REAL-TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM

PROJECT REPORT - NALAIYATHIRAN

Submitted by

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CONTENTS

ABBREVIATIONS

GSM	Global Systemfor Mobile Communications
IoT	Internet of Things
WSN	Wireless Sensor Network
UAT	User Acceptance Testing
pH	Potential of Hydrogen
NFR	Non-Functional Requirement
DFD	Data Flow Diagram
DB	Data Base
TA	Technical Architecture

1. INTRODUCTION

The need for effectiveand efficient monitoring, evaluation and control of water quality in residential area has become more demanding in this era of urbanization, pollution and population growth. Ensuring safe water supply of drinkingwater is big challenge for modern civilization. Traditional methods that rely on collecting water samples, testing and analyses in water laboratories are not only costly but also lack capability for real-time data capture, analysesand fast dissemination of information to relevant stakeholders for making timely and informed decisions. In the 21st century, there are lots of inventions, but at the same time were pollutions, global warming and so on are being formed, because of this there is no safe drinking water for the world's pollution. Nowadays, maintaining pure supply of water to the people is getting more challenging day by day. In India mainly in big cities the municipality corporation use lots of chemicals to purify the river water then supply that to the people. And we reserved that water without any test. And we also don't know the water is either safe for drinking or not. And now a day's water quality monitoring in real time faces challenges because of global warming limited water resources, growing population, etc. Hence there is need of developing better methodologies to monitor the water quality parameters in real time. The water parameters pH measures the concentration of hydrogen ions. It shows the water is acidicor alkaline. Pure water has 7 pH value, less than 7pH has acidic, more than 7pH has alkaline. The range of pH is 0-14pH. For drinking purpose, itshould be 6.5-8.5pH.

Turbidity measuresthe large number of suspendedparticles in water that is invisible. Higher the turbidity higher the risk of diarrhea, cholera. Lower the turbidity then the water is clean. Temperature sensor measureshow the water is, hot or cold. Here in this paper, we tried to find the problem and then make a solution for it. Water is a scarce but essential naturalresource for humans,animals, and plants.

- Approximately 5-10 million deaths due to water-related diseases are reported annually. However, of the available water on earth, approximately 97%, is saline,implying that freshwater only comprises 3%.
- Furthermore, 68.75% of freshwater is stored in the form of glaciers and icecaps, whereas 30.1% is groundwater and 0.3% is surface water.
- As of 2013, only 2.6 billion people had access to improved water quality standard.
- The quality of water determines whether it is a source of life and good health or death and diseases.It is affected by increasing environmental degradation due to varioussources of pollution, including sewage discharge, effluents from industries, and runoff from agricultural and urban setups.
- Floods, drought, and lack of awareness are also significant contributors to waterpollution.
- Developing countries such as the Republic of Iraq suffer significantly from water pollution, as evidenced by the number of reported deaths and cases due to water-related diseases.

1.1 Project Overview

The parameters monitored in the proposed systemare described below:

- **Potential of Hydrogen(pH)**: pH is a measure of the acidityor alkalinity of a solution,which is usuallydetermined by the concentration of hydrogen ions (H+). Drinkingalkaline water poses no healthrisks but can cause discomfort such as alkaline taste in the mouth, which makes coffee taste bitter and results in lime scale that lowers the efficiency of electric waterheaters.
- **Temperature**: Temperature regulates the metabolism of an aquatic system. Death of aquatic life occurs due to high temperatures as water cannot hold dissolved gases such as oxygen at such temperatures.
- **Turbidity**: Turbidity indicates the extent to which water loses its transparency due to the presence of suspended particles. The higher the concentration of particles, the higher the turbidity.
- **Conductivity**: The conductivity of water is a measure of the capability of water to pass electrical flow. This ability directly depends on the concentration of conductive ions in the water. These conductive ions originated due to inorganic materials such as chlorides, alkalis, carbonate and sulphide compounds and dissolved salts. In this article, let’s study the conductivity of water.
- **Dissolved Oxygen**: Dissolved oxygen (DO) is a measure of how much oxygen is dissolved in the water - the amount of oxygen available to living aquatic organisms. The amount of dissolved oxygen in a stream or lake can tell us a lot about its water quality.

The systemaffords following features:

- High usability
- Remote monitoring of waterstations
- Real-time operation
- Ability to send warningSMS
- Generating reports on water quality over different durations. The project has been developed with the use of **IBM IOT Watson** platformthroughwhich the randomvalues are obtained.
- The design flow is developed with the help of **Node –RED.**The web application is developed with **MIT app inventor.**
- The data'sobtained are storedin the cloudant DB(Database).

1.2 Purpose

Monitoring water quality is very importantfor 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. As water plays a very important role in the well-being of all the organism. It is mandatory for the intake of qualitywater. Here the water quality monitoring system plays a vital role. Due to the rapid growth of industries and various technologies, the environment is pollutedWorsley affected. The pollution is occurred in various forms such land, water, noise etc. The effectsof pollution are hazardous. The real time river water quality system focuses on the regular monitoring of river water and the control of polluted water supply. The project therefore reduces the risk of increasing water borne diseases and improves the quality of life.

2. LITERATURE SURVEY

A literature review is a comprehensive summaryof previous research on a topic. The literature review surveys scholarly articles, books, and other sources relevant to a particular area of research**.** The review should enumerate, describe, summarize, objectively evaluate and clarify this previous research. It should give a theoretical base for the research and help you (the author) determine the nature of your research.

The literature review acknowledges the work of previous researchers, and in so doing, assuresthe reader that your work has been well conceived. It is assumed that by mentioning a previous work in the field of study, that the author has read and evaluated.

2.1 Existing problem

Due to the fast-growing urbanization supply of safe drinkingwater is a challenge for every city authority. Water can be polluted any time. So, the water we reserved in the water tank at our roof top or basement in our society or apartment may not be safe. Still in India most of the people use simple water purifier that is not enough to get surety of pure water. Sometimes the water has dangerous particles or chemical mixed and general-purpose water purifier cannot purify that. And it’s impossible to check the quality of water manually in every time. So, an automatic real-timemonitoring system is required to monitor the health of the water reserved in our water tank of the society or apartment. So it can warn us automatically if there is any problem with the reserved water. And we can check the quality of the water anytimeand from anywhere.

1. Water is a finite resource that is necessary for agriculture, industry and the survival of all livingthings on the planet, includinghumans.

2. Many people are unaware of the need of drinkingadequate amounts of water on a daily basis. Many unregulated methodswaste more water.

3. Poor water allocation, inefficient consumption, lack of competent and integrated water management are all factors that contribute to this problem.

2.2 References

[1] Vaishnavi V. Daigavane and Dr. M.A Gaikwad entitled “Water Quality Monitoring System Based on IOT” Publishedin 2017 Advances in Wireless and Mobile Communications. ISSN 0973-6972 Volume 10, Number 5 (2017),pp. 1107-1116 © Research India Publications. This paper highlights Monitoring of Turbidity, PH & Temperature of Water makes use of water detectionsensor with unique advantage and existing GSM network. The system can monitor water quality automatically, and it is low in cost and does not require people on duty. By keeping the embedded devices in the environment for monitoring enables self-protection (i.e., smart environment) to the environment. To implement this need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, we can bring the environment into real life i.e., it can interact with other objects through the network. Then the collected data and analysisresults will be available to theend user through the Wi-Fi.

[2] Jyotirmaya Ijaradar and Subhasish Chatterjee entitled” Real- Time Water Quality Monitoring System” published in the year 2018 International Research Journal of Engineering and Technology (IRJET). This paper highlights Monitoring of real time quality of Water from reserve tank of house and colony makes use of PH, turbidity and temperature sensor with Raspberry Pi and existing Cloud system for data analytics. The system can monitor water quality automatically, triggers alarms immediately to prevent any health hazards and it is low in cost and does not requirepeople on duty.

[3] Mohammad Salah Uddin Chowdurya, Talha Bin Emranb, Subhasish Ghosha, Abhijit Pathaka, Mohd. Manjur Alama, Nurul Absara,Karl Anderssonc, MohammadShahadat Hossaind entitled "IoT Based Real-time River Water Quality Monitoring System" published in the year 2019 at the 16th International Conference on mobile Systems and Pervasive Computing (MobiSPC) August 19-21, 2019, Halifax, Canada. This paper highlights Real-time monitoring of water quality by using IoT integrated Big Data Analyticswill immensely help people to become consciousagainst using contaminated water as well as to stop pollutingthe water. The research is conducted focusing on monitoring river water quality in real-time. Therefore, IoT integrated big data analytics is appeared to be a better solution as reliability, scalability, speed, and persistence can be provided.During the project development phase an intense comparative analysis of real-time analytics technologies such as Spark streaming analysis throughSpark MLlib, Deep learning neuralnetwork models, and Belief Rule Based (BRB) system will be conducted[20- 27].

[4] ALI J. RAMADHANentitled "SMART WATER-QUALITY MONITORING SYSTEM BASED ON ENABLED REAL-TIME INTERNET OF THINGS"published in the year 2020 Journal of Engineering Science and Technology Vol. 15, No. 6 (2020) 3514 - 3527 © School of Engineering, Taylor's University. The paper highlights smart electronic system to monitor the quality of water supplied to people in Najaf, Republic of Iraq. Characteristics of the proposedsystem include remote monitoring capabilities supported by WSN and IoT along with a more efficient system architecture comparedto similar systemsowing to its use of ten sensorsto monitor water quality at five stations.The proposed system measures values of ten parameters pertaining to water quality and can issue timely warnings in the form of SMS and e-mails to responsible authorities to ensure appropriate action.

[5] Bhoomika R, Netra Jalagar, Pooja F B, Sangeetha Sontera, & Shanthveeresh N S (Asst., Professor) entitled “IOT Based Real-Time River Water Quality Monitoring System” published in the year 2021. The paper highlights Water turbidity, PH, and temperature are monitored using a water detection sensor that has a unique advantage and is alreadyconnected to a GSM network.The technology can automatically monitor water quality, is low-cost, and does not require personnel to be on duty. As a result, water quality testing will most likely be more cost-effective, convenient, and quick. This system may be used to monitor different water quality metrics by simply replacing the matching sensorsand modifying the required softwarepackages

[6] Nikhil Kedia, Water Quality Monitoring for Rural Areas- A Sensor Cloud Based Economical Project, in 1st International Conference on Next Generation ComputingTechnologies (NGCT-2015) Dehradun,India, 4-5 September2015. 978-1-4673-6809-4/15/$31.00 ©2015 IEEE

[7] Jayti Bhatt, Jignesh Patoliya, Iot Based Water Quality Monitoring System,IRFIC, 21feb,2016.

