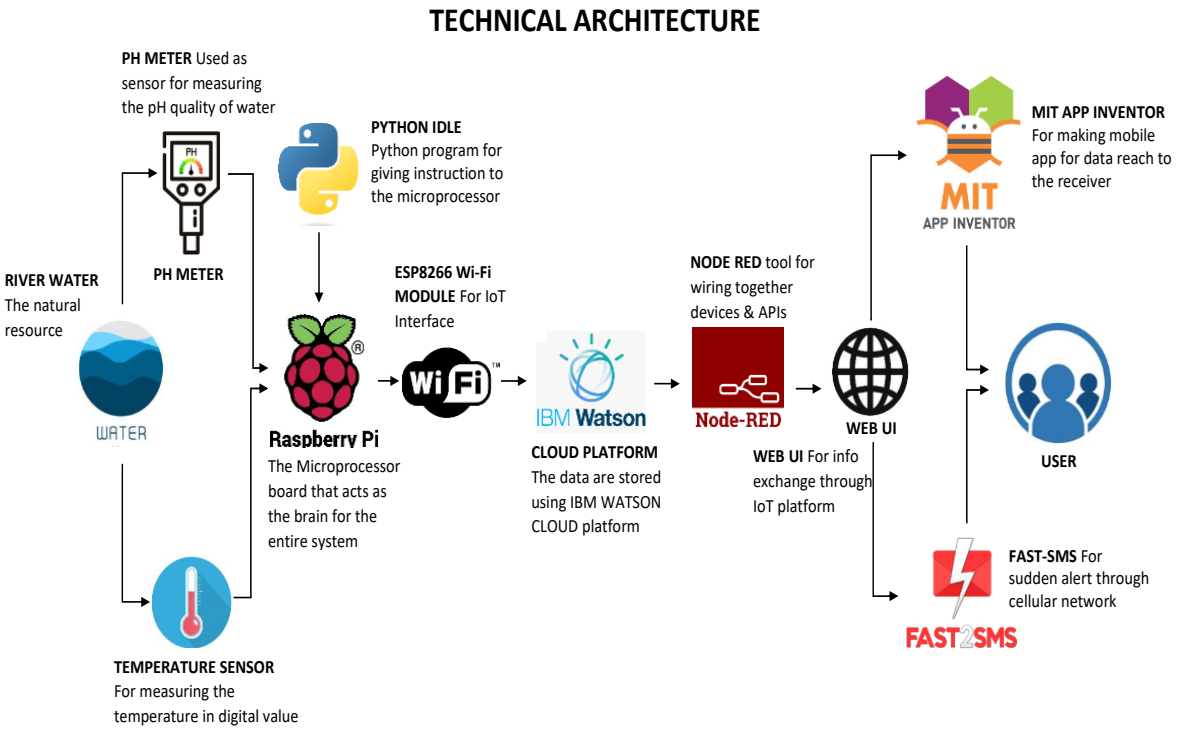
Project Design Phase-II
Data Flow Diagram & User Stories

Date	03 October 2022
Team ID	PNT2022TMID00376
Project Name	Project - Real-Time River Water Quality Monitoring and Control System
Maximum Marks	4 Marks

Data Flow Diagrams:



