KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

HX 8001-PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

SMART FARMER- IOT ENABLED SMART FARMING APPLICATION

NALAIYA THIRAN PROJECT REPORT 2022

Submitted by

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NOVEMBER 2022

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW

A third of India's population directly depends on agriculture as a source of income, and agriculture is the sector of the economy that contributes the most to India. Technology has now transcended every aspect of modern life. But compared to other sectors, which have gradually grown over the past ten years, the contribution of technology to the field of agriculture is notably modest.

Given this, even a little improvement in this area will have a significant effect on both the Indian economy and farmers' quality of life. This benefits both farmers and customers equally because, in the end, it is consumers who get to enjoy inexpensive commodities without any compromise in quality.

Farmers' ability to provide the food we all require is impacted by the consequences of climate change. Altered growing seasons, reduced water availability, the potential for weeds, pests, and fungi to flourish, and more extreme weather patterns, such as floods and droughts, can all result in decreased crop yield.

The inadequency of farming instrumentation and value of toil area unit handicaps within the lives of farmers and fashionable. Therefore, there is AN pressing want of technology innovations that assist the farmers in observation and manufacturing high yield of crops.

1.2 PURPOSE

The project aims to improve the farmer’s lifestyle by providing technical assistance to maximize the yield and intends to ease up the farm monitoring and irrigation process with the help of IoT. Sensors can be installed at a uniform distance across the length and breadth of the farmland to collect the accurate soil data, which can be further used in the dashboard or mobile application for the farm monitoring. Both farmers and customers get benefitted from this project.

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING PROBLEM

The changing seasons have a great impact on agricultural activities. Prolonged drought conditions and devastating floods affect crop yields all over the world. Some regions in the world are facing years-long drought conditions with minimal rainfall.

Mart irrigation provides optimal water delivery to crops while ensuring there is minimal to no wastage in water used for agriculture The inadequacy of farming equipment and cost of manual labor are handicaps in the lives of farmers and modern.

Farmers sometimes use a sampling technique to calculate soil fertility, wetness content. This sampling doesn't offer correct results as chemical decomposition varies from location to location.

2.2 REFERENCES

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2.3 PROBLEM STATEMENT DEFINITION

Farmers are unable to constantly monitor farm conditions. Unavailability of proper technique to operate irrigation pumps remotely in accordance with the crop's water requirement results in low yield. Farmers also face difficulty in identifying the most suitable crop variety that can be grown in the farm. The inadequacy of farming equipment and cost of manual labor are handicaps in the lives of farmers and modern. Therefore, is an urgent need of technological innovations that assist the farmers in monitoring and producing high yields of crops and other problem mentioned in Fig 2.1.