[8] Michal lom, ondrej priby & miroslav svitek, Internet 4.0 as apart of smartcities, 978-1-5090-1116-2/16/$31.00 ©2016IEEE

[9] Zhanwei Sun, Chi Harold Liu, Chatschik Bisdikia_, Joel W. Branch and Bo Yang, 2012 9th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks

[10] Sokratis Kartakis, Weiren Yu, Reza Akhavan, and Julie A. McCann, 2016 IEEE First International Conference on Internet-of-Things Design and Implementation, 978-1-4673-9948-7/16 © 2016IEEE

2.3 Problem Statement Definition

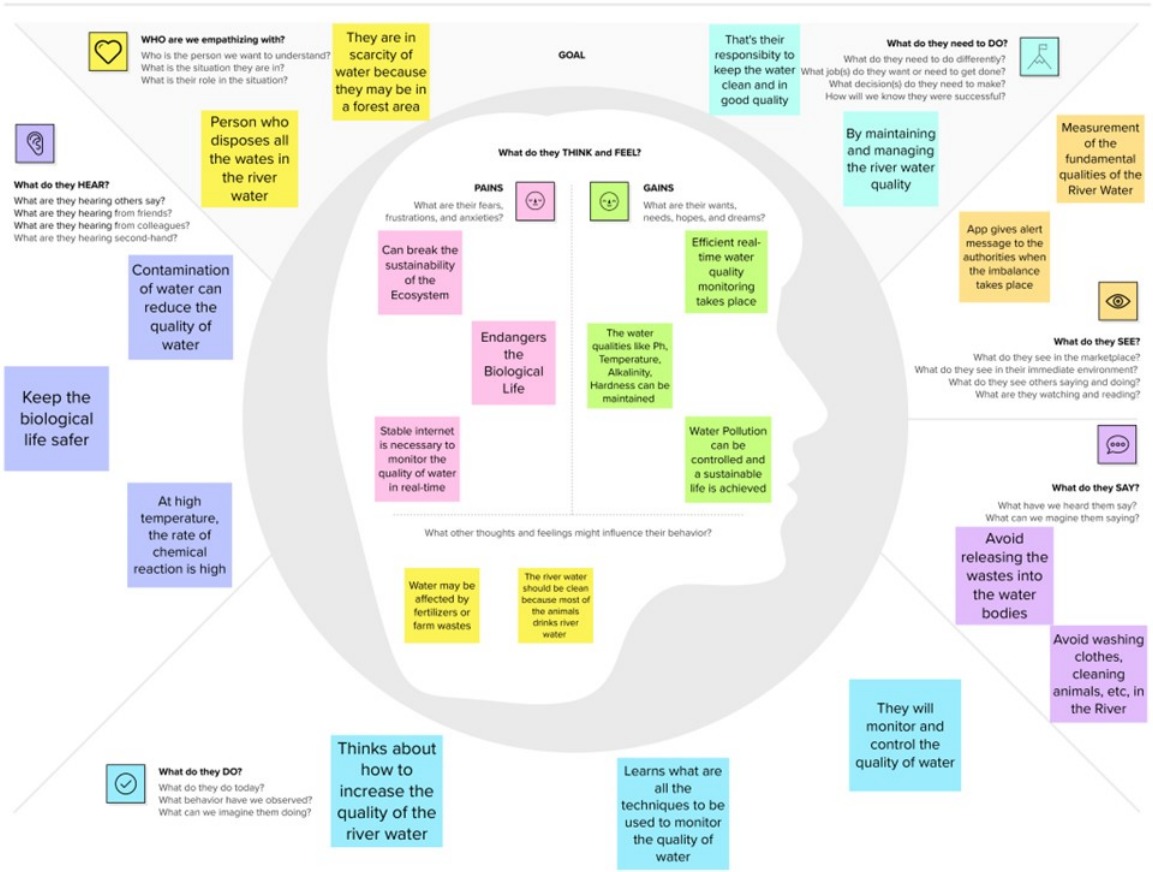
Water is a finite resource that is necessaryfor agriculture, industry and the survival of all living things on the planet, including humans. Many people are unaware of the need of drinking adequate amounts of water on a daily basis. Many unregulated methods waste more water. Poor water allocation, inefficient consumption, lack ofcompetent and integrated water management are all factorsthat contribute to this problem.Therefore, efficient use and water monitoring are potential constraint for home or office water management system. Due to the fast-growing urbanization supply of safe drinking water is a challenge for every city authority. Water can be polluted any time. So, the water we reservedin the water tank at our roof top or basement in our society or apartment may not be safe. Still in India most of the people use simple water purifier that is not enough to get surety of pure water. Sometimesthe water has dangerous particlesor chemical mixed and general-purpose water purifier cannot purify that. And it's impossible to check the quality of water manually in every time. So, an automatic real-time monitoring system is required to monitor the health of the water reserved in our water tank of the societyor apartment.

3.IDEATION & PROPOSED SOLUTION

Ideation is the process where you generate ideas and solutions through sessions such as Sketching, Prototyping, Brainstorming, Brainwriting, Worst Possible Idea, and a wealth of other ideationtechniques provided by the Implementation agency in response to the requirements and the objectives of the Project.

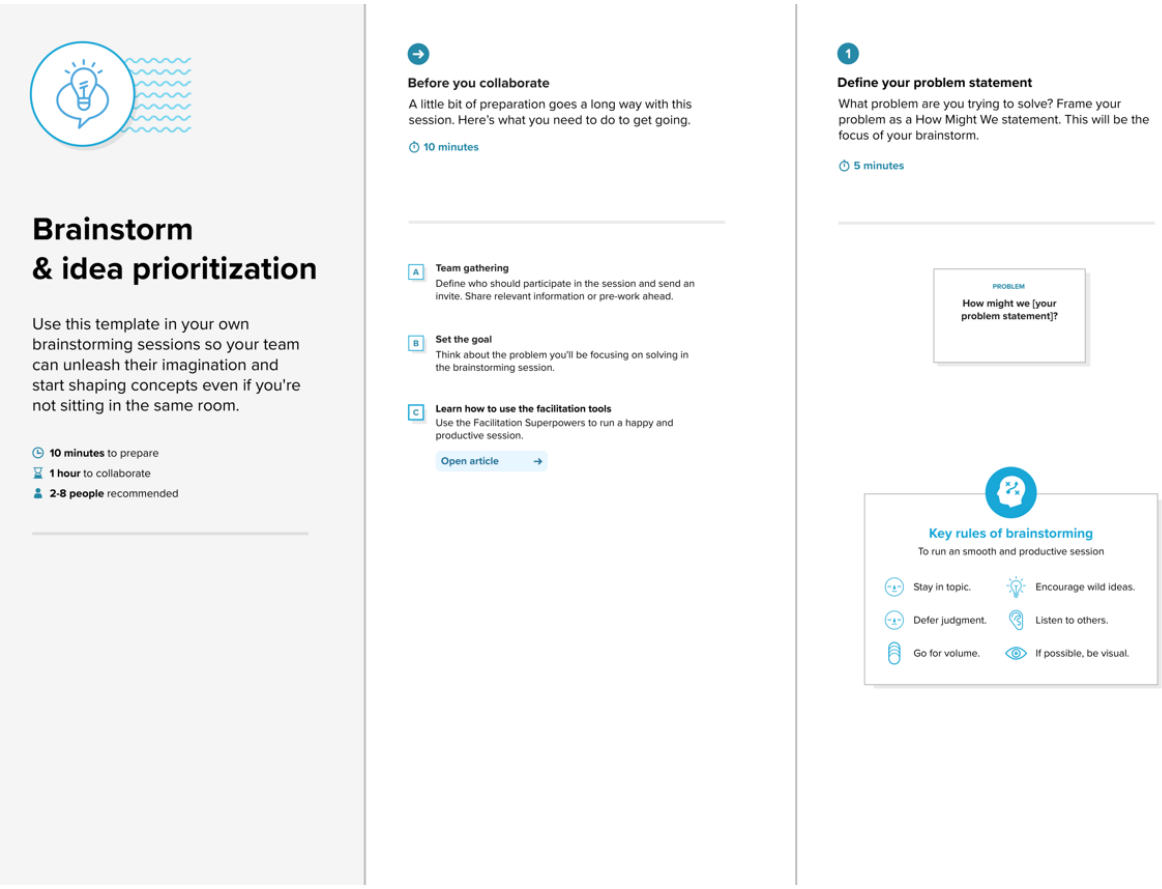
3.1 Empathy Map Canvas

An empathy map helps to map what a design team knows about the potential audience.This tool helps to understand the reason behind some actionsa user takes deeply. This tool helps build Empathy towards users and helps design teams shift focus from the product to the users who are going to use the product. The empathy map template which we have used has four sections namely Says, feels, Thinks, Does.it also includes the user pains and gains. The opinionof all our team membershas been recordedin this template.



3.2 Ideation &Brainstorming

Brainstorming is a group problem-solving method that involves the spontaneous contribution of creative ideas and solutions. This technique requires intensive, freewheeling discussion in which every member of the group is encouraged to think aloud and suggest as many ideas as possible based on their diverse knowledge.



2

Brainstorm

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

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

Tharun Prasath R C

- Collect samples of water from the rivers
- Measure parameters like Ph, Turbidity, TDS of the samples
- Analyze and set the threshold value
- Use NodeMCU to interface with the sensors