5.2 Solution Architecture:



5.3 User Stories

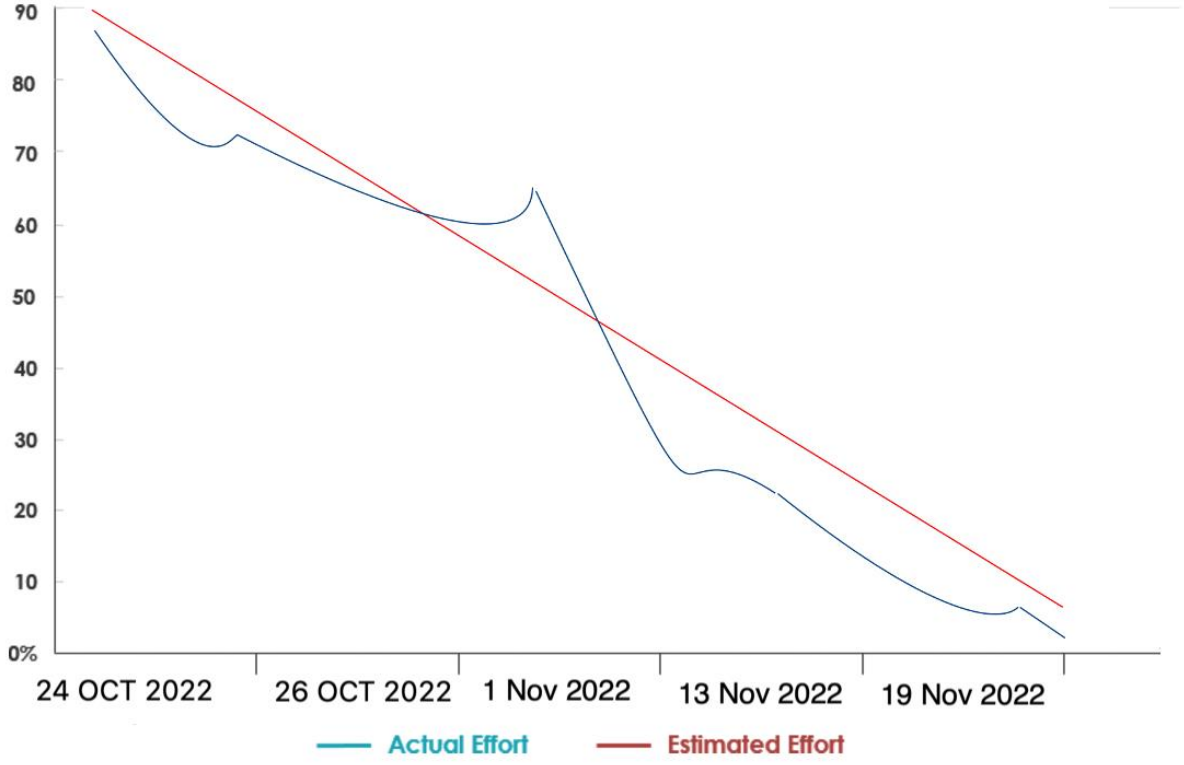
Journey Steps Which step of the experience are you describing?	**Discovery** Why do they even start the journey?	**Registration** Why would they trust us?	**First Use** How can they feel successful?	**Sharing** Why would they invite others?
Actions What does the customer do? What information do they look for? What is their context?	• To checks the quality of water in real time through various sensors (one for each parameter: pH, conductivity, temperature) to measure the quality of water.	• Monitoring water quality is very important for maintaining ecosystem health and the livelihood of the population. It reflects the health of surface water bodies as a snapshot in time (weeks, months, and years). • Therefore, best practices and efforts are needed to monitor and improve water quality.	• The drinkability of any water source involves testing its chemical composition, such as its pH (acidity), whether it contains toxins such as microplastics, and other variables such as temperature. • A qualified scientist takes a sample from a water source every so often, analyzes it, and compares it with the recommended standards of a reputable organization, such as the WHO or the USEPA.	• Monitoring provides the objective evidence necessary to make sound decisions on managing water quality today and in the future. • Water-quality monitoring is used to alert us to current, ongoing, and emerging problems; to determine compliance with drinking water standards, and to protect other beneficial uses of water.
Needs and Pains What does the customer want to achieve or avoid? *Tip: Reduce ambiguity, e.g. by using the first person narrator.*	• The customer wants to avoid unnecessary details not related to product • Wants an effective and reliable product and service • Value offered by the product	• Provide top-notch customer service • Share positive reviews and testimonials • Ask for and act on feedback	• Provide excellent customer service • Get customer success metrics that matter • Organize around the customer	• Offer discounts and incentives • Provide them with best customer service • Improve your website and Promote you r expertise • Ask for referrals
Touchpoint What part of the service do they interact with?	• Water quality authorities and analyst • Providing highly water quality efficient service	• Industries should register themselves with the service and equip themselves • Government agencies	• We issue them to manual oof operation along with guidelines to target customers	• This would invite many private companies to the market
Customer Feeling What is the customer feeling by *Using the* ***emoji***.				
Opportunities What could we improve or introduce?	• By providing better requirements for The customer needs.	• Increase the number of users and in turn satisfying the Requirements for registration	• Demonstrate the use of product in front of customers and its working capabilities.	• We could contact the old customers and ask them For referral on the service offered and Increase the quality of service.