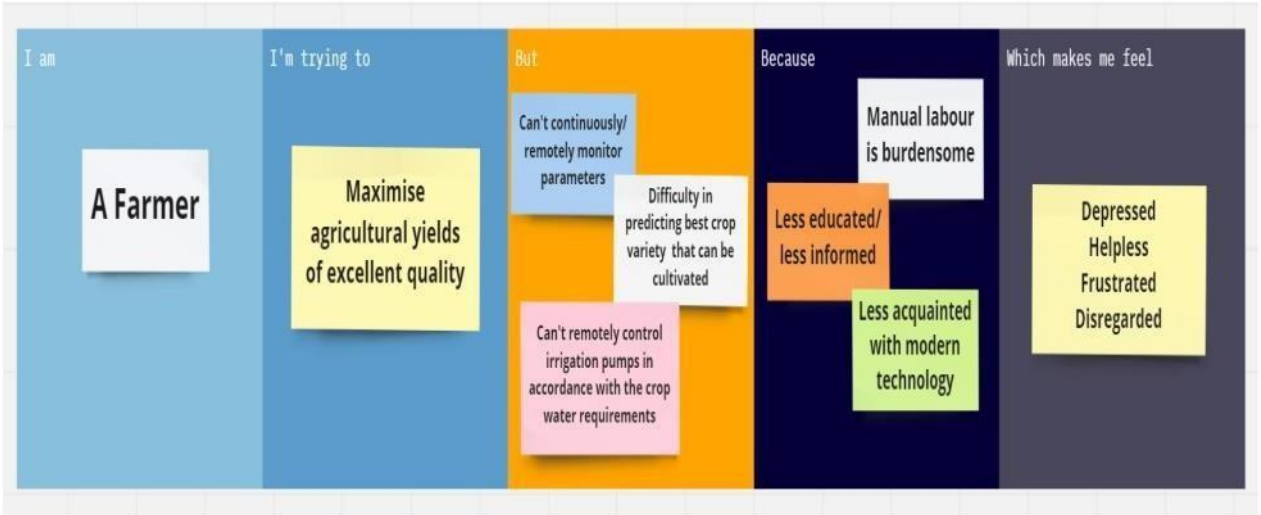


Fig 2.1 Customer problem statement

CHAPTER 3

IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An empathy map is a collaborative visualization used to express clearly what one knows about a particular type of user. It externalizes knowledge about users in order to create a shared understanding of user needs, and aid in decision making.

Empathy maps are split into 4 quadrants (Says, Thinks, Does, and Feels), with the user in the middle. Empathy maps provide a glance into who a user is as a whole. The ***Says*** quadrant contains what the user says or what he needs. The ***Thinks*** quadrant captures what the user is thinking throughout the experience. The ***Does*** quadrant encloses the actions the user takes. The ***Feels*** quadrant is the user's emotional state.
The empathy map for SmartFarmer - IoT Enabled Smart Farming Application is shown in Fig 3.1