Nandhakumar L

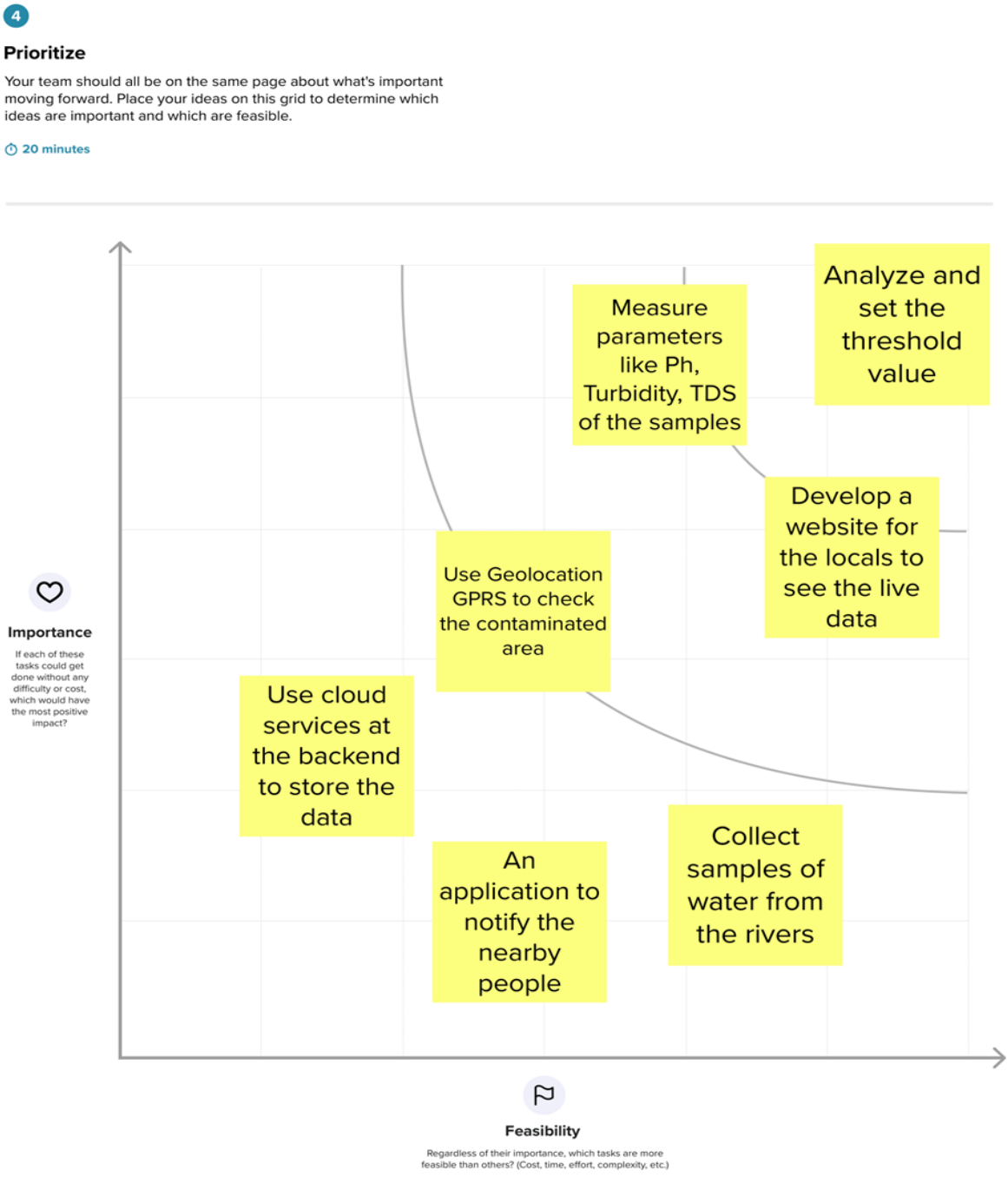
- An application to notify the nearby people
- Use geolocation GPRS to check the contaminated area
- Alert the locals through WiFi
- Collect and store the values in a cloud DB

Palani M

- Use the collected values and analyze
- Find the relationship between the parameters
- Plot the values in a graph
- Analyze the graph and set the threshold values

Vikram Siva K V

- Use cloud service at the backend to store the data
- Check for the best and efficient microprocessor that can be used
- Analyze and check using different sensor modules available in the market
- Develop a website for the locals to see the live date



- The ideas that hit our mind by defining the problem statementwas discussed withinour team.
- The brainstorming session was held at our college by our facultymentor.
- The ideas were enteredin the template provided and prioritized.

3.3 Proposed Solution

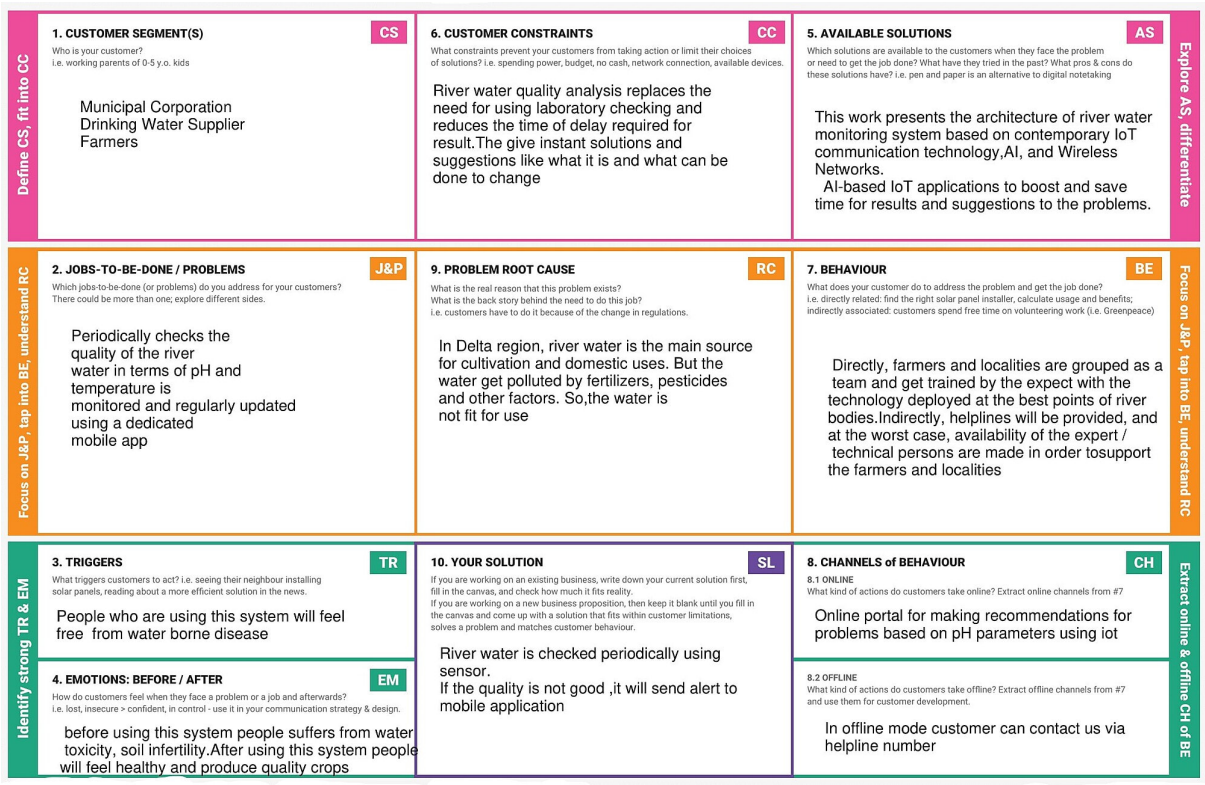
Proposed Solution means the technical solution to be provided by the Implementation agency in response to the requirements and the objectives of the Project.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Water is used for drinking, domestic use, and food production or recreational purposes, So it is highly imperative for us to maintain water quality balance. Otherwise, it would severely damage the health of the humans and affect the ecological balance. It has been studied that water pollution is the leading cause of mortalities and diseases worldwide. The records show that more than 14,000 people die daily worldwide due to water pollution and other issue is growth of algae called eutrophication This happens due to the lack of water quality monitoring system.
2.	Idea/Solution description	Detecting the dust particles, PH level of water, temperature to be monitored and altering the authorities if water quality is not good.
3.	Novelty/Uniqueness	IoT devices use various types of sensors to collect data about turbidity, temperature, pH, conductivity, etc. of river water continuously. Also, IoT devices have capability to stream the array of collected data wirelessly to the cloud.
4.	Social Impact / Customer Satisfaction	In many developing countries, dirty or contaminated water is being used for drinking without any proper prior treatment. Water pollution is a foremost global problem which needs ongoing evaluation and adaptation of water resource directorial principle.
5.	Business Model (Revenue Model)	It is cost effective and affordable for all stages of people. it is used in industrial water treatment plant, river bodies, aqua forming and river water monitoring system.
6.	Scalability of the Solution	Measuring of real time values and continuous monitoring helps in maintaining the quality of water

The problem statement has been analyzed detaillyand the proposed solution has been designedconsidering the variousfactors to make the projectmuch efficient.

3.4 Problem Solution fit

The Problem-Solution Fit Canvas is a templateto help identify solutions with higher chances of solution adoption, reduce time spent on testingand get a better overview of the currentsituation**.**



Based on the devisedproblem statement, the pains, emotions, customer limitations, root cause, behavior and the behavior has been captured.

4. REQUIREMENT ANALYSIS

Requirements analysis, also called requirements engineering, is the process of determining user expectations for a new or modified product. These features, called requirements, must be quantifiable, relevant and detailed. In softwareengineering, such requirements are often calledfunctional specifications.

4.1 Functional requirements

Functional requirements may involve calculations, technical details, data manipulation and processing, and other specificfunctionality that define what a system is supposed to accomplish. Behavioral requirements describe all the cases where the system uses the functional requirements, these are captured in use cases. These are the requirements that the end user specifically demands as basic facilities that the system should offer. All these functionalities need to be necessarily incorporated into the systemas a part of the contract.

The functional requirements are proper functioning of the sensor nodes, data collection and proper intimation of the water quality level

FR No.	**Functional Requirement (Epic)**	**Description (Story/Sub-task)**
FR-1	User Registration	Registration through product mobile UI
FR-2	User Login	Login to the product Mobile UI
FR-3	Ph level detection	Ph sensor is used to monitor the water quality.
FR-4	Turbidity detection	Turbidity sensor TS-300B measures the turbidity (counter of suspended matter) in the wash water.
FR-5	Temperature detection	Temperature sensor (DHT11) is used to measure the temperature of the river water.

FR-6	Oxygen Level detection	Analog Dissolved Oxygen Sensor / Meter is used to measure the temperature of the river water.
FR-7	Conductivity Detection	Conductivity Sensor is used to measure the conductivity of the river water.

4.2 Non-Functional requirements

Non-Functional Requirements are the constraints or the requirements imposed on the system. They specify the quality attributeof the software. Non-Functional Requirements deal with issues like scalability, maintainability, performance, portability, security, reliability, and many more. Non-Functional Requirements address vital issuesof quality for software systems.

- Users, clients, and developers are unsatisfied.
- Inconsistent software.
- Time and cost overrun to fix the software which was prepared without keepingNFRs in mind.

NFR No.	**Non-Functional Requirement**	**Description**
NFR-1	Usability	Efficient to use and has simple monitoring system.
NFR-2	Security	Mobile application is secured with firewalls protection.
NFR-3	Reliability	Real time sensor output values with future predicted data storage. 98% efficient monitoring output. Assurance for aquaculture safety
NFR-4	Performance	Greater performance and environmentally safe model.
NFR-5	Availability	In form of mobile UI 24 x 7 monitoring system.

NFR-6	Scalability	Highly Scalable. It is capable to produce a best final output.
NFR-7	Stability	It is highly stable.
NFR-8	Efficiency	It is highly efficient and it has simple monitoring system.

These can be classified as :

- **Performance constraints** –Reliability, security, responsetime, etc.
- **Operating constraints** – These include physical constraints (size, weight),personnel availability, skill level considerations, system accessibility for maintenance, etc.
- **Interface constraints** – These describe how the system is to interface with its environment, users, and other systems. For example, user interfaces and their qualities (e.g., user-friendliness).
- **Economic constraints** –Immediate and/or long-termcosts.
- **Lifecycle requirements** – Qualityof the design: These measuredin terms such as maintainability, enhance ability, portability.

5. PROJECT DESIGN

Project design is an early phase of the project lifecycle where ideas, processes, resources, and deliverables are planned out. A project design comes before a project plan as it's a broad overview whereas a project plan includes more detailed information.

