19L039 PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

DOMAIN: IOT

REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM

TEAM ID: PNT2022TMID12777

Swetha S	(718018L155)
Kiruba Shankari L	(718019L121)
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Sakthi J	(718020L411)

Dissertation submitted in partial fulfilment of the requirements for the degree of

BACHELOR OF ENGINEERING

Branch: ELECTRONICS AND COMMUNICATION ENGINEERING

Of Anna University

NOVEMBER 2022

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PSG COLLEGE OF TECHNOLOGY

(Autonomous Institution)

COIMBATORE – 641 004

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Bona fide record of work done by

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DR. S. HEMA CHITRA	**DR. G UMAMAHESWARI**
Faculty Mentor	Faculty Evaluator

CHAPTER 1

INTRODUCTION

1.1 Overview

The Water quality department of every city tries to ensure that people are ensured with the potable water. For that they need to ensure that the quality of the water is good and is devoid of any impurities and have to keep a check on the value of critical parameters that are needed to ensure the quality of the water. For that they need real time data to have a greater focus on the quality of the water. But the major problem in getting the real time data is it takes lot of human effort plus it leads to huge cost in implementing it. So the idea of our project is to have real time data with low cost by using sensors which are installed near the water body so that it senses any change in the parameters and alert the officials if there's any alarming changes in the levels. By this way we can avoid dependency of the department on huge man force also the cost can also be reduced significantly. The model also ensures the Publish – Subscriber model of collecting real time data such that the user can check the water body he desires to concentrate.

1.2 Purpose

The sole purpose of the project is to reduce the dependency on large man force in monitoring the quality of the river water by installing sensors to sense the critical parameters needed for ensuring potable water to people. The sensors provide real time data such that the officials can act swiftly if there's any discrepancies in the parameter values. Also he can visualize the data on particular entity by incorporating the Publish-Subscriber model.

CHAPTER 2

LITERATURE SURVEY

2.1 Existing problem

To ensure potable water for people, continuous monitoring of water quality is inevitable but, continuous monitoring requires real time data which further demands high cost and large labor force.

2.2 References

[1] Kartik Maheshwari and Adrija Chakraborty, "Water Quality Monitoring System Implemented With IoT", International Journal of Emerging Trends in Engineering Research (IJETER) , Volume 9. No. 7, July 2021

Proposed Work: This paper discusses on the Internet of Things which provides a robust and cost-effective solution for real-time monitoring of various parameters of water. This paper aims to implement an intelligent water quality monitoring system with the aid of IoT. They proposed a system which was successfully implemented to determine the turbidity, TDS, flow rate and the level of water for a given sample. The data obtained from the sensors are uploaded to the ThingSpeak dashboard for online monitoring purpose. Besides, an SMS alert is sent to the user through IFTTT and also, whenever the turbidity and TDS values have crossed the threshold limit defined for good quality water.

[2] Bhoomika R, Netra Jalagar, Pooja F B, Sangeetha Sontera and Shanthveeresh N, **"IOT Based Real-Time River Water Quality Monitoring System"**, International Journal of Research in Engineering and Science (IJRES) Volume 9 Issue 7 ‖ 2021.

Proposed Work: This Paper is mainly based on the monitoring of the quality of river water so as to reduce the pollution. The system consists of various sensors connected with a microcontroller thereby making a WSN system. The Proposed system is cost effective because it does not involve any man-made analysis of testing the quality of water and also it is very convenient to set up and configure the system and provided that it is highly adaptable to the environment.

[3] Yashwanth Gowda K.N, Vishali C, Sumalatha S.J and Spoorth G.B, **"Real-Time Water Quality Monitoring System"**, International Journal of Engineering Research & Technology (IJERT), Special Issue - 2020.

Proposed Work: In this paper they proposed a design and implemented the same to have a prototype with remote, automatic, portable, real time and lowcost water quality monitoring system. The proposed system consists of Sensors (three in no.) and microcontroller and is found to be considerably low of cost when compared to other man-made techniques to collect and analyse the parameters.

[4] Mohammad Salah Uddin Chowdurya, Talha Bin Emranb, Subhasish Ghosha, Abhijit Pathaka, Mohd. Manjur Alama, Nurul Absara, Karl Anderssonc and Mohammad Shahadat Hossaind, **"IoT Based Real-time River Water Quality Monitoring System"**,The 16th International Conference on Mobile Systems and Pervasive Computing (MobiSPC) August 19-21, 2019, Halifax, Canada.

Proposed Work: This paper proposed a sensor-based water quality monitoring system using a WSN system that includes a microcontroller for processing the system, communication system for inter and intra node communication and several sensors. They used Remote access and Internet of Things (IOT) to collect data. With the help of Spark streaming analysis through Spark MLlib we can visualize the data collected, Deep learning neural network models and Belief Rule Based (BRB) system are used for computation and is also compared with standard values. SMS alerts are also provided if there is any discrepancies in the values. The system is proposed with high frequency, high mobility, and low powered.

[5] Prasad M. Pujar, Harish H. Kenchannavar, Raviraj M. Kulkarni and Umakant P. Kulkarni, **"Real-time water quality monitoring through Internet of Things and ANOVA-based analysis: a case study on river Krishna"**, Springer, Received 15 June 2018 / Accepted: 22 November 2019

Proposed Work: This paper is attempted to develop a statistical model based on Internet of Things (IOT) for water quality analysis on River Krishna by analyzing different parameters like pH, conductivity, dissolved oxygen, temperature, biochemical oxygen demand, total dissolved solids and conductivity. But the timely information about water quality is thus unavailable to the people in the river basin area. This creates a perfect opportunity for swift real-time water quality check through analysis of water. Further they have emphasized on IoT based water quality monitoring by applying the statistical

analysis for the data collected from the river Krishna. One-way analysis of variance (ANOVA) and two-way ANOVA were applied for the data collected, and found that one- way ANOVA was more effective in carrying out water quality analysis. The hypotheses that are drawn using ANOVA were used for water quality analysis.

[6] Nihil R, Riya Rajan and Rangit Varghese, **"IoT Based Real Time Water Quality System"**, International Journal of Engineering Development and Research (IJEDR) 2019, Volume 7, Issue 4.

Proposed Work: This paper proposes the concept of using the Internet of Things as an effective measure to monitor the quality of water by simply making use of Sensors and and a microcontroller there by making a WSN system. They introduced the GSM for communication purposes. They proposed that the system can be configured to have different sensors in order to measure other parameters as well as they can be implemented much easily and without much man power thus by reducing the overall man power and cost.

[7] Prasanna Kumar S.C, Ashwini Kotrappa, Indraja N, K. Jyothi and Soumya B.L, **"Real- Time Water Quality Monitoring system for Vrishabhavathi River of Bengaluru"**, IJARIIE, Vol-5 Issue-3 2019.