6. PROJECT PLANNING AND SCHEDULING

6.1 Sprint Planning and Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task
Sprint-1	Procurement of Hardware requirements (if needed)	USN-1	Procurement of quality sensors and actuators, microcontroller that will be required to sense the physical parameters like pH, turbidity and Temperature.
	Create IBM Cloud Services	USN-2	Creation of an IBM Cloud account and registering a device.
	Configure the IoT device in IBM Cloud.	USN-3	Creation and registering of a device
Sprint-2	Development of the Python code in IDLE, Install all required libraries like ibmiotf.	USN-4	To develop the Python Code to generate random values of pH ,Temperature and turbidity values along with their units.
	Create a IBM Watson IoT service and Publish the values generated by python code to Cloud.	USN-5	To create the IBM Watson IoT Platform and integrate the microcontroller with it, to send the sensed data on cloud
Sprint-3	Create a Node Red Service	USN-6	To create a node red service to integrate the IBM Watson along with the Web UI
	Create a Web UI	USN-7	To create a Web UI, to access the data from the cloud and display all parameters.
	Generate a link to Interface the node red service with the Web UI/Mobile app	USN-8	Generate Link to interface the services.
Sprint-4	Design a Mobile App, to display pH, Temperature and turbidity values	USN-9	To design a Android App using MIT App inventor, to display pH, Temperature and turbidity values.
	Fast-SMS Service	USN-10	Use Fast SMS to send alert messages once the parameters like pH, Turbidity and temperature goes beyond the threshold
	Product Testing	USN-11	Testing of project and final deliverables

Estimation:



6.2 Sprint delivery schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)
Sprint-1	20	6 Days	24 Oct 2022	30 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	5 Nov 2022
Sprint-3	20	6 Days	5 Nov 2022	12 Nov 2022
Sprint-4	20	6 Days	12 Nov 2022	19 Nov 2022

7. CODING AND SOLUTIONING

7.1 Feature-1:

To continuously generate sensor value:

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

Explanation:

The above program code just generates random values of pH temperature and Turbidity. We are using randint inbuilt function to get values generated randomly, and this values that we are obtaining from random function is going to denote the values that we are going to be getting from the sensor.

7.2 Feature-2

To send SMS in case of degradation of water quality

#TWILIO_CREDENTIALS:

```
from twilio.rest import Client
import keys
Client = Client(keys.account_sid, keys.auth_token)
account_sid ='ACa0eb9bf43aa629b503bdd01d0962dxxx'
auth_token ='48c1a0ade0472038ab36d45e0d9fbxxx'
twilio_number ='+19804095xxx'
target_number ='+919940555xxx'
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()
```

Explanation:

We are using Twilio.rest in order to generate the message in case , water quality parameter's are getting exceeded the threshold value that is set in python code. This feature is mainly used to alert the authority in charge- just in case if the water quality has been degraded.

7.3 Feature-3

To publish the data that we have generated randomly:

```
import ibmiotf.application
import ibmiotf.device
organization = "lwkiec"
deviceType = "Microcontroller_Device_1"
deviceId = "00002"
authMethod = "token"
authToken = "sushi@123"

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:
```

```
    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()
```

Explanation:

This is one simple code that is written in order to publish the data that we have generated randomly and locally in the python code using the randint function and the value is been sent to the IBM Watson IOT platform and from there we are going to be interconnecting those values to Node red.