- A project design is a method of organizing ideas, materials, and processes in order to achieve a specific goal. Project managers rely on smart design to avoid mistakes and offer parameters to keep key components of the project, such as the Project Timeline and budget.

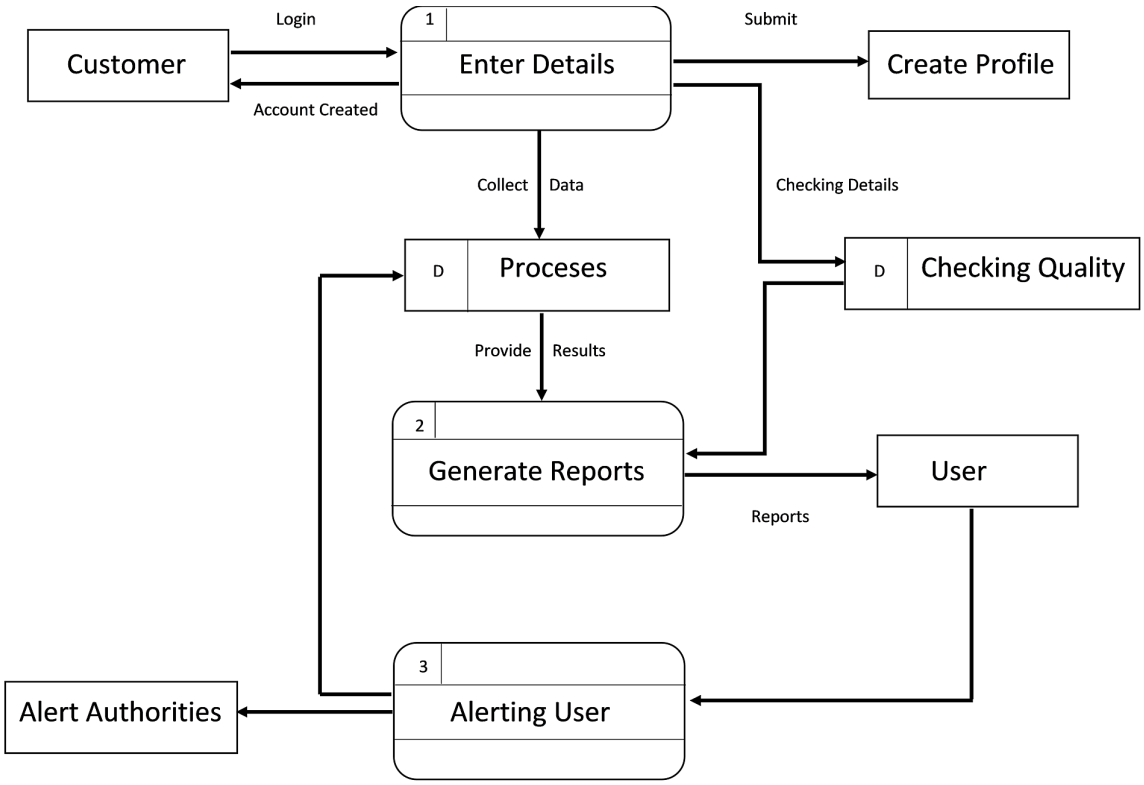
- Some people make the mistake of rushing through the basic stages of a project,such as a Project Design.Any seasoned project manager will tell you that the more effortyou put into the front-end of a project,the better the backendresults will be.

- One of the initialroles of the project manageris to design the project.Decisions regarding how to administer and govern the project are made at this point. A project plan is developed, focusing on the needs of the stakeholders, the organisation, and, of course, the project itself. This document will thereafter be used to oversee the project's remaining stages.

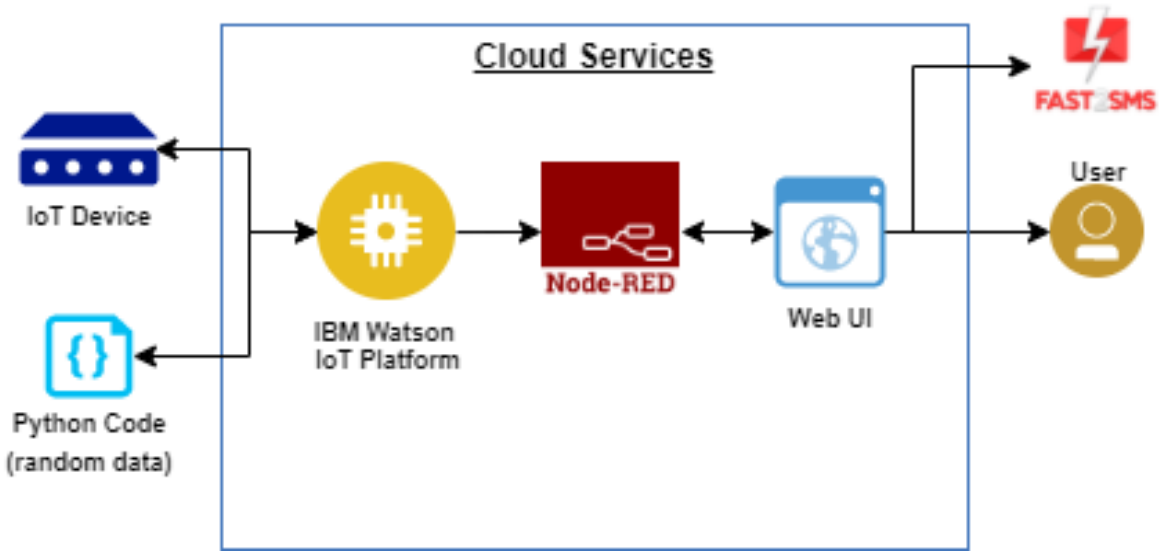
5.1 Data Flow Diagram

DFD is the abbreviation for Data Flow Diagram. The flow of data of a system or a process is represented by DFD. It also gives insight into the inputs and outputs of each entity and the process itself. DFD does not have controlflow and no loops or decision rules are present. Specific operations depending on the type of data can be explainedby a flowchart. Data Flow Diagram can be represented in several ways. The DFD belongs to structured-analysis modeling tools. Data Flow diagrams are very popular because they help us to visualize the major steps and data involved in software-system processes.

Data flow describes the information transferring between different parts of the systems. The arrow symbol is the symbol of data flow. A relatable name should be given to the flow to determine the information which is being moved. Data flow also represents materialalong with information that is being moved. Material shifts are modeled in systems that are not merely informative. A given flow should only transfer a single type of information. The direction of flow is represented by the arrow which can also be bi-directional.



5.2 Solution & Technical Architecture



Technical architecture, which is also often referred to as application architecture, IT architecture, business architecture, etc., refers to creating a structured software solution that will meet the business needs and expectations while providing a strong technical plan for the growth of the software application through its lifetime.

Technical Architecture (TA) is a form of IT architecture that is used to design computer systems. It involves the development of a technical blueprint with regard to the arrangement, interaction, and interdependence of all elements so that system-relevant requirements are met. At its core, the term architecture describes the formation of a structure by strategically assembling single components. In this process of assembling, the architecthas to adhere to certainrules or requirements like legal constraints, financial constraints, or scientific laws. New application is compatible with the existing technology at a company by specifying things like the communications networkor hardware that it uses.

5.3 User Stories

A user story is a well-formed, short and simple description of a software requirement from the perspective of an end-user, written in an informal and natural language. It is the main artifact used in the agile software development process to captureuser requirements.

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 username, password and confirming my password.	I can access my account/dashboard	High	Sprint-1

	Login	USN-2	As a user, I can log into the application by entering username & password	I can receive login credentials.	High	Sprint-1
	Interface	USN-3	As a user, the interface should be user-friendly manner	I can able to access easily.	Medium	Sprint-1
Customer (Web user)	Dashboard	WUSN-1	As a web user, I can access the specific info (ph value, temp, turbidity, oxygen level, etc.,).	I can able to know the quality of the water.	High	Sprint-1
Customer Care Executive (input)	View manner	CCE-1	As a customer care, I can view data in visual representation manner(graph)	I can easily understand by visuals.	High	Sprint-1
	Taste	CCE-2	As a customer care, I can able to view the quality(salty) of the water	I can easily know whether it is salty or not	High	Sprint-1
	Color visibility	CCE-3	As a customer care, I can able predict the water Color	I can easily know the condition by color	High	Sprint-1
Administrator	Risk tolerant	ADMIN-1	An administrator who is handling the system should update and take care of the application.	Admin should monitor the records properly.	High	Sprint-2

User storiesare either written by a product manager or a team member on behalf of the end-user, explaining the expected functionality from the system being developed. User stories are written to capture the most important elementsof a requirement following a predefined template.The most commonlyused user story template is called the connextra template where a user describes his role, his capabilities, and what benefits he expects to receive from the system using a single sentence.

Users should keep the following agile principles in mind whenwriting user stories.

1. Working softwareis the primary measure of progress.
2. The highestpriority is to satisfy the customer throughearly and continuous delivery of valuablesoftware.

6. PROJECT PLANNING& SCHEDULING

Project Planning and Scheduling', though separate, are two sides of the same coin in project management. Fundamentally, 'Project planning' is all about choosing and designing effective policies and methodologies to attain project objectives. While 'Project scheduling' is a procedure of assigning tasks to get them completedby allocating appropriate resources within an estimated budgetand time-frame.

The basis of project planning is the entire project. Unlikely, project scheduling focuses only on the project-related tasks,the project start/enddates and project dependencies. Thus, a'project plan' is a comprehensive documentthat contains the project aims, scope, costing,risks, and schedule.And a project schedule includesthe estimated dates and sequential project tasks to be executed.

6.1 Sprint Planning& Estimation

Sprint planning is an event in scrum that kicks off the sprint. The purposeof sprint planningis to define what can be deliveredin the sprint and how that work will be achieved. Sprint planning is done in collaboration with the wholescrum team.

The sprint is a set period of time where all the work is done. However, before you can leap into action you have to set up the sprint. You need to decide on how long the time box is going to be, the sprint goal, and where you're going to start. The sprint planningsession kicks

off the sprint by setting the agenda and focus. If done correctly, it also creates an environment where the team is motivated, challenged, and can be successful.

The What – The product owner describes the objective(or goal) of the sprint and what backlog items contribute to that goal. The scrum team decides what can be done in the coming sprint and what they will do during the sprint to make that happen.

The How – The development team plans the work necessary to deliver the sprint goal. Ultimately, the resulting sprint plan is a negotiation between the development team and product owner based on value and effort.

The Who – You cannot do sprint planning without the product owner or the development team. The product owner defines the goal based on the value that they seek. The development team needs to understand how they can or cannotdeliver that goal.

The Inputs – A great starting point for the sprint plan is the product backlog as it provides a list of ‘stuff’ that could potentially be part of the current sprint.

The Outputs– The most importantoutcome for the sprint planningmeeting is that the team can describe the goal of the sprint and how it will start working toward that goal. This is made visible in the sprint backlog.