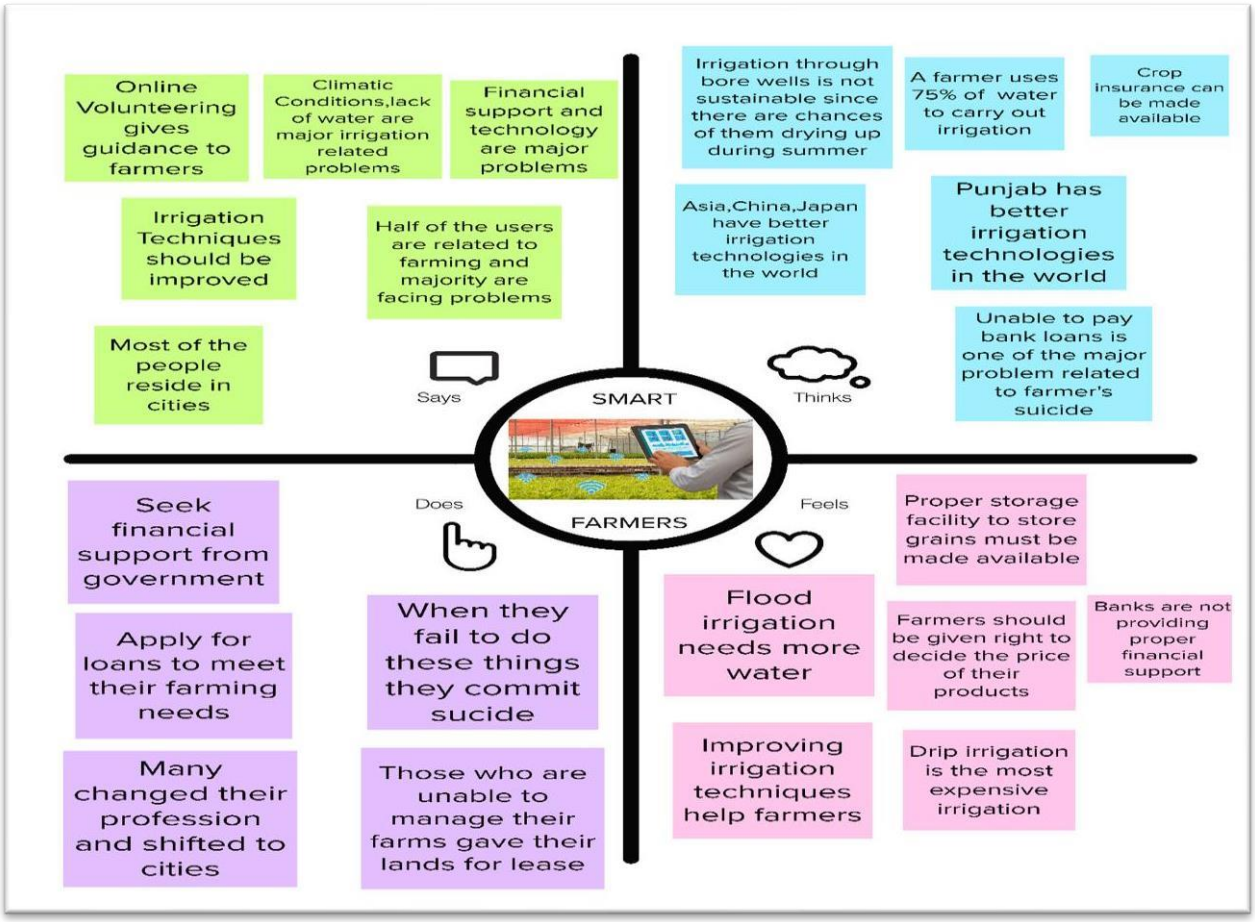


Fig 3.1 Empathy map

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	Farmer	Maximise agricultural yields of excellent quality.	• Can't continuously/ remotely monitor parameters • Difficulty in predicting best crop variety that can be cultivated • Can't remotely control irrigation pumps in accordance with the crop water requirements	• Manual labour is burdensome • Less educated/ less informed • Less acquainted with modern technology	• Depressed • Helpless • Frustrated • Disregarded