8. TESTING

8.1 Test cases

Google Drive link:

https://docs.google.com/spreadsheets/d/1G3QrLftaqq1oClENia0_yd3dYs_Afg-9/edit?usp=share_link&ouid=104095958245058402218&rtpof=true&sd=true

8.2 User acceptance Testing

1. *Defect Analysis*

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	5	0	2	1	8
Duplicate	4	3	2	4	13
External	2	3	2	1	8
Fixed	6	4	0	13	23
Not Reproduced	1	0	1	0	2
Skipped	0	3	1	1	5
Won't Fix	0	5	2	1	8
Totals	18	18	10	21	61

2. *Test Case Analysis*

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

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	4	0	0	4
Client Application	17	0	0	17
Security	13	0	0	13
Outsource Shipping	1	0	0	1
Exception Reporting	5	0	0	5
Final Report Output	15	0	0	15
Version Control	2	0	0	2

9. RESULTS

9.1 Performance Testing

https://docs.google.com/spreadsheets/d/15Ly2V1IlB91DKNsa5xB5jXEcZUCzL8Nc/edit?usp=share_link&ouid=104095958245058402218&rtpof=true&sd=true

10. ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

1. CONVINIENT
2. COST EFFECTIVE
3. EFFIECIENT AND RELIABLE
4. COMMERCIALLY AVAILABLE
5. LOW MAINTENANCE
6. HASTLE FREE OPERATION

DISADVANTAGES

1. ILLITERATE PEOPLE MAY FIND IT DIFFICULT TO OPERATE
2. REQUIRES INTERNET CONNECTIVITY TO BE STRONG
3. SENSORS MAY NEED TO BE REPLACED EVERY YEAR

11. CONCLUSION

Water quality monitoring determines the goodness of water for specific purposes. The water quality tests give information about the health of the water resources. This project was implemented by one of the technological revolutions of computing and communications which is none other than the Internet of Things (IoT).

This project mainly aimed at implementing a solution to the ongoing problem faced by government authorities or civilians in general, in monitoring the water quality on a regular basis.

It is a smart interconnected device that sense, interpret and react to the environment due to the combination of the internet and embedded sensors system. The challenged for this emerging technology is how to craft a system that collects and monitors water temperature of a water resource in real-time. The objective of this study is to design and develop an efficient and cost effective real-time mobile-based water temperature monitoring system that could aid the aquaculture farmers in the improvement of the aquaculture industry, and for the general civilians and government authorities to have a track of the quality of water.

The project was measured to be an complete success, as the main objective behind making of the project was seemed to be fulfilled.

12. FUTURE SCOPE

With increase in demand for such product that analyzes the river water quality, therefore it is evident that product is in full demand and therefore can be even made commercially available in the cities, suburban area and even villages , as change the number of users that are going to be using the product is in great figures.

Some efforts can be made in order to improve the product and to extend the sales in international markets as well and to make it more manageable and more cost-effective.

13. APPENDIX

SOURCE CODE:

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

organization = "lwkiec"
deviceType = "Microcontroller_Device_1"
deviceId = "00002"
authMethod = "token"
authToken = "sushi@123"


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()

#TWILIO_CREDENTIALS:
‘’’
account_sid ='ACa0eb9bf43aa629b503bdd01d0962dxxx'
auth_token ='48c1a0ade0472038ab36d45e0d9fbxxx'
```

```
twilio_number ='+19804095xxx'
target_number ='+919940555xxx'
‘’’
```

GitHub & Project Demo Link:

Github Link:

https://github.com/IBM-EPBL/IBM-Project-12358-1659448229

Project Demo Link:

https://www.youtube.com/watch?v=X7PRDNPJdME

https://drive.google.com/file/d/1rbVLnDu0d7OS1f0nsa9Vdwurb5bzzkLD/view?usp=share_link