Proposed Work: This paper aims to design real time water quality monitoring system in IoT environment for Vrishabhavathi River of Bengaluru. Five parameters are being monitored i.e. Temperature, pH, Turbidity, Flow and Conductivity using sensors. All the sensors are interconnected to form a sensor node. The data from the sensor node is conditioned and transmitted to Arduino microcontroller. Thus, forming wireless sensor network (WSN). The real time water quality monitoring system proposed by this paper for real time applications is efficient and is of low cost.

[8] Jyotirmaya Ijaradar and Subhasish Chatterjee, **"Real-Time Water Quality Monitoring System"**, International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 03 | Mar-2018

Proposed Work: This paper proposes the idea of using WSN system such that the data collected is sent to the cloud and timely usage of data for comparing with standard

values. The proposed method is found to be cost efficient by reducing the usage of manpower to collect samples and computation of data, as well as providing warning signals in case of any discrepancies in values. The main limitation is that they used household water instead of using lake or river water.

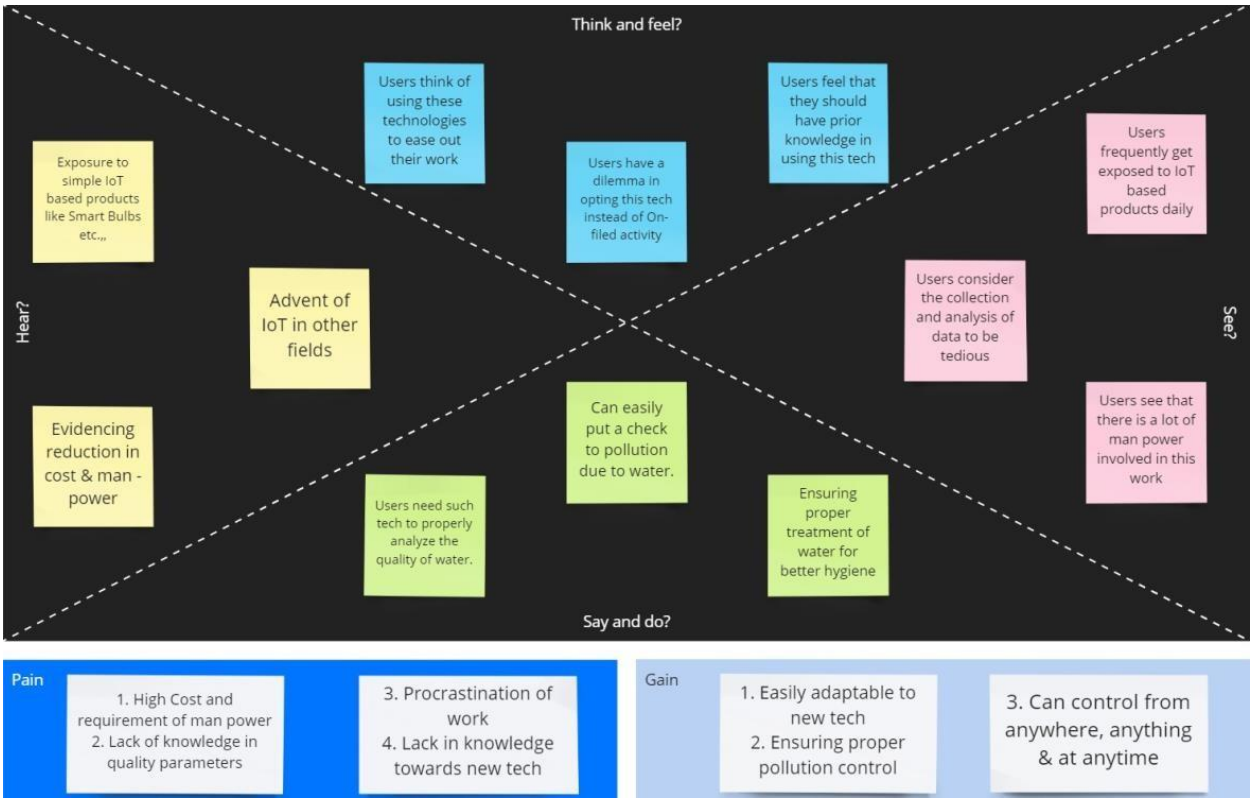
2.3 Problem Statement Definition

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	**Officer, Water Quality Wing, TWAD** 1. Provider of high quality measurement services 2. Ensuring potable for Public 3. Creating Awareness for good quality of water	1. Ensuring that the public drinks good quality water by providing good quality measurement techniques 2. Create awareness on hoe to maintain the quality of water by taking necessary steps	1. To ensure quality, real time data is needed 2. Difficult to check the quality on daily basis 3. Difficult to watch over any unwanted disposals are being dumped	1. Lots of Man Power Required 2. Requires high cost 3. Setting up of Instruments is tedious and disturbs public	1.Self reliant is not achievable because of dependent on large man power. 2. Sometimes Budget constraints will be imposed in testing so proper testing is not ensured