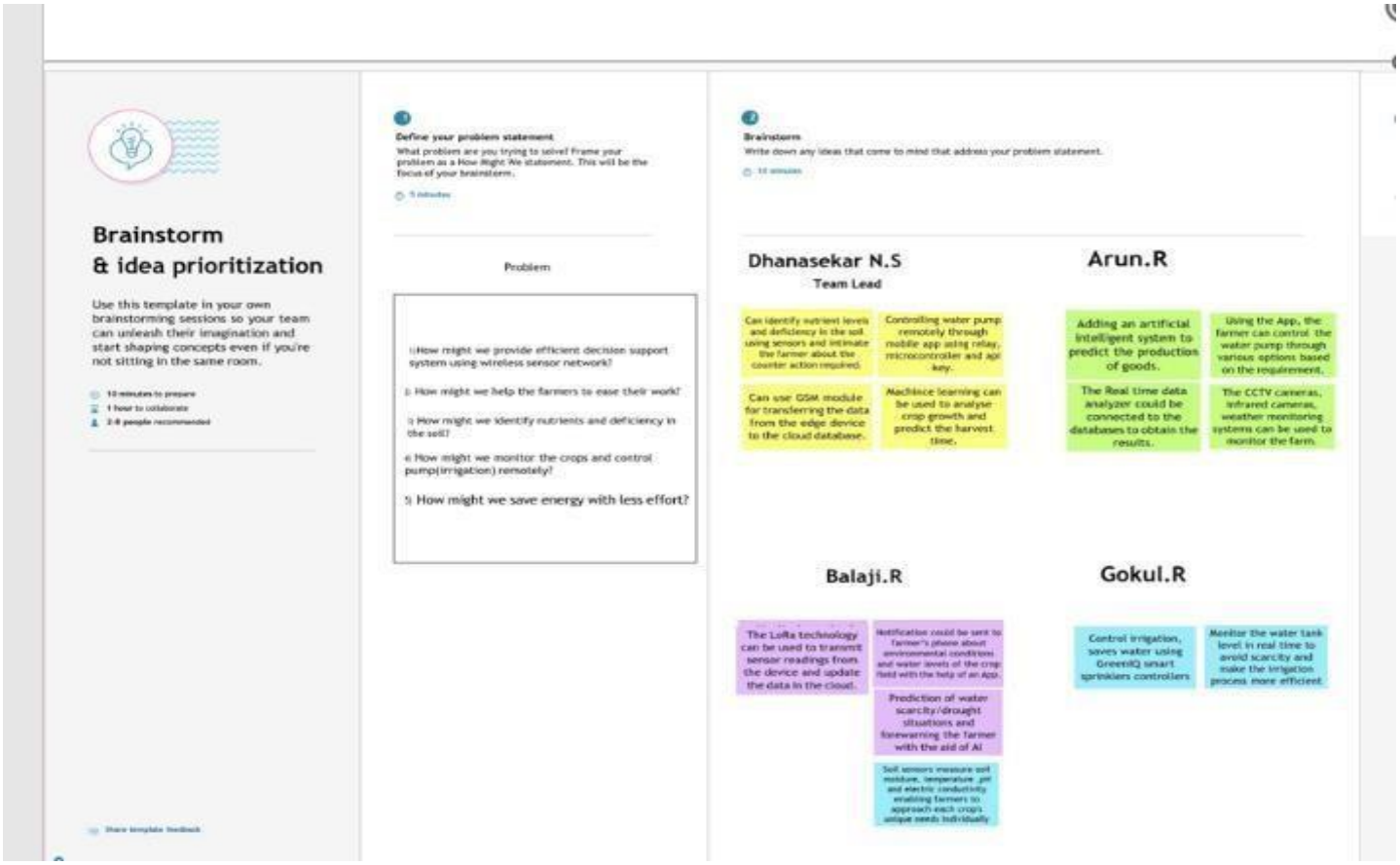
3.2 IDEATION AND BRAINSTORMING

Ideation is often closely related to the practice of brainstorming, a specific technique that is utilized to generate new ideas. Brainstorming is usually conducted by getting a group of people together to come up with either general new ideas or ideas for solving a specific problem or dealing with a specific situation.

Both brainstorming and ideation are processes invented to create new valuable ideas, perspectives, concepts and insights, and both are methods for envisioning new frameworks and systemic problem solving.

Figures 3.2 and 3.3 show the brainstorm and idea presentation completed during planning phase.