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	30 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	06 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	13 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.2. Sprint Delivery Schedule

A sprint schedule is a document that outlines sprint planning from end to end. It's one of the first steps in the agile sprint planningprocess—and something that requires adequate research, planning, and communication.

Agile Product Delivery is a customer-centric approach to defining, building, and releasing a continuous flow of valuableproducts and servicesto customers and users.

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 username, password.	2	High	Palani M
Sprint-1	Login	USN-2	As a user, I can log into the application by entering my username & password	2	Low	Tharun Prasath R C
Sprint-1	IBM Cloud service Access	USN-3	As a user, I can get access to IBM cloud services.	2	Medium	Nandhakumar L
Sprint-2	Create the IBM Watson IoT and device Settings	USN-4	As a user, I can create the IBM Watson IoT Platform and integrate the microcontroller with it, to send the sensed data on Cloud	2	High	Vikram Siva K V

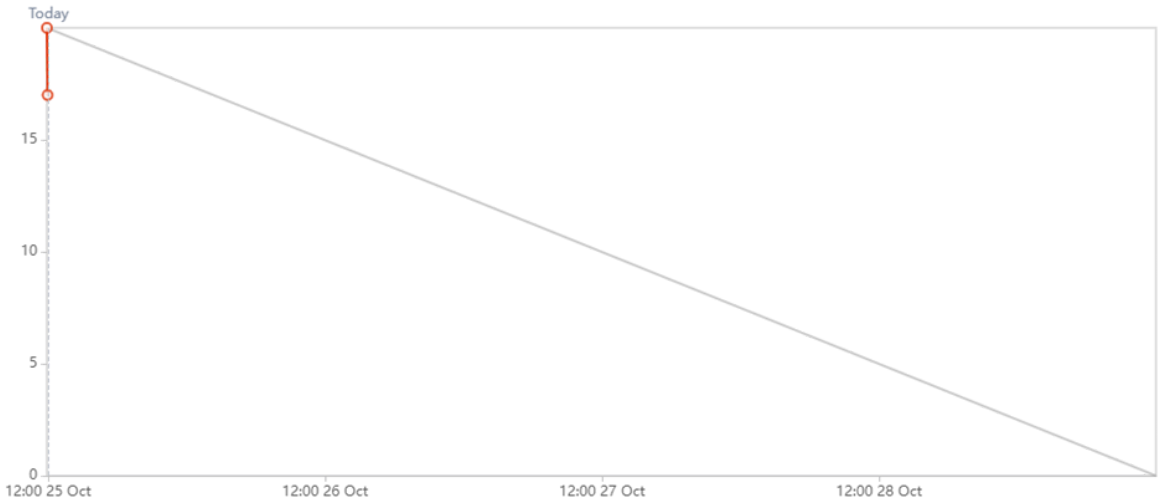
Sprint-2	Create a node red service	USN-5	As a user, I can create a node red service to integrate the IBM Watson along with the Web UI	2	Medium	Tharun Prasath R C
Sprint-2	To develop a Python code	USN-6	As a user, I can create a python code to sense the physical quantity and store data.	2	Medium	Palani M
Sprint-3	Publish Data to cloud.	USN-7	As a user, I can publish Data that is sensed by the microcontroller to the Cloud	3	High	Nandhakumar L
Sprint-3	MIT app inventor (Front end Design)	USN-8	As a user, I can create the front end design for the application using MIT app Inventor	2	Medium	Vikram Siva K V
Sprint-3	MIT app inventor (Back-end Design)	USN-9	As a user, I can create the back end design for the application using MIT app Inventor	3	High	Palani M
Sprint-4	Create a Web UI using Node-red	USN-10	As a user, I can create a Web UI, to access the data from the cloud and display all parameters.	2	Medium	Nandhakumar L
Sprint-4	Connecting Node-red to Mobile Application	USN-11	As a user, I can connect the node-red to the mobile application to display all the parameters in the mobile app	2	Medium	Tharun Prasath R C

Sprint-4	Testing	USN-12	As a user, I can test the project and final deliverables	3	Medium	Palani M

6.3 Reports from JIRA

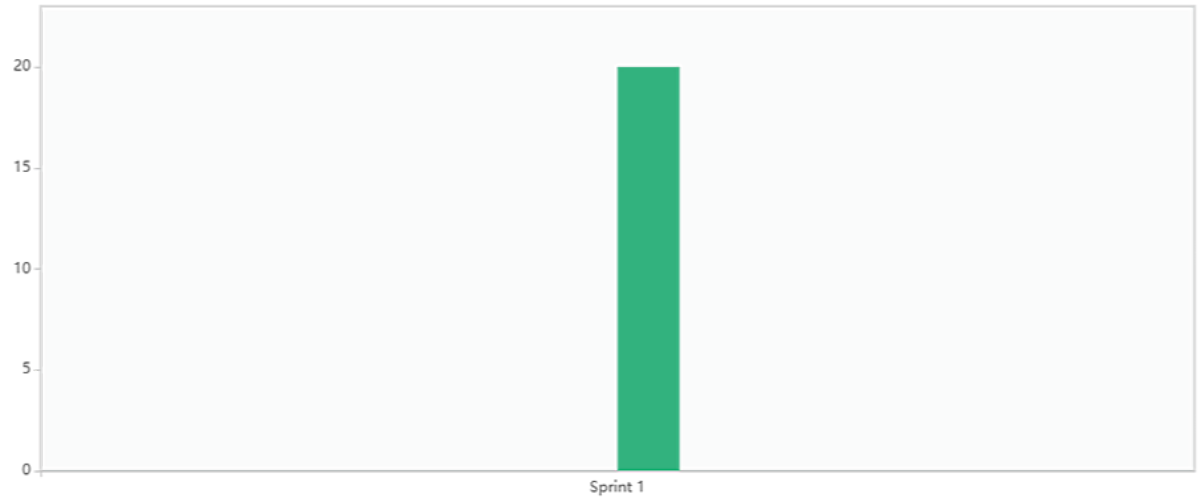
Jira is a software application used for issue tracking and project management. The tool, developed by the Australian software company Atlassian, has become widely used by agile development teams to trackbugs,stories,epics,andothertasks.

Sprint burndownchart:

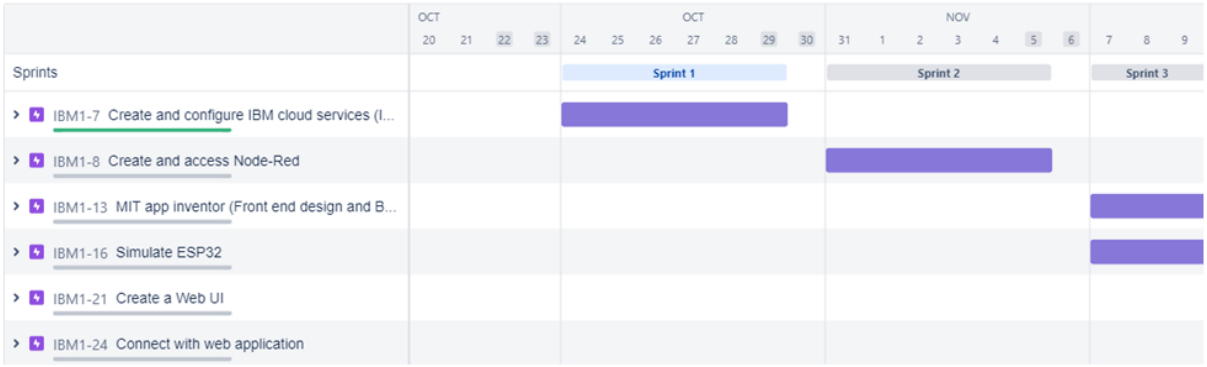


JIRA FILES FOR SPRINT-1:

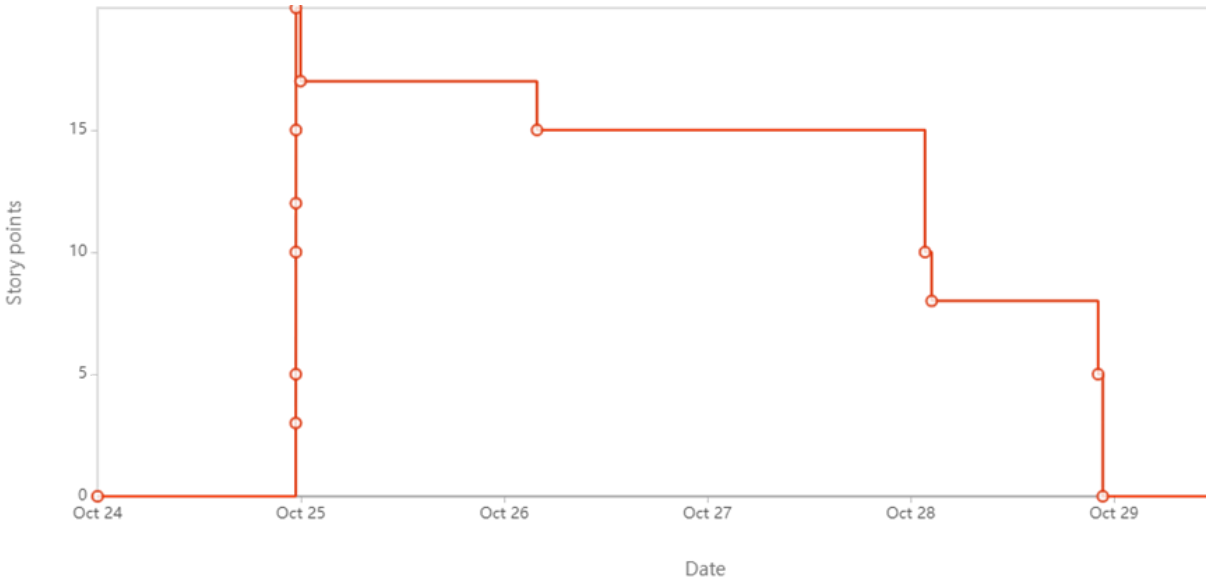
Velocity chart:



Road map:

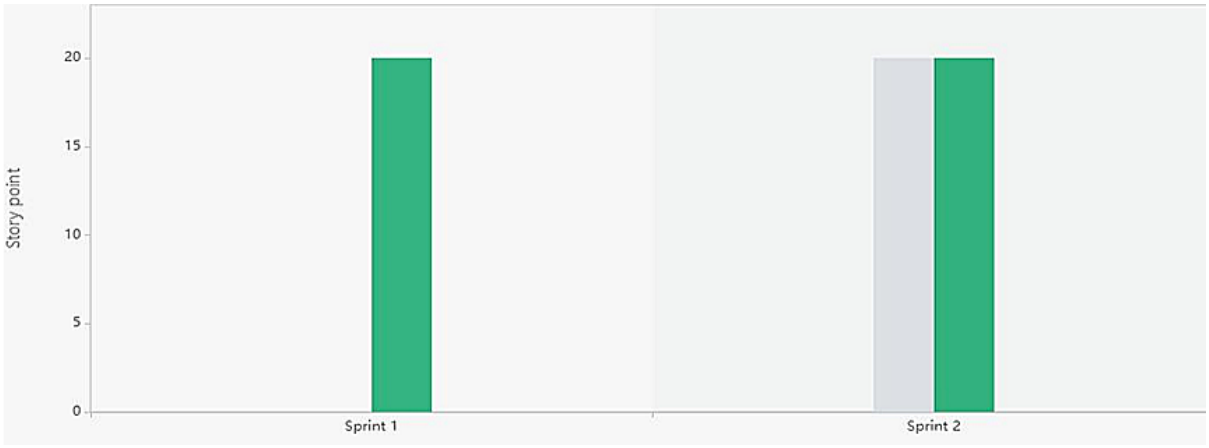


Burndown chard:

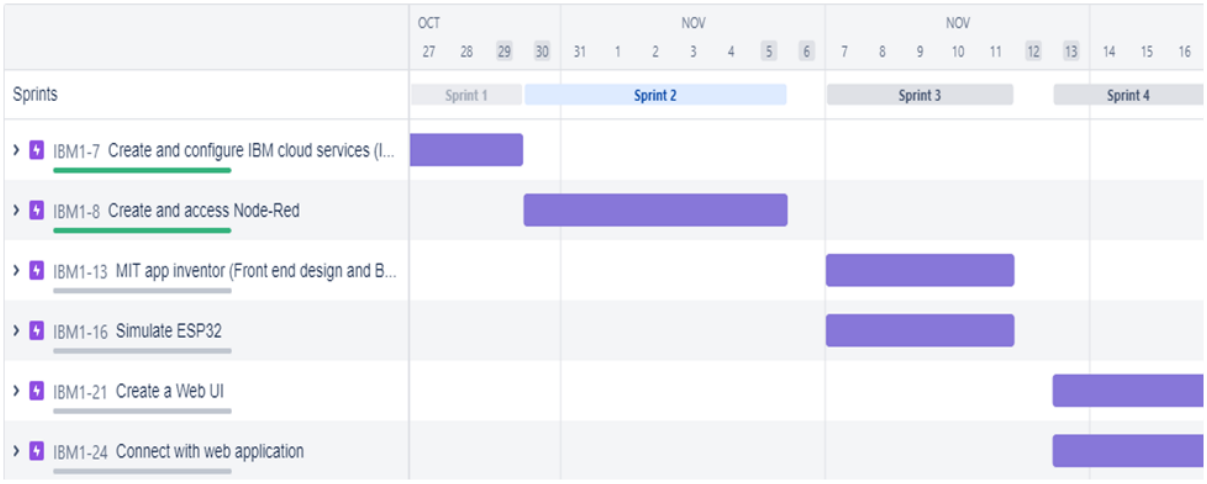


JIRA FILES FOR SPRINT-2:

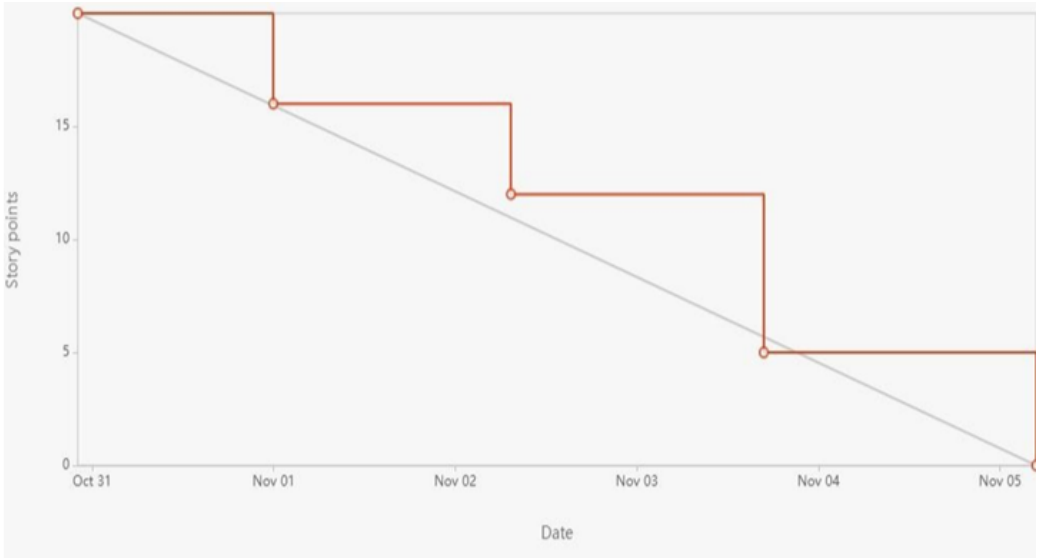
Velocity chart:



Road map:

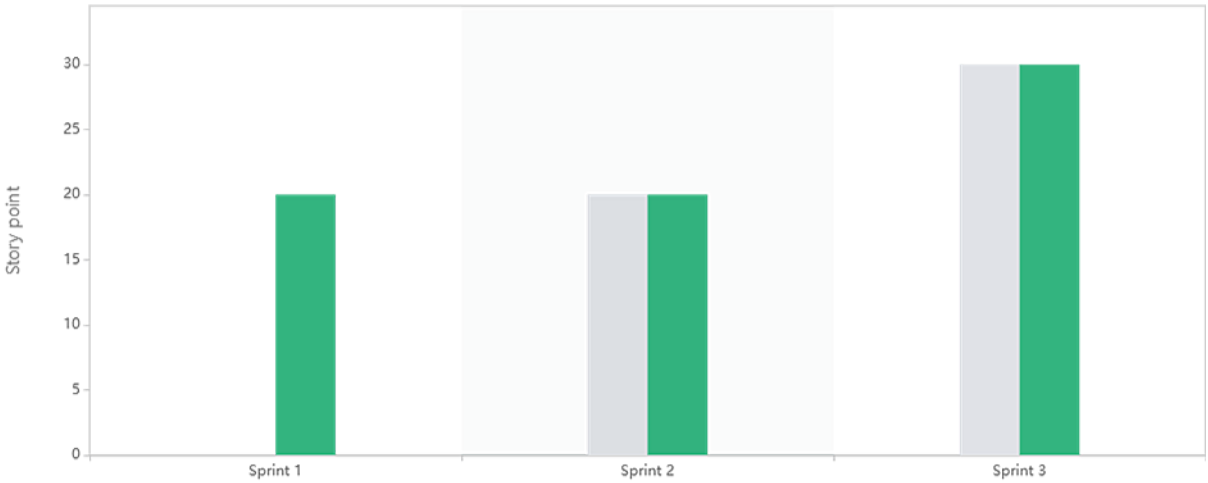


Burndown chart:

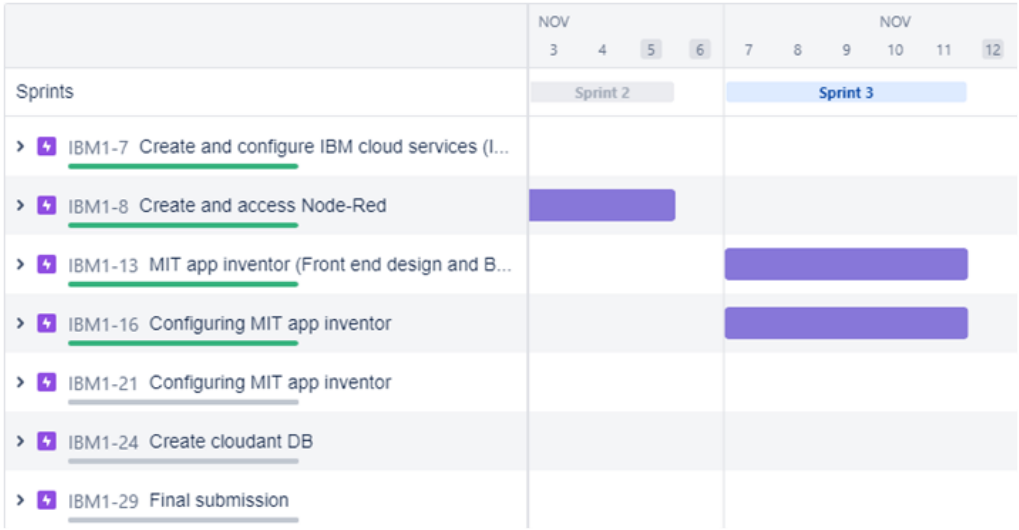


JIRA FILES FOR SPRINT-3:

Velocity chart:



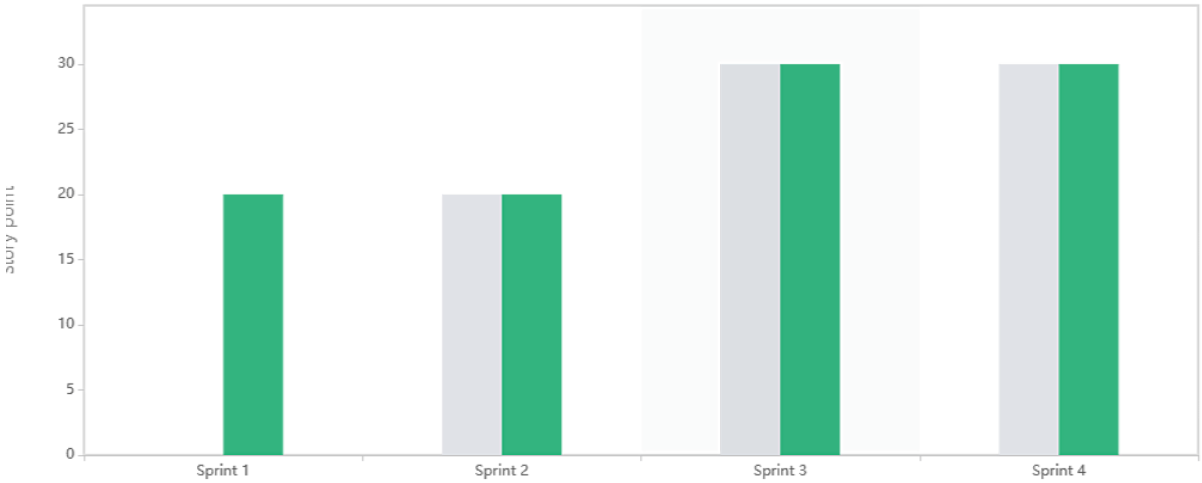
Road map:



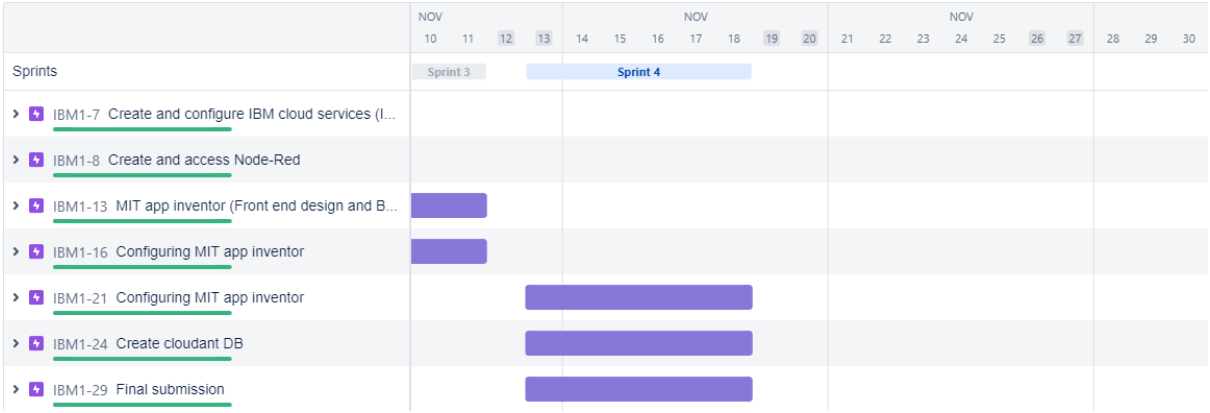
Burndown chart:

JIRA FILES FOR SPRINT-4:

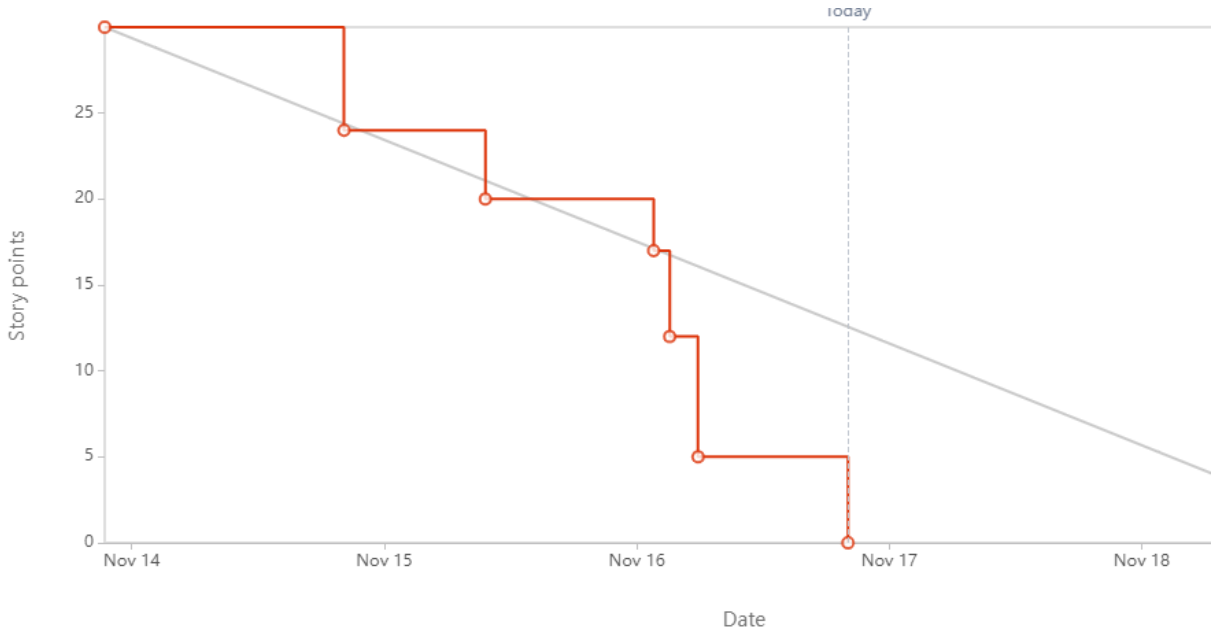
Velocity chart:



Roadmap:



Burndown chart:



7. CODING &SOLUTIONING

Coding is basically the computer language used to develop apps, websites, and software. Without it, we'd have none of the most popular technology we've come to rely on such as Facebook, our smartphones, the browser we choose to view our favorite blogs, or even the blogs themselves an actionor process of solving a problem.

PYTHON:

Python is a high-level, general-purpose programming language.Its design philosophy emphasizes code readability with the use of significant indentation. Python is dynamically-typed and garbage- collected. It supports multipleprogramming paradigms, includingstructured, object-oriented and functional programming

7.1 Feature 1

PH, TEMPERATURE, CONDUCTIVITY:

- **pH sensor:** The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. It operates on 5V power supply and it is easy to interfacewith arduino.Thenormalrange of pH is6 to 8.5.

- **Water Temperature**: indicates how water is hot or cold. The range of DS18B20 temperature sensor is -55 to +125 °C. This temperature sensor is digitaltype which gives accurate reading.

- **Conductivity**: The conductivity of water is a measure of the capability of water to pass electrical flow. This ability directly depends on the concentration of conductive ions in the water. These conductive ions originated due to inorganic materials such as chlorides, alkalis, carbonate and sulphide compounds and dissolved salts. In this article, let’s study the conductivity of water.

7.2 Feature 2

TURBIDITY, DISSOLVED OXYGEN:

- **Turbidity sensor**: Turbidity is a measureof the cloudiness of water. Turbidity has indicated the degree at which the water loses its transparency. It is considered as a good measure of the quality of water. Turbidity blocks out the light needed by submerged aquatic vegetation. Italso can raise surface water temperatures above normal becausesuspended particles near the surfacefacilitate the absorption of heatfrom sunlight. The measurement of turbidity is a key test of water quality.Turbidity, as identified with a turbidity meter or sensor, is the measurement of water clarity.
- **Dissolved Oxygen**: Dissolved oxygen (DO) is a measure of how much oxygen is dissolved in the water - the amount of oxygen available to living aquatic organisms. The amount of dissolved oxygen in a stream or lake can tell us a lot about its water quality.

8. TESTING

The process or method of finding error/sin a software application or program so that the application functions according to the end user'srequirement is calledtesting.

Software testing is the processof verifying a system with the purpose of identifying any errors, gaps or missing requirement versus the actual requirement.

	Test Scenarios
1	Verify user is able to see login page
2	Verify user is able to get gauge values
3	Verify user is able to get the parameter values
4	Verify user is able to get the alert messages
5	Verify the project works in real time

8.1 Test Cases

A test case is a document,which has a set of test data, preconditions, expectedresults and postconditions, developed for a particular test scenario in order to verify complianceagainst a specific

requirement.Test Case acts as the starting point for the test execution, and after applying a set of input values, the application has a definitive outcome and leaves the system at some end point or also known as execution postcondition.

Date	10-Nov-22	
Team ID	PNT2022TMID06691	
Project Name	Real time river water quality monitoring and control system	
Maximum Marks	4 marks	

	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Commnets	TC for Automation(Y/N)	BUG ID	Executed By
LoginPage_TC_OO1	Functional	Home Page	Verify user is able to see the Login/Sign up popup when user clicked on My account button	IBM Cloud services	1.Enter URL and click go 2.Click on My Account dropdown button 3.Verify login/Singup popup displayed or not	www.cloud.ibm.com	Login/Signup popup should display	Working as expected	Pass				Palani M
LoginPage_TC_OO2	UI	Home Page	Verify the UI elements in Login/Sign up popup	IBM Cloud services	1.Enter URL and click go 2.Click on My Account dropdown button 3.Verify login/Singup popup with below UI elements: a.email text box b.password text box c.Login button d.New customer? Create account link e.Last password? Recovery password link	www.cloud.ibm.com	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 password link	Working as expected	Fail	Steps are not clear to follow			Nandhakumar L

LoginPage_TC_OO3	Functional	Home page	Verify user is able to log into application with Valid credentials	IBM Cloud services	1.Enter URL(https://shopenzer.com/) and click go 2.Click on My Account dropdown button 3.Enter Valid username/email in Email text box 4.Enter valid password in password text box 5.Click on login button	Username:61071912130@smartinternz.com password: Mpgu1234#	User should navigate to user account homepage	Working as expected	Pass				Tharun Prasath R C
LoginPage_TC_OO4	Functional	Log in page	Verify user is able to log into application with InValid credentials	IBM Cloud services	1.Enter URL(https://shopenzer.com/) and click go 2.Click on My Account dropdown button 3.Enter InValid username/email in Email text box 4.Enter valid password in password text box 5.Click on login button	Username:61071912130@smartinternz.com password: Mpgu1234#	Application should show 'Incorrect email or password ' validation message.	Working as expected	Pass				Vikram Siva K V
LoginPage_TC_OO4	Functional	Log in page	Verify user is able to log into application with InValid credentials	IBM Cloud services	1.Enter URL(https://shopenzer.com/) and click go 2.Click on My Account dropdown button 3.Enter Valid username/email in Email text box 4.Enter Invalid password in password text box 5.Click on login button	Username:61071912130@smartinternz.com password: Mpgu1234#	Application should show 'Incorrect email or password ' validation message.	Working as expected	Pass				Palani M

LoginPage_TC_OO5	Functional	Log in page	Verify user is able to log into application with InValid credentials	IBM Cloud services	1.Enter URL(https://shopenzer.com/) and click go 2.Click on My Account dropdown button 3.Enter InValid username/email in Email text box 4.Enter Invalid password in password text box 5.Click on login button	Username:61071912130@smartinternz.com password: Mpgu1234#	Application should show 'Incorrect email or password ' validation message.	Working as expec ted	Pass			Nandhakumar L
Design_TC__(	Functional	Back end	Creating the design flow and making the proper connection to get the output	Tinkercad	1.Creating an account in tinkercad. 2.Making the circuit connections . . 3.Editing the program as per the circuit . 4. simulating the project.	LED ON and OFF with Parameter values	The led must be able to operate with the program. The parameters must be obtained.	Not working as expec ted	Fail	Connection error		Tharun Prasath R C
Design circuit_	Functional	Back end	Creating the design flow and making the proper connection to get the output	Node-RED	1.Downloading all the dashboard nodes required. 2.Picking and pasting the dashboard nodes 3.Connecting the nodes 4.Deploying the design flow	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The Node Red must be able to get the real time values of temperature, pH and turbidity.	Working as expec ted	Pass			Vikram Siva K V
Designing the circuit_TC_03	Functional	Back end	Creating the design flow and making the proper connection to get the output	Node-RED	1.Downloading all the dashboard nodes required. 2.Picking and pasting the dashboard nodes 3.Connecting the nodes 4.Deploying the design	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The Node Red must be able to get the real time values of temperature, pH and turbidity.	Working as expec ted	Pass			Palani M

					flow								
Create a program suitable for the circuit and also compile and execute the programs_TC_01	Functional	Back end	Developing the python script to get the parameter values	Python 3.7	1.Installing python version 3.7.0 2.Developing the python code 3.Resolving the errors 4.Executing the program 5.Obtaining the output	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The program must be executed without any error and the values must be obtained.	Working as expected	Pass		Y		Nandhakumar L
Create a program suitable for the circuit and also compile and execute the programs._Tc_02	Functional	Back end	Developing the python script to get the parameter values	Python 3.7	1.Installing python version 3.7.0 2.Developing the python code 3.Resolving the errors 4.Executing the program 5.Obtaining the output	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The program must be executed without any error and the values must be obtained.	Working as expected	Pass		Y		Tharun Prasath R C
Create a program suitable for the circuit and also compile and execute the programs_TC_03	Functional	Back end	Developing the python script to get the parameter values	Python 3.7	1.Installing python version 3.7.0 2.Developing the python code 3.Resolving the errors 4.Executing the program 5.Obtaining the output	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The program must be executed without any error and the values must be obtained.	Working as expected	Pass		Y		Vikram Siva K V