CHAPTER 3

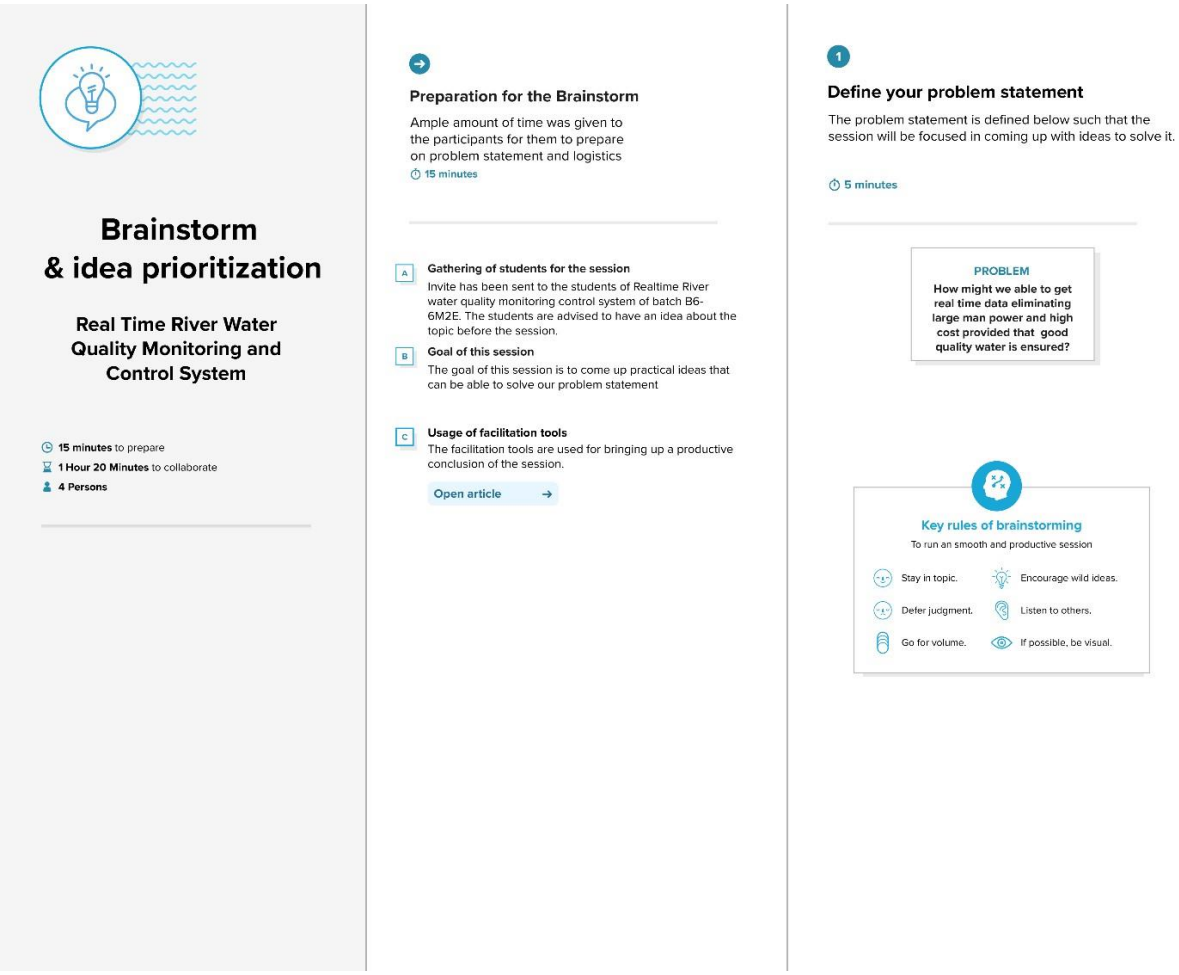
IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

Step-1: Team Gathering, Collaboration and Select the Problem Statement



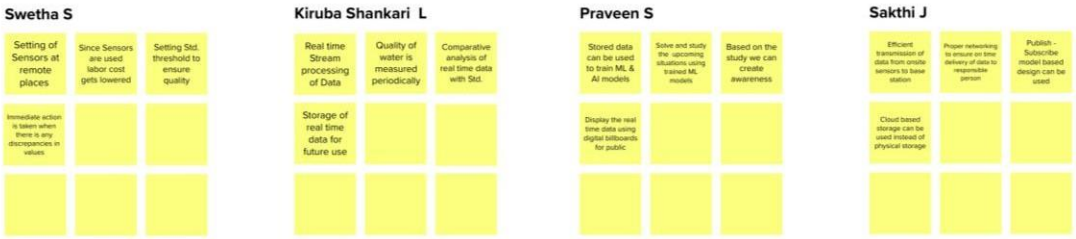
Step-2: Brainstorm, Idea Listing and Grouping

2

Brainstorm

Ideas that were put forwarded by the students have been listed out below.

20 minutes

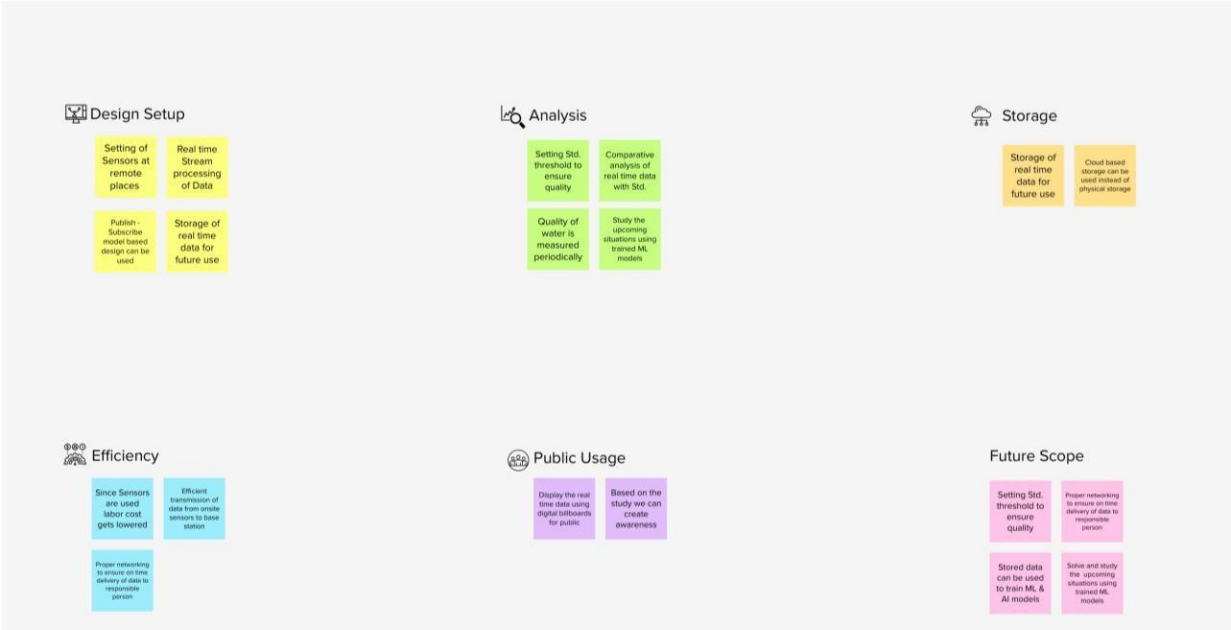


3

Group ideas

Ideas given by the students are grouped together based on the similarities in them and labels are given for each group.