Fig 3.2 Brainstorm and idea prioritization



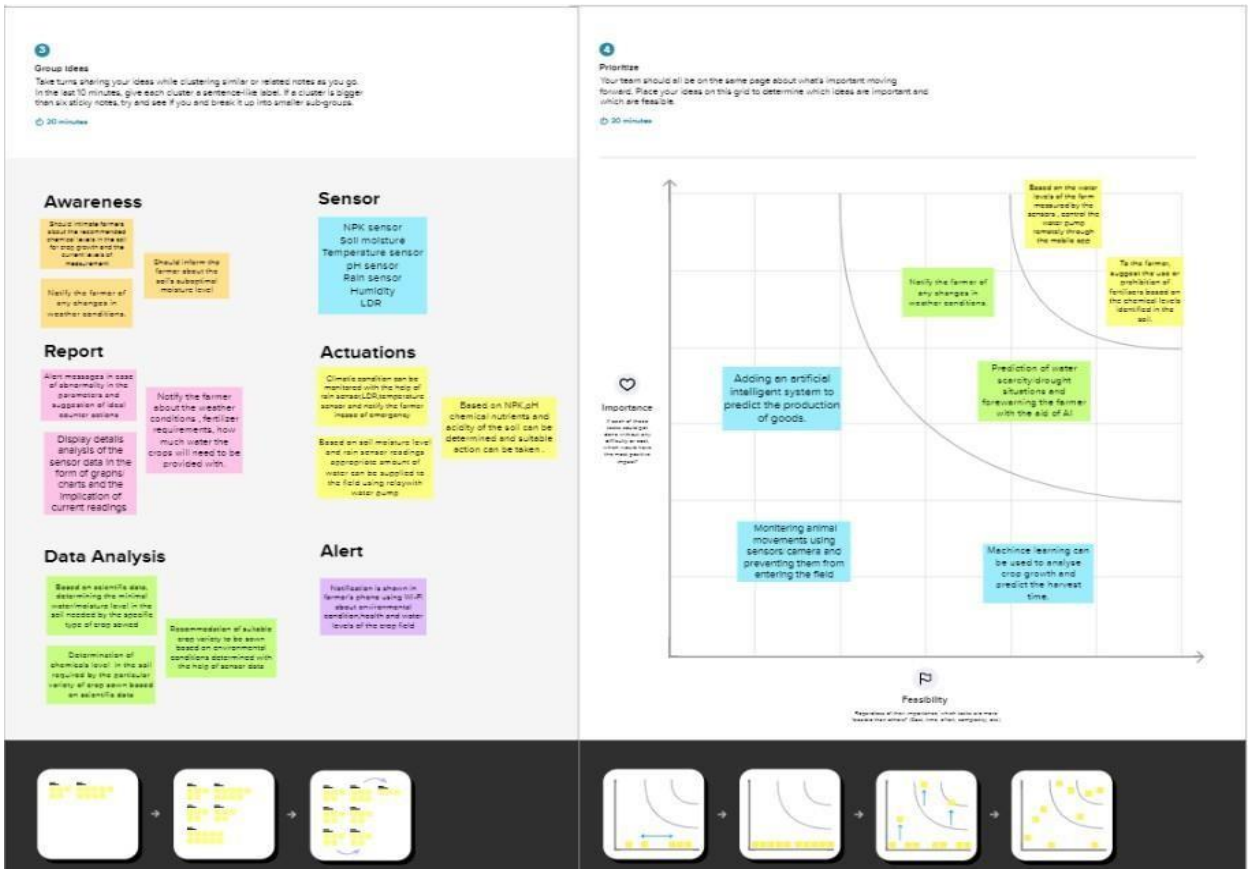


Fig 3.3 Brainstorm and idea prioritization

3.3 PROPOSED SOLUTION

Table 3.1 Parameter and Description for the proposed solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	• Farmers can't continuously & remotely monitor parameters like soil moisture, pH level, temperature etc. • They have difficulty in predicting most suitable and beneficial crop variety that can be cultivated • Can't remotely control irrigation pumps according to the crop water requirements

2.	Idea / Solution description	• Plant various sensors (pH, NPK, soil moisture etc.,) to monitor the conditions continuously and use IoT to integrate and observe them remotely. • Warn the farmer regarding any undesirable change in the weather conditions and suggest pre-emptive measures. • Can compare sensor readings, scientific research data and market demand to suggest most suitable crop for cultivation. • Can use mobile application to monitor and control the irrigation pumps that are actuated using relays and integrated with the help of IoT.
3.	Novelty / Uniqueness	• It can guide in performing crop rotation with the help of NPK and other sensor readings by suggesting the most suitable crop variety. • It can aid in remote irrigation and prevent water scarcity. • It helps in improving crop quality by regulating the parameters to the optimum levels.

4.	Social Impact / Customer Satisfaction	• Growth of Economy: Agriculture constitutes about 60% of the production sector in India. Thus, maximizing throughputs in this sector will directly boost the GDP of the country. • Proper guidance can be provided with respect to the fertilizer usage and chemical levels in the soil, thus reducing soil degradation. • Water conservation: water can be irrigated to the crops only when water level in the soil goes below optimal level thus helping in preventing wastage of water.

5.	Business Model (Revenue Model)	• Usage of these technologies can help reduce extravagant expenses, conserve resources, improve crop quality and maximize yield thus leading to higher profits for the farmer. • The cost of implementation is very less when compared to the returns/ maximized profits • Increase in production: the optimization of all the processes related to agriculture and livestock rearing increases production rates and improves the turnover.
6.	Scalability of the Solution	• Smart Farming systems uses modern technology to increase the quantity and quality of agricultural products. • Sensors are relatively inexpensive and the installation of the setup is very easy. Hence, it can be installed at multiple new locations and the integration of the nodes are fairy straight forward. • Thus, the system can be adopted in large numbers easily and securely. • Livestock tracking and Geo fencing. Smart logistics and warehousing. Smartpest management.

3.4 PROBLEM SOLUTION FIT

The Problem solution fit simply means that one have found a problem with the customer and that the solution one have realized for it actually solves the customers problem. The problem answer match is a very important step towards the Product-Market match .The structure of problem solution fit is given below.

Customer state fit: To make sure one understand the target group, their limitations and their currently available solutions, against which one is going to compete.

Problem-Behavior fit: To help one to identify the most urgent and frequent problems, understand the real reasons behind them and see which behavior supports it.

Communication-Channel fit: To help one to sharpen the communication with strong triggers, emotional messaging and reaching customers via the right channels.

Solution guess: Translate all the validated data one have gathered into a solution that fits the customer state and his/her limitations, solves a real problem and taps into the common behavior of the target group.