Create a program suitable for the circuit and also compile and execute the programs_TC_04	Functional	Back end	Developing the python script to get the parameter values	Python 3.7	1.Installing python version 3.7.0 2.Developing the python code 3.Resolving the errors 4.Executing the program 5.Obtaining the output	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The program must be executed without any error and the values must be obtained.	Working as expected	Pass		Y		Palani M
connect the output values to the cloud services by using NODE RED._TC_01	Functional	Back end	Connecting the python code with the node red by providing the watson credentials	IBM IOT Watson platform and Node-RED	1.Provide the watson credentials in the python script 2.Verify the values are displayed in node red 3.Values must be obtained in watson,Node-red and python	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The Temperature, pH and Turbidity values must be obtained.	Not working as expected	Fail	Not authorised			Nandhakumar L
connect the output values to the cloud services by using NODE RED_TC_02	Functional	Back end	Connecting the python code with the node red by providing the watson credentials	IBM IOT Watson platform and Node-RED	1.Provide the watson credentials in the python script 2.Verify the values are displayed in node red 3.Values must be obtained in watson,Node-red and python	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The Temperature, pH and Turbidity values must be obtained.	Working as expected	Pass				Tharun Prasath R C
connect the output values to the cloud services by using NODE RED_TC_03	Functional	Back end	Connecting the python code with the node red by providing the watson credentials	IBM IOT Watson platform and Node-RED	1.Provide the watson credentials in the python script 2.Verify the values are displayed in node red 3.Values must be obtained in watson,Node-red and python	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The Temperature, pH and Turbidity values must be obtained.	Working as expected	Pass				Vikram Siva K V

Connects the cloud data with the authorities communication device._TC_01	Functional	User Interface	Making the parameter values visible in the mobile through MIT app inventor.	MIT app inventor	1.Install MIT Ai2 companion app in mobile phone. 2. Scan QR code with mobile device. 3.Check whether the values can be obtained in the mobile.	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The parameter values must be visible in the mobile application.	Not working as expected	Fail	Error 1101		Error 1101	Palani M
Connects the cloud data with the authorities communication device._TC_02	Functional	User Interface	Making the parameter values visible in the mobile through MIT app inventor.	MIT app inventor	1.Install MIT Ai2 companion app in mobile phone. 2. Scan QR code with mobile device. 3.Check whether the values can be obtained in the mobile.	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The parameter values must be visible in the mobile application.	Working as expected	Pass				Nandhakumar L
Connects the cloud data with the authorities communication device._TC_03	Functional	User Interface	Making the parameter values visible in the mobile through MIT app inventor.	MIT app inventor	1.Install MIT Ai2 companion app in mobile phone. 2. Scan QR code with mobile device. 3.Check whether the values can be obtained in the mobile.	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The alert messages must be sent to the authorities with the exact values.	Working as expected	Pass				Tharun Prasath R C
Connects the cloud data with the authorities communication device._TC_01	Functional	User Interface	Making the parameter values visible in the mobile through MIT app inventor.	MIT app inventor	1.Install MIT Ai2 companion app in mobile phone. 2. Scan QR code with mobile device. 3.Check whether the values can be obtained in the mobile.	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The parameter values must be visible in the mobile application.	Not working as expected	Fail	Error 1101		Error 1101	Vikram Siva K V

Connects the cloud data with the authorities communication device._TC_02	Functional	User Interface	Making the parameter values visible in the mobile through MIT app inventor.	MIT app inventor	1.Install MIT Ai2 companion app in mobile phone. 2. Scan QR code with mobile device. 3.Check whether the values can be obtained in the mobile.	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The parameter values must be visible in the mobile application.	Working as expected	Pass				Palani M
Connects the cloud data with the authorities communication device._TC_03	Functional	User Interface	Making the parameter values visible in the mobile through MIT app inventor.	MIT app inventor	1.Install MIT Ai2 companion app in mobile phone. 2. Scan QR code with mobile device. 3.Check whether the values can be obtained in the mobile.	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The alert messages must be sent to the authorities with the exact values.	Working as expected	Pass				Nandhakumar L
Final Report Output_TC_01	UI	Output	The entire project is simulated and the outputs are recorded.	Project doc	1.The entire output can be obtained. 2.Final report is prepared wi th the suggested format	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The entire system must work accordingly.	Working as expected	Pass				Tharun Prasath R C
Final Report Output_TC_02	UI	Output	The entire project is simulated and the outputs are recorded.	Project doc	1.The entire output can be obtained. 2.Final report is prepared wi th the suggested format	Temperature=" " PH=" " Conductivity=" " Oxygen="" Turbidity=""	The entire system must work accordingly.	Working as expected	Pass				Vikram Siva K V

Test Cases Excel:

https://drive.google.com/drive/folders/1lkrjoqYB1XCXGEVJSGAPlGXULJZP55Ms

8.2 User Acceptance Testing

User acceptance testing (UAT), also called application testing or end-usertesting, is aphase of softwaredevelopment in which the softwareis tested in the real world by its intendedaudience.

User Acceptance Testing (UAT) or application testing, is the final stage of any software development or change request lifecycle before go-live. It is the final stage of any development process to determine that the software does what it was designedto do in real-world situations. Actual users test the software to determine if it does what it was designed to do in real-world situations, validating changes made and assessing adherenceto their organization's business requirements.

Defect Analysis

This report shows the numberof resolved or closed bugs at each severity level,and howthey were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	8	5	2	3	18
Duplicate	2	0	3	0	5
External	1	0	0	1	2
Fixed	8	2	4	6	20
Not Reproduced	0	0	1	0	1
Skipped	0	0	2	1	3
Won't Fix	0	6	2	1	9
Totals	19	13	14	12	58

Test Case Analysis

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

Section	Total Cases	Not Tested	Fail	Pass
Designing the circuit	3	0	1	2
Create a program suitable for the circuit and also compile and execute the programs.	4	0	0	4
Connects the clouddata with the authority'scommunication device.	3	0	1	2
Final ReportOutput	2	0	0	2

9. RESULTS

Project results are the changes or effects that are expected to take place after implementing the project. The results are generally positive improvements to the lives of the beneficiaries.

9.1 Performance Metrics

Performance metrics are defined as figures and data representativeof an organization's actions, abilities, and overall quality. There are many different forms of performance metrics, including sales, profit, return on investment, customerhappiness, customer reviews,personal reviews, overall quality, and reputation in a marketplace. Performance metrics can vary considerably when viewed throughdifferent industries.

Performance metrics are integral to an organization's success. It's important that organizations select their chief performance metrics and focus on these areas because these metrics help guide and gauge an organization's success.

10. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Immediate updation to authorities
- Large storage of data
- Accurate values of ph,temperature,turbidity
- Sensor based testing
- Less down time
- Task Management

A real time operating system typically takes less amount of time to shift from one task to another. Usually it takes 3 microseconds or less to shift tasks.

DISADVANTAGES:

- Differentiated data from the main station is given to environment and public department using internet.
- large quantities of data storage and retrieval may be less efficient
- Sensors has to be recharged periodically
- Itdoes not has the capacityto purify water

11. CONCLUSION

Monitoring of Turbidity, PH & Temperature of Water makes use of water detection sensor . The system can monitor water quality automatically, and it is low in cost and does not require people on duty. So the water quality testing is likely to be more economical, convenient and fast. The system has good flexibility. Only by replacingthe corresponding sensorsand changing the relevant softwareprograms, this system can be used to monitor other water quality parameters. The operation is simple. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value. By keeping the embedded devices in the environment for monitoring enables self protection (i.e., smart environment) to the environment. To implement this need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, we can bring the environment into real life i.e. it can interactwith other objectsthrough the network. Then the collected data and analysis results will be available to the end user throughthe WiFi.

This project can be extended into an efficient water management system of a local area. Moreover, other parameters which wasn’t the scope of this project such as total dissolved solid, chemical oxygen demand and dissolved oxygen can also be quantified. So the additional budget is requiredfor further improvement of the overallsystem

12. FUTURE SCOPE

- Infuture we use advanced IOT concept in this project
- Detecting the more parameters for most securepurpose
- Increase the parameters by addition of multiple sensors
- Byinterfac51ing relay we controls the supply of water
- Monitoring environmental conditions, drinking water quality,treatment and disinfection of waste water etc.
- The system could also be implemented in various industrial processes.
- The system can be modified according to the needs of the user and can be implemented along with lab view to monitor data on computers.

13. APPENDIX

13.1 SOURCE CODE:

```
import random

import time

import sys

import ibmiotf.application

import ibmiotf.device

# Provide your IBM Watson Device Credentials

organization = "um5y3e"  # repalce it with organization ID

deviceType = "ESP32"  # replace it with device type

deviceId = "13448"  # repalce with device id

authMethod = "token"

authToken = "8883686824"  # repalce with token

def myCommandCallback(cmd):

    print("Command received: %s" % cmd.data)

    if cmd.data['command'] == 'motoron':

        print("MOTOR ON")

    elif cmd.data['command'] == 'motoroff':

        print("MOTOR OFF")

try:

    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method":

authMethod,

                     "auth-token": authToken}
```

```
    deviceCli = ibmiotf.device.Client(deviceOptions)
# ..............................................
except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()
deviceCli.connect()
while True:
    temp = random.randint(0,100)
    ph = random.randint(0,14)
    cond = random.randint(0,100)
    oxy = random.randint(0,100)
    turb= random.randint(0,100)
    # Send Temperature & Humidity to IBM Watson
    data = {'Temperature': temp, 'PH': ph, 'Conductivity': cond, 'Oxygen': oxy, 'Turbidity': turb}
    # print data
    def myOnPublishCallback():
        print("Published", data, "to Watson IoT Platform")
    success = deviceCli.publishEvent("event", "json", data, 0, myOnPublishCallback)
    if not success:
        print("Not connected to IoTF")
    time.sleep(5)
    deviceCli.commandCallback = myCommandCallback
```

13.2 GitHub &Project Demo Link

Project Team ID : PNT2022TMID06691.

GitHub Link : **https://github.com/IBM-EPBL/IBM-Project-30321-1660144058**

Project Demo Link: https://youtu.be/raXppZbCjF8