20 minutes



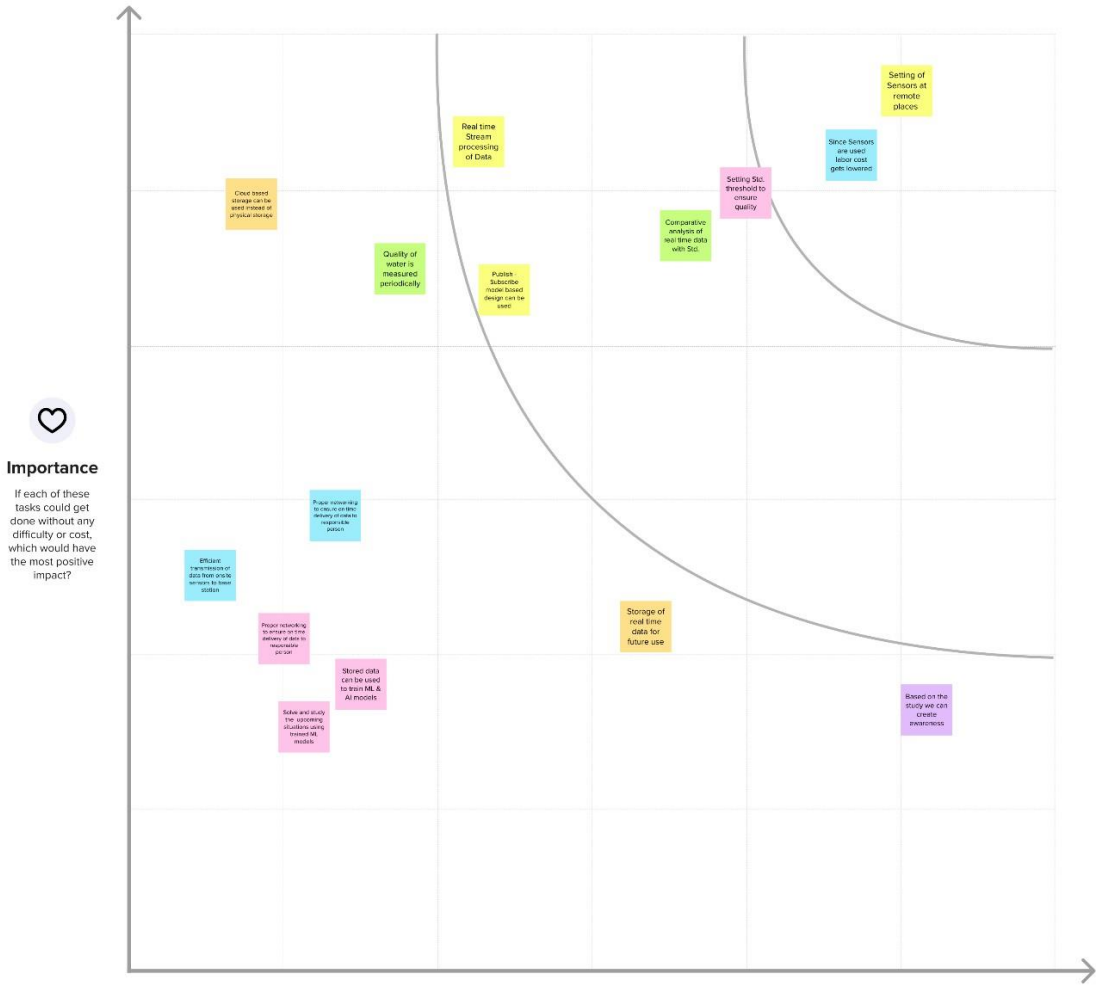
Step-3: Idea Prioritization

4

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.

20 minutes



3.3 Proposed Solution.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To ensure potable water for people, continuous monitoring of water quality is inevitable but, continuous monitoring requires real time data which further demands high cost and large labor force.
2.	Idea / Solution description	The problem of retrieving real time data is solved by using respective sensors to collect data and streaming them in real time to the corresponding person thereby establishing the publish – subscribe model.
3.	Novelty / Uniqueness	Since we handle data from various entities it is difficult for the user to track from which entity the data is coming so, we establish **Publish – Subscriber** model to ensure the person view data from the entity he desires.
4.	Social Impact / Customer Satisfaction	The person will be able to achieve self-reliant as well as he / she can overcome cost constraints.
5.	Business Model (Revenue Model)	The designed model can be provided not only to Quality officers but also a small-scale version of the model can be given to residents to ensure water quality in their households.
6.	Scalability of the Solution	The designed model can measure up to a certain area but the area range can be scaled up / down depending upon who the customer.

3.4 Problem Solution Fit

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Officer, Water Quality wing, TWAD

6. CUSTOMER CONSTRAINTS CC

Constraints like cost of labor and instrument setup, disturbances prevailing in the surrounding of the water bodies while undergoing inspections, time taken to evaluate the results from samples taken from the water body, etc.,

5. AVAILABLE SOLUTIONS AS

At present, there are on field inspections to rivers to check the water quality parameters when they face the issue of poor quality of potable water. Though, it requires a lot of men power and daily inspection of quality is quite impossible, it has an advantage of live monitoring of the surrounding.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

To collect the real time data from the river to check the water quality through sensors and retaining those data for future use or whenever required

9. PROBLEM ROOT CAUSE RC

The real reason that the problem existence is that there is a need to monitor the water parameters periodically because of increase in the pollutants where manual monitoring takes more time to analyse the results and provide solution. The main idea to have this solution is that the parameters must be checked from time to time and the real time data must be analysed instantaneously to provide a better solution to undertake necessary steps ensuring potable water supply

7. BEHAVIOUR BE

The customers address the problem to any organization by passing quotations to provide solution to these problems in the form of projects or any internships programs where any volunteers can contribute in providing positive results thus achieving the scope or need of the customer.

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS

The increasing pollution in the recent environment triggers the customers to monitor the water quality periodically to ensure a safe and potable water

4. EMOTIONS: BEFORE / AFTER

create awareness among people to become conscious against using contaminated water as well as to stop polluting the water.

10. YOUR SOLUTION

Initially by setting up the sensors at remote places, the real time data can be processed and the collected data can be stored and accessed via cloud services according to the customer needs, whenever required. By fixing a standard threshold value in prior and performing comparative analysis with the collected data can provide results on the water quality based on the parametric values, which further helps in studying the upcoming situations. It also helps in creating awareness among the people about the prevailing situation. instead of physical storage, cloud based storage can be implemented by achieving proper networking to ensure the timely delivery of data and storage for future use

8.CHANNELS OF BEHAVIOUR

8.1 ONLINE

Customers can create online internships to collegestudents or as projects to any IT service sector.

8.2 OFFLINE

Customers take offline actions by passing circularsto organizations thus seeking their approach to provide a solution to their problems.

Identify strong TR & EM

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 Functional requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Data Collection	• **Data Collection by Sensors** – Collection of data by using sensors to sense various parameters. • **Data Transfer & Storage** – Data collected is transferred and stored in the cloud.
FR-2	User Subscription	• **Subscribing particular entity** – Choosing a particular entity (which river / pond) is left to the choice of user.
FR-3	User Aspect	• **Publishing the data** – Once the user chooses the entity, data of that particular entity is shown.
FR-4	Data Processing	• **Retrieving Data** – Data of that entity is retrieved using Wi-Fi module. • **Processing of data collected** – The data of that entity is converted to realizable by applying mathematical formula in Microcontroller modules.
FR-5	Data Comparison	• **Comparison of Data** – Once the data is collected it is compared with Standard or Threshold values to check for any discrepancies.
FR-6	Action	• **Display of data** – The data collected is displayed to respective persons. • **Raise the Alarm** – If there are any discrepancies or the current value is intolerable than the standard values, raise the alarm to alert the authorities.