The problem solution fit for SmartFarmer - IoT Enabled Smart Farming Application is shown in Fig 3.4

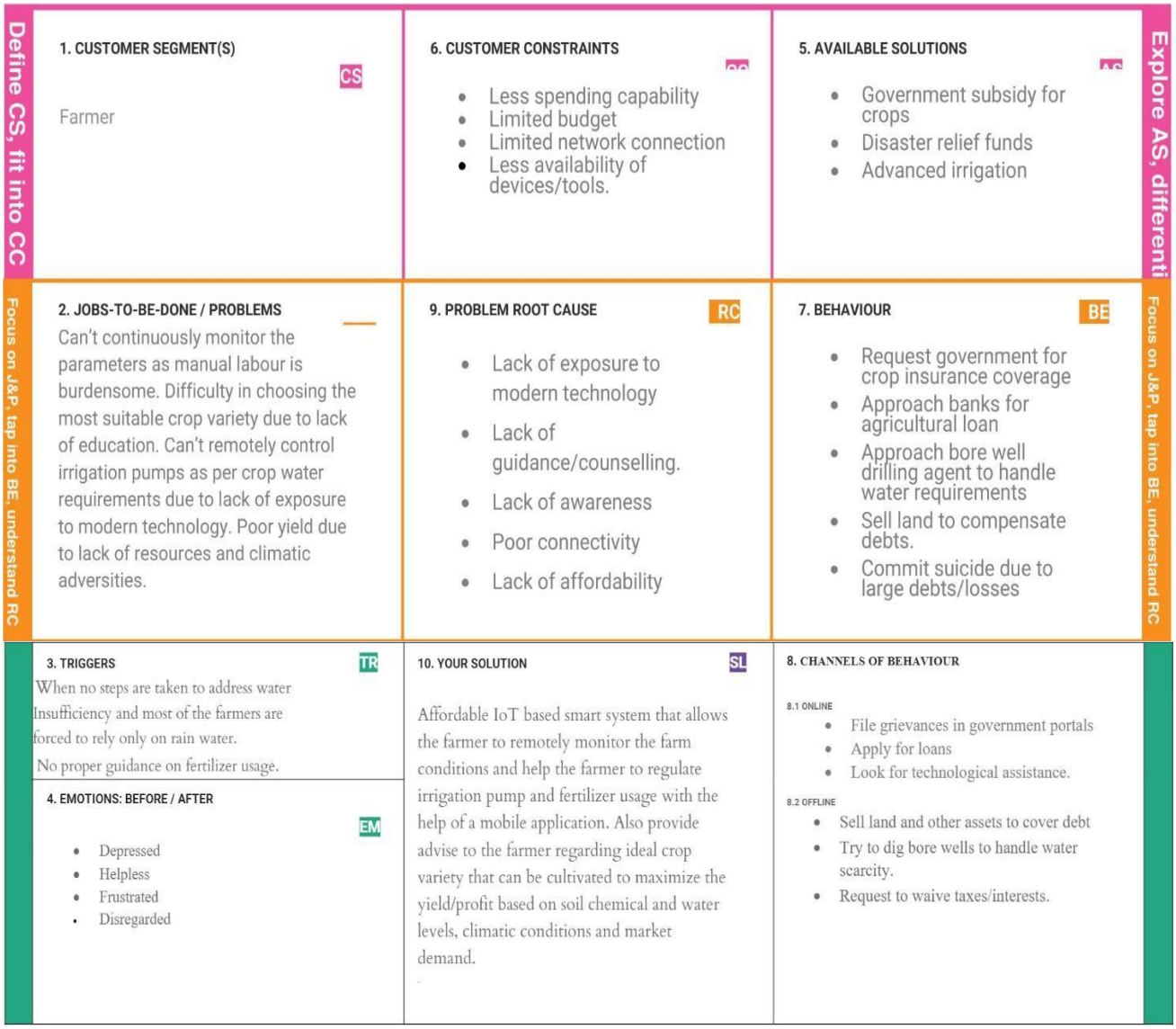


Fig 3.4 Problem solution Fit

CHAPTER 4

REQUIREMENT ANALYSIS

Requirements analysis is very critical process that enables the success of a system or software project to be assessed. Requirements are generally split into two types: Functional and Non-functional requirements.

4.1 FUNCTIONAL REQUIREMENTS

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 system as a part of the contract. These are represented or stated in the form of input to be given to the system, the operation performed and the output expected. They are basically the requirements stated by the user which one can see directly in the final product, unlike the non-functional requirements.

The following table 4.1 shows the functional requirements for The SmartFarmer - IoT Enabled Smart Farming Application.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Dashboard	● Display profile ,sensor readings, crop variety details, fertilizer recommendation, weather report, water level indicator ● Generate weather report and disaster notification. ● Option for irrigation control ● Provision of service agent details and help line chat. ● Sensor fault / disruption in power supply notification ● Specify Referral code

FR-2	User Registration	• Register using Mobile number / Mail ID • Set user name and password • Generate captcha and OTP for verification • Confirmation SMS/mail
FR-3	User login	• Login using user name and password • Option for forget password
FR-4	Admin login	• Server login, check for errors in sensor reading and forwards details to helpline admin • Manage customer details • Manage payment due notification and software update
FR-5	Service agent	• Login using user name and password • Generate captcha for verification • Display list of service calls pending in the dashboard • Generate Error clearance report
FR-6	Helpline Admin	• Assist when error occurs through service agent • Server login, check for error / helpline notification and search for available service agent • Admin forwards the service agent profile to the customer • Add customer details to the agent dashboard incase of abnormal sensor conditions/customer complaints • Forward Mobile number of service agent to customer

4.2 NON - FUNCTIONAL REQUIREMENTS

These are basically the quality constraints that the system must satisfy according to the project contract. The priority or extent to which these factors are implemented varies from one project to other. They are also called non-behavioral requirements.

They basically deal with issues like Portability, Security, Maintainability, Reliability, Scalability, Performance, Reusability, Flexibility.

The following table 4.2 shows the Non-Functional Requirements of SmartFarmer - IoT Enabled Smart Farming Application

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	• User friendly guidelines for users to avail the features. • Most simplistic user interface for ease of use.
NFR-2	**Security**	• All the details about the user are protected from unauthorized access. • Detection and identification of any malfunction of sensors.
NFR-3	**Reliability**	• Secure server maintenance • Accurate data monitoring • Real time error detection and updation
NFR-4	**Performance**	• Big data analytics • Robust system • Uninterrupted communication networks • Ease of use
NFR-5	**Availability**	• Easy to access without much expenses • App is compatible with most devices and easily accessible
NFR-6	**Scalability**	• More users can be added easily • Multiple sensors/ features can be introduced in future without replacing current system. • Easy to update

CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAM:

A data flow diagram (DFD) maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show data inputs, outputs, storage points and the routes between each destination. Data flowcharts can range from simple, even hand-drawn process overviews, to in-depth, multi-level DFDs that dig progressively deeper into how the data is handled. Like all the best diagrams and charts, a DFD can often visually "say" things that would be hard to explain in words, and they work for both technical and nontechnical audiences, from developer to CEO. Figure 5.1 shows the data flow diagram for the proposed solution