		• **Creating Awareness** – With the data in our hand awareness can be created to safeguard the resource for future use. • **Storage of Processed data** – This situation may arise in future so present data can be used to tackle similar situation in future or can be used to train ML models.

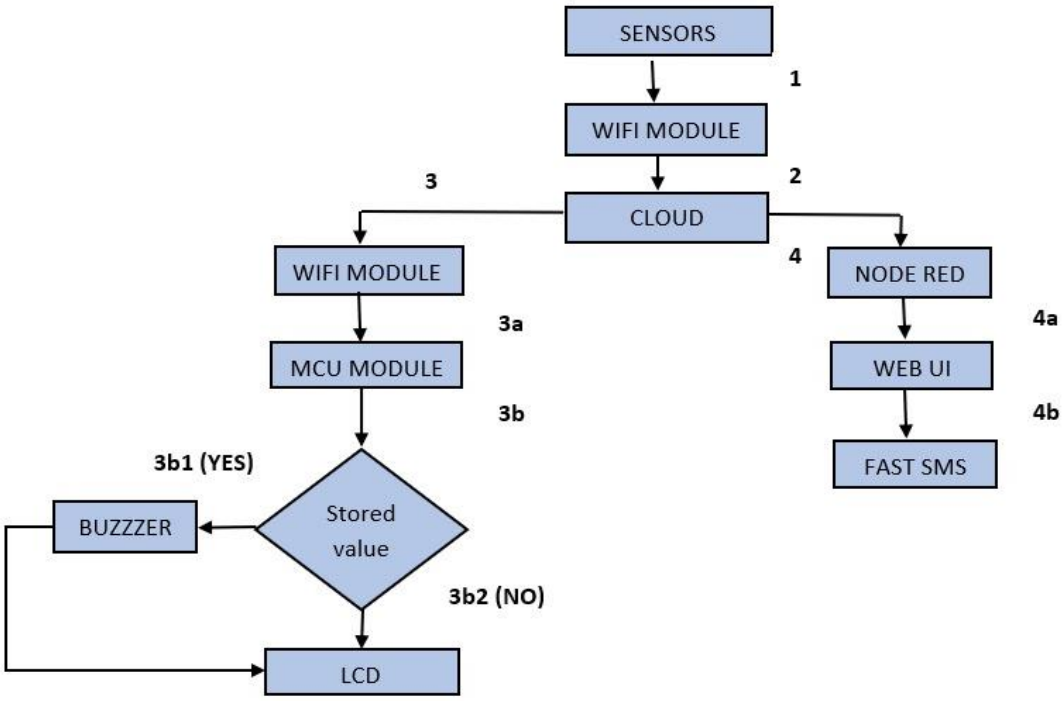
4.2 Non-functional Requirements:

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	• The model can be used in any rivers or ponds to collect, process and raise the alarm. • The Publish – Subscribe model can be used to track ponds / rivers of our desire.
NFR-2	Security	• The data collected is stored in reputed cloud platform which is of highly secured one.
NFR-3	Reliability	• The collected data is processed and the compared with highly standard values thus increasing the accuracy of the device.
NFR-4	Performance	• The performance will be quite similar to that of what we expect from lab results with some plus / minus in values measured.
NFR-5	Availability	• The set-up of the device can be easily doneso that it can be used at any time.
NFR-6	Scalability	• The designed model can measure up to a certain but this area coverage can be increased / decreased depending on the customer needs.
NFR-7	Portability	• Since the device consists of small sensors, they are easily carriable to any places.
NFR-8	Maintainability	• The device consists of sensors of small size and low cost so, if there's any damage, they are easily replaceable.

CHAPTER 5

PROJECT DESIGN

5.1 Data Flow Diagrams



1. Sensors like turbidity and pH sensors detects the sample and collects the data and forwards to the Wi-Fi module in the transmitter side.
2. The forwarded data is gathered and uploaded to the cloud.
3. The data is sent to the Wi-Fi module on the receiver.

   3.a The gathered data is uploaded to the Microcontroller module.

   3.b Result will be compared with the threshold value or standard value.

   3.b1. If greater than threshold, it sets up a buzzer and value also get displayed in LCD

   3.b2. If not, Buzzer will not get turned ON but, the value is just displayed on the LCD alone.

4. Building workflows for the scenario using Node Red

   4.a Web design for the scenario is designed using Web UI

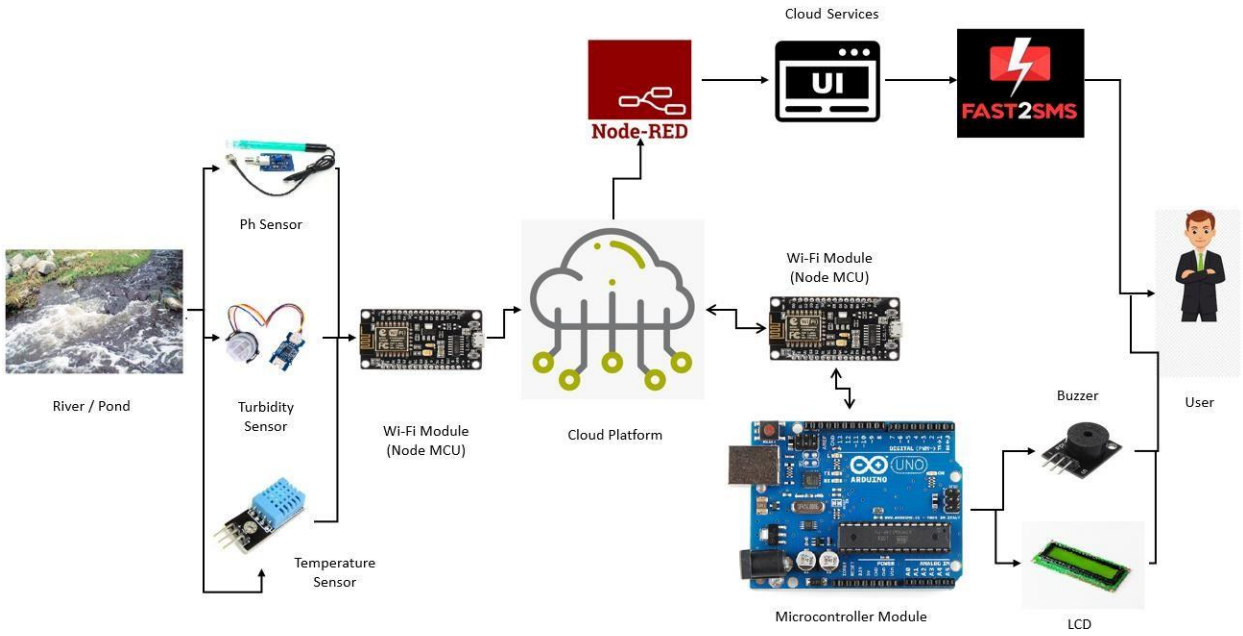
   4.b Analysis of results and output is obtained from Fast SMS

5.2 Solution & Technical Architecture

Problem Statement

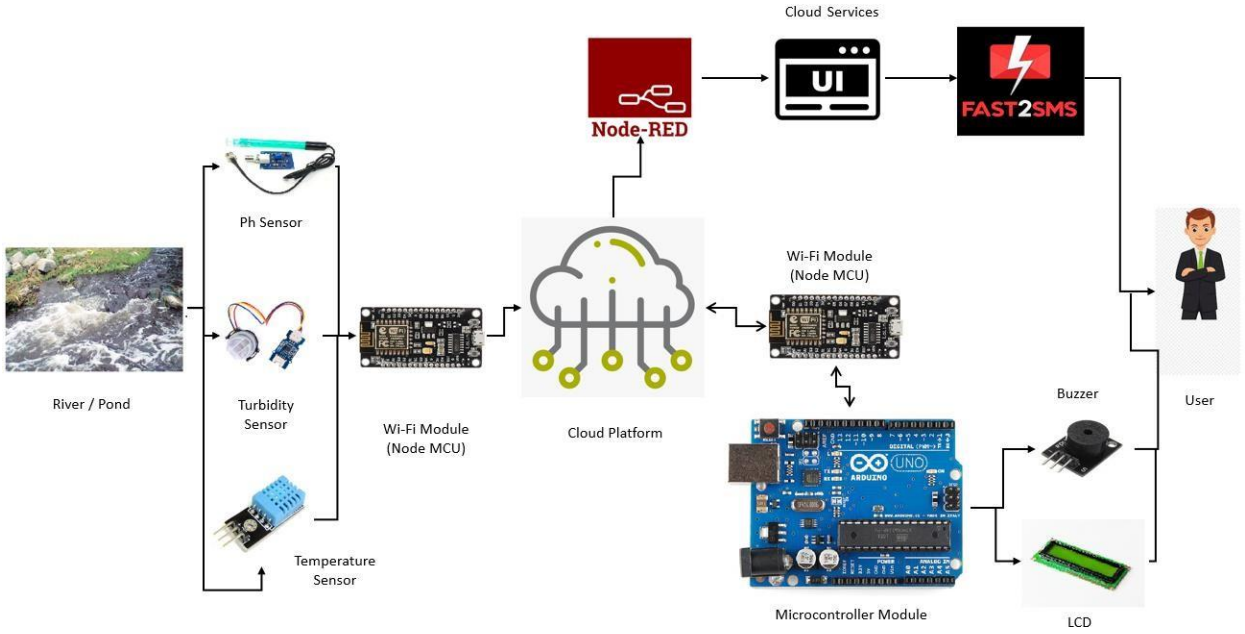
The responsible of the Officers from Water quality wing is to ensure the quality of river water is good and is suitable for the people to drink. For that they have to test the quality of the water but, it is difficult to do. Because, it requires large labor force, costly equipments and time to assess the quality. To do faster analysis and swift action they are in need of real time data. But it is difficult to achieve and it cost large labor force and money. It also creates demand for self-reliant and cost constraints in ensuring the quality of water.

Solution Architecture



First the Sensors (Turbidity, Ph, Temperature) senses the essential parameters that are needed to assess the quality of the water. These values are then transferred to the cloud through any wireless communication protocols like Wi-Fi (here Wi-Fi module – Node MCU is used for that purpose). Then from the cloud using **Publish-Subscriber** model to retrieve data from the entity the desires to assess. The data is then assessed using any microcontroller module (here Arduino).If there's any discrepancies in the values it'll raise the buzzer or it the warning is displayed in the LCD or any display boards. The processed data can also be stored in the cloud for future use such as using them to train Machine Learning models. Another case is the data retrieved from the cloud is sent as an SMS to the corresponding user by using website user interfaces.

Technical Architecture



1. First the Sensors (pH, Turbidity & Temperature) collect data from the concerned River / Pond.
2. The data is then transferred to the Cloud (IBM Cloud, Thingspeak, etc.,) through any wireless communication module like Wi-Fi (NodeMCU), Zigbee, etc.,
3. Once the data is transferred to the cloud, it is retrieved from the cloud using **Publish-Subscriber** model (because the user may have a desire to concentrate one entity alone).
4. The data is then retrieved using the above model and then it is transferred to the microcontroller module (Arduino, ESP8266, Raspberry Pi, etc.,) using any wireless communication module.
5. The data received will not be in realizable form so it is made realizable in the microcontroller module using mathematical relations.
6. The realizable values are then compared with the Standard values to find if there's any discrepancies in the Water quality.
7. If so, it'll raise the buzzer, give warning messages in the LCD, OLED displays, etc.,
8. Another case is the data is retrieved from the cloud it is sent to the Node red to provide flow-based development for visual programming.
9. Then we'll create web-based User Interface and then it is incorporated with Fast SMS to provide SMS based messages if, there is any discrepancies in water quality.

Table-1: Components and Technologies

S. No	Component	Description	Technology
1.	Sensors	To collect data in relevant to the parameter we see after.	pH (pH sensor kit), Turbidity (SKU: SEN0189) & Temperature (DHT-11, RTD, etc.,)
2.	Wireless Communication Module	To relay the data to cloud base for storage and retrieval at the receiver end.	Wi-Fi module (NodeMCU-ESP8266, etc.,)
3.	Cloud	To store the collected data and to establish the way in which the user wants to collect data.	IBM Cloudant, Thingspeak, etc.,
4.	Wireless Communication Module	To retrieve the data from the cloud for processing.	Wi-Fi module (NodeMCU-ESP8266, etc.,)
5.	Microcontroller Module	To process the raw data to realizable one and compare them with standard values.	Arduino (UNO, Nano, Mega, etc.,), Raspberry Pi, etc.,
6.	Application logic-1	To establish the logic in the evaluation of data in the microcontroller module.	C++ / Python
7.	Display and Indicators	To notify the user about the current situation.	LCD / OLED displays, Buzzers, etc.,
8.	Visual Programming	To provide flow-based development for wiring hardware devices and online services as part of IOT.	Node RED
9.	Application logic-2	To establish the logic	Java Script
10.	Web UI	To create user interface through web	WEB UI
11.	SMS	To notify the user about the current situation or provide warning.	FAST SMS