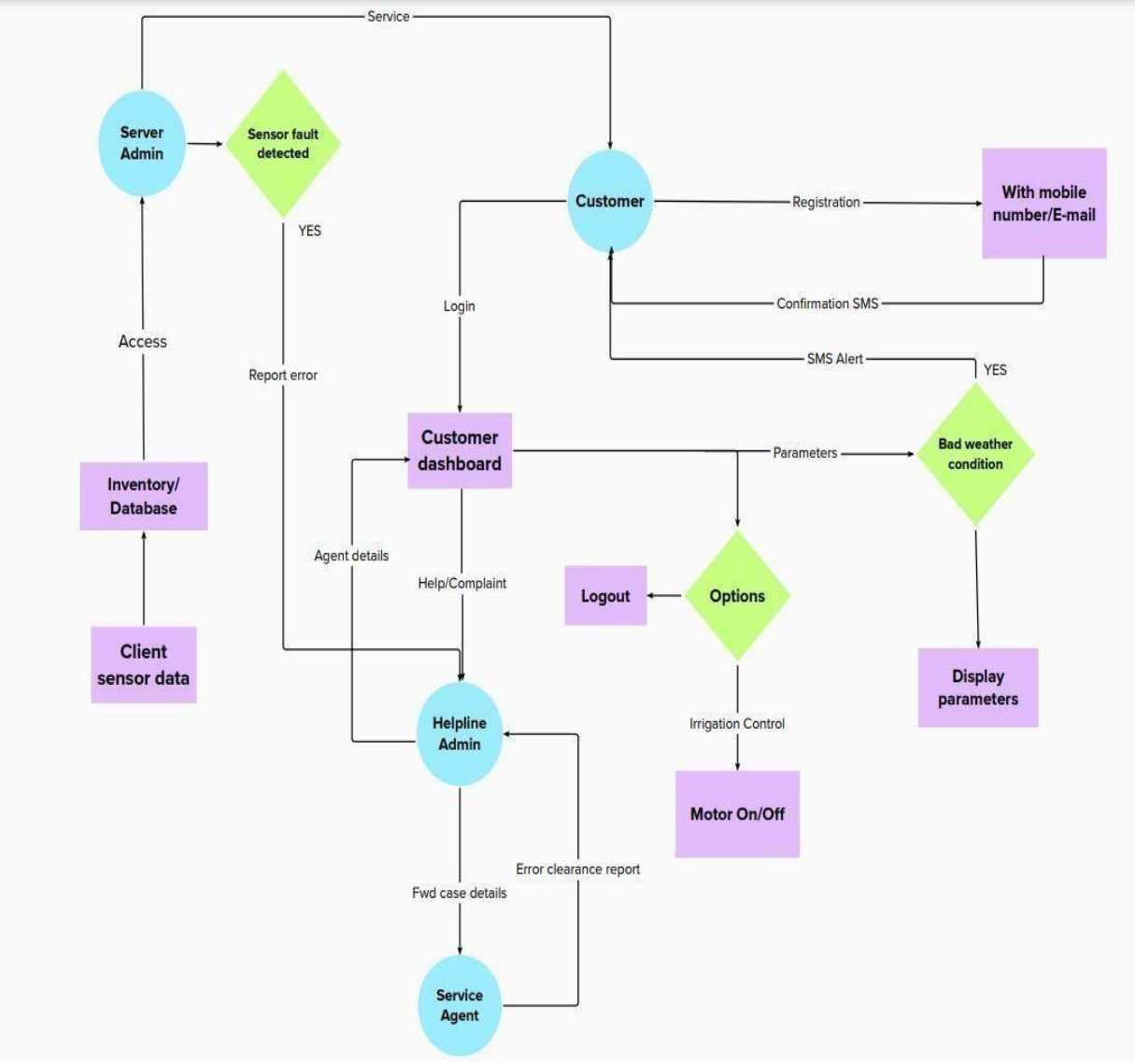


Fig 5.1 Data flow Diagram

5.2 SOLUTION AND TECHNICAL ARCHITECTURE

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to find the best tech solution to solve existing business problems, describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders. It also defines the features, development phases, and solution requirements. It provides specifications according to which the solution is defined, managed, and delivered.

Figure 5.2 shows the solution architecture and 5.3 shows the technical architecture.

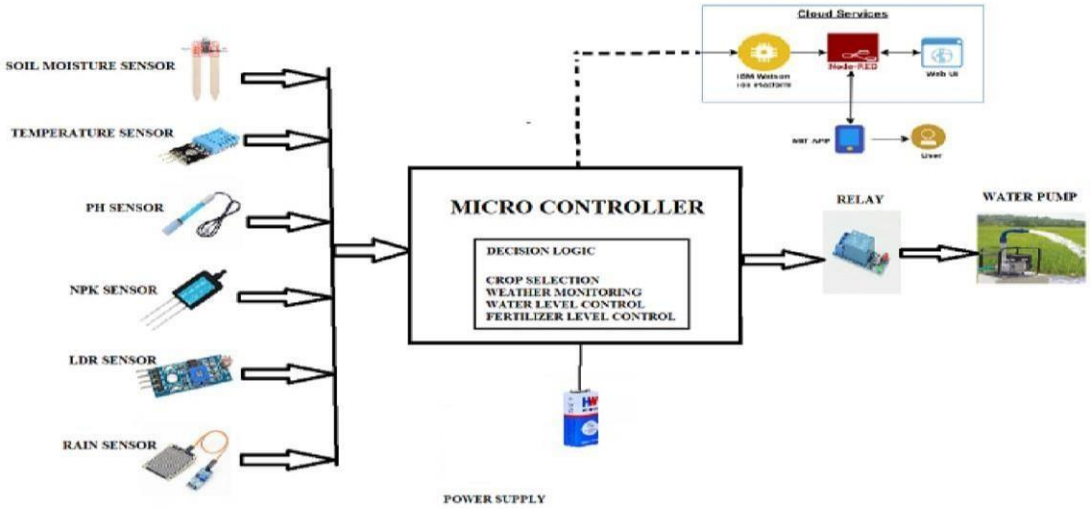


Fig 5.2 Solution Architecture