Table-2: Application and Characteristics

S. No	Characteristics	Description	Technology
1.	Open-Source Frameworks & Platforms	In the project we'll be using some of the well reputed open – source platforms like Arduino, Thingspeak	Arduino is written in C / C++, Thingspeak is developed in RUBY.
2.	Security Implementations	In order to have secure connection between modules we rely on security features available within them to have encrypted connection.	Wi-Fi – WPA, WPA2, WPA3, IBM Cloudant - LUKS1 with 256-bit Advanced Encryption Standard (AES-256)
3.	Scalable Architecture	If suppose, to increase the scale in terms of area covered we may vary the size of the cloud storage to accommodate the data also the no. of components used.	Thingspeak, an IoT platform that lets us to analyse and visualise the data even for devices that are nonfunctioning in the mainframe.
4.	Performance	To increase the performance of the device in terms of how efficiently it uses the input it receives, how quickly it relays the information, etc.,	I2C protocol can be used to relay information to LCD displays, etc.,

5.3 User Stories

User type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Officer, Water Quality Wing, TWAD)	Data Collection	USN-1	As a user, he can collect data from the cloud that has been already collected by using the sensors.	The user will not receive the data directly but the data is sent to the cloud	High	Sprint-1
	Data Selection	USN-2	The user will select only the data he needed to process by using Publish Subscribe model	The user will receive data only from that entity	High	Sprint-1
	Data Retrieval	USN-3	The data collected is retrieved for processing	The user will receive realizable values at the end	High	Sprint-2
	Data Comparison	USN-4	The processed data is compared withstandard values.	The user will receive message / buzzer if there is discrepancy	High	Sprint-2
	Data Display	USN-5	The compared data is then displayed to notify the person.	The user will get notified through SMS or through LCD window if there's any discrepancies in values.	High	Sprint-3

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

S. NO	ACTIVITY TITLE	ACTIVITY DESCRIPTION	DURATION
1.	Understanding the Project requirement	The team members are asked to understand the need of the project along with searching for the prerequisite software needed for the project completion.	1 Week
2.	Installing Prerequisites	Every team member is asked to equip their laptop or PC with the prerequisite software in order to understand the working of the project and completion of the assignments.	1 Week
3.	Assigning the tasks	The tasks are assigned by the team lead to all team members including the team lead by conducting a brainstorming session among the members and finding out who is interested and capable of completing of the task.	1 Week
4.	Starting the Project	The team members are asked by the team lead to watch the training sessions on how to code in Python, using of IBM cloud & NodeRed. Also, on time	1 Week

		completion of assignments and quizzes given by the instructor and acknowledging of the same with the team.	
5.	Attending Training Sessions	The team members along with team lead are requested to attend the training sessions provided by IBM and NALAIAYA THIRAN and proceed towards the project accordingly.	4 Weeks
6.	Understanding the scope of the Project	Once the team acquires the necessary knowledge, they need to find the scope of the project like how it's going to help the targeted user and how it can be scaled up in order to reach large scale of user.	1 Week
7.	Development of Project	Based on the knowledge acquired from the training sessions and requirements of the user the project is developed.	4 Weeks
8.	Delivery of Project Deliverables	After completing the project, the document and recorded video of the project along with explanation will be submitted.	1 Week

6.2 Sprint Delivery Schedule

Sprint	Functional Requirement (Epic)	USN	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data Collection	USN-1	Setting the circuit using any simulationsoftware like Wokwi, TinkerCAD, etc.,	5	High	Kiruba Shankari L &Swetha S
Sprint-1	Data Collection	USN-2	The data is then collected for various use cases from best to normal to worst condition.	5	High	Kiruba Shankari L &Swetha S
Sprint-1	Data Collection	USN-3	The data is then sent to the cloud to beretrieved at the other end.	5	High	Kiruba Shankari L &Swetha S
Sprint-1	Data Collection	USN-4	The user will collect the data from the other end.	5	High	Kiruba Shankari L &Swetha S
Sprint-2	Data Collection	USN-5	The user at the river / pond side will publishthe data in the name of temperature / pH / Turbidity. Also, in the name of the location for easy retrieval.	5	High	Praveen S &Sakthi J
Sprint-2	Data Collection	USN-6	The user uses MQTT protocol to establishthe Publish-Subscriber model.	5	High	Praveen S &Sakthi J
Sprint-2	Data Collection	USN-7	The user will subscribe the data according tothe place he desires to concentrate.	5	High	Praveen S &Sakthi J
Sprint-3	Data Retrieval	USN-8	The user subscribes for a particular entityand this will be purely on his desire.	5	Medium	Swetha S &Sakthi J
Sprint-3	Data Retrieval	USN-9	The data is then collected and processed because it'll be a raw data and had to be pre-processed before using for any comparison.	5	High	Swetha S &Sakthi J

Sprint-4	Data Comparison	USN-10	The pre-processed data is then comparedwith standard values or threshold values	5	High	Kiruba Shankari L &Praveen S
Sprint-4	Data Comparison	USN-11	The comparison of data takes place throughNodeRED platform which provides	5	High	Kiruba Shankari L &Praveen S
Sprint-4	Data Comparison	USN-12	The comparison is made in such a way thatif there's any discrepancies.	5	Medium	Kiruba Shankari L &Praveen S
Sprint-4	Data Display	USN-13	Web UI is created to provide a better visualization and better appealing of the data.	5	High	Kiruba Shankari L &Praveen S
Sprint-4	Data Display	USN-14	The Web UI created should be made suchthat it is compatible for to be used in SMS.	5	Medium	Kiruba Shankari L &Praveen S
Sprint-4	Data Display	USN-15	The data is then sent through Fast2SMS toprovide the information as a SMS	5	High	Kiruba Shankari L &Praveen S

Project Tracker, Velocity & Burndown Chart

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	04 Nov 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	15	12 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	10	14 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	25	19 Nov 2022

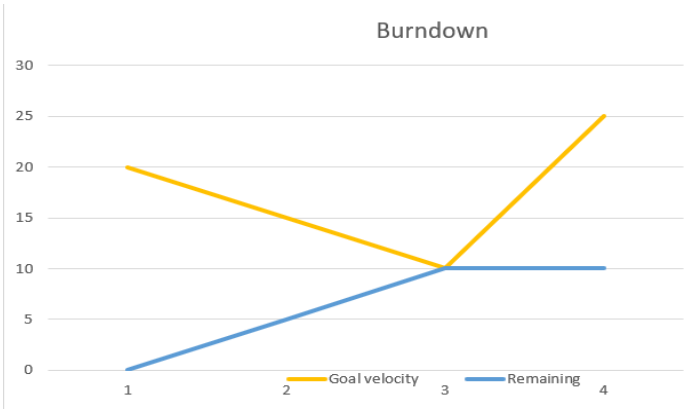
Velocity

$$AV = \frac{\text{Sprint Duration}}{\text{Velocity}} = \frac{20 + 15 + 10 + 25}{4} = 17.5$$

Though we have only 4 Sprints it is estimated that 4.6 sprints are required to complete the task.

Burndown Chart:

Sprint	Goal	Done	Goal velocity	Remaining
1	20	0	20	0
2	20	0	15	5
3	20	0	10	10
4	20	0	25	10



CHAPTER 7

CODING & SOLUTIONING

7.1 Feature 1

```
import time
import sys
import random
import ibmiotf.application
import ibmiotf.device

#Provide the IBM Watson Device Credentials
organization = "m21300"
deviceType = "iot_project"
deviceID = "31052000"
authMethod = "use-token-auth"
authToken = "31050308"
```

The above part of the code is written in Python and utilized the library ibmiotf to establish the link and publish the code in the IBM Watson Cloud using the generated auth token from the IBM Watson Cloud.

7.2 Feature 2

```
pH = random.randint(0,100)
conductivity = random.randint(0,100)
temperature = random.randint(0,100)
oxygen = random.randint(0,100)
turbidity = random.randint(0,100)
sulphate = random.randint(0,100)
chloride = random.randint(0,100)
```

The above part of code used the randint method from the module random to generate random data from 0 to 100

CHAPTER 8

TESTING

8.1Test cases

Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status
Python Code 1	Code	Backend	Verifying whether the code is working or not	IBM watson cloud library file and parameters' optimum values	1. Compile the code to find any errors in the program and run the code to get out put in the shell. The data are then published to the cloud		Desired output at the shell and data is being published in the cloud	Working as expected	Pass
Board creation in IBM Watson Cloud Platform	UI	Front End	To show the published data in a more appealing way by creating gauge, dough nut based display.	Creation of Board in IBM Watson Platform	1. Create board for every parameter it may be either gauge, chart, doughnut. 2. Specify the Range in which the data can be displayed in the board 3. Give unit to give a better understanding.	https://sswm.info/sites/default/files/reference_attachments/MCCAFFREY%20ny%20Water%20Quality%20Parameters%20&%20Indicators.pdf	Application should show below UI elements: a.email text box b.password text box c.Login button with orange colour d.New customer? Create account link e.Last password? Recovery	Working as expected	Pass
Node Creation in Node RED	UI	Front End	Creating node to visualize the data in Web UI by hosting in a website	Creating nodes in Node RED	1. Create node for each parameter and connect them with the cloud database inorder to visualize the dat published in a more appealing manner.		Foramtion of Gauge and doughnut based UI in the host website and displaying data in them.	Working as expected	Pass
Mobile App Creation	UI	Front and Back end	Displaying the published data in the mobile app thorugh HTTP request	developing the UI for the mobile app	1. create layout for the app 2. create labels, text boxes for the parameters you need to visualize 3. Create control buttons for controlling if there is any dicrepanices		display of data in the mobile app which is coinciding with that of the dat published in the cloud	Working as expected	Pass

8.2 User Acceptance Testing

			NFT - Risk Assessment						
S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Volume Changes	Risk Score	Justification
1	er Quality Monitoring	New	Moderate	No Changes	High	Nil	>5 to 10%	ORANGE	As we have seen the chnages

CHAPTER 9

RESULTS

9.1 Performance Metrics

Performance wise the model reduced the dependency on the man force by incorporating sensors which senses the critical parameters needed for ensuring the quality of the water and the collected data is sent to the cloud to be retrieved at one end for interpreting the data and take actions accordingly.

The model is found to be working in single channel that is we can get the data and view it in app but we can’t control the device through buttons provided in the app.

CHAPTER 10

ADVANTAGES & DISADVANTAGES

The advantage of the model is that the data collected is sent to the cloud that is the data is published in the cloud and utilized the boards provided by the platform to create a more appealing way of visualizing the data. The data published is sent to be utilized in the node RED to create a Web UI using the nodes provided by the platform and then it is utilized by the MIT app inventor through HTTP request in order to provide the user the data collected and take action accordingly.

The main disadvantage is that there is no dual channel established in the model only single channel is established that is only data is retrieved and visualized and no control action is taken based on it.

CHAPTER 11

CONCLUSION

Thus, we have created the model which will publish the data to the IBM Cloud platform and boards are created to provide better appealing of the data published and the nit is sent to the node RED to create Web UI and then through the HTTP request we are able to visualize the data in the mobile APP created but no action can’t be take based on the data viewed in the app because of establishment of only the single channel way and not dual channel way.

CHAPTER 12

FUTURE SCOPE

The dual channel will be established to have control over the system based on the data published and viewed in the app. Also, hardware based model will also be developed thus providing a practical system which can be used by many to visualize the data.

APPENDIX

CODE

```
import time
import sys
import random
import ibmiotf.application
import ibmiotf.device

#Provide the IBM Watson Device Credentials
organization = "m21300"
deviceType = "iot_project"
deviceID = "31052000"
authMethod = "use-token-auth"
authToken = "31050308"

def myCommandCallBack(cmd):
    print("Command received: %s" %cmd.data['command'])
    status = cmd.data['command']
    if status =='lighton':
        print("Light ON")
    elif status == 'lightoff':
        print("Light OFF")
    else:
        print("please send proper command")
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(0,100)
    conductivity = random.randint(0,100)
```

```
 temperature = random.randint(0,100)
    oxygen = random.randint(0,100)
    turbidity = random.randint(0,100)
    sulphate = random.randint(0,100)
    chloride = random.randint(0,100)
    data = {"temperature":
temperature,'pH':pH,'conductivity':conductivity,'oxygen':oxygen,'turbidity':turbidity,'sulphate':sulphate,'chl
oride':chloride}
    def myOnPublishCallBack():
        print("Published data",data,"to IBM Watson")
    success = deviceCli.publishEvent("event","json",data,0,myOnPublishCallback)
    if not success:
        print ("Not connected to IoTF")
    time.sleep(5)
    deviceCli.commandCallback = myCommandCallback
```

GITHUB LINK

https://github.com/IBM-EPBL/IBM-Project-36373-1660294607

VIDEO DEMO LINK

YOUTUBE LINK

https://youtu.be/nNFMbhfR8sE

DRIVE LINK

https://drive.google.com/drive/folders/1GR326_LLDFCQVjLqTFaNOGOtn6SsuU7E?usp=share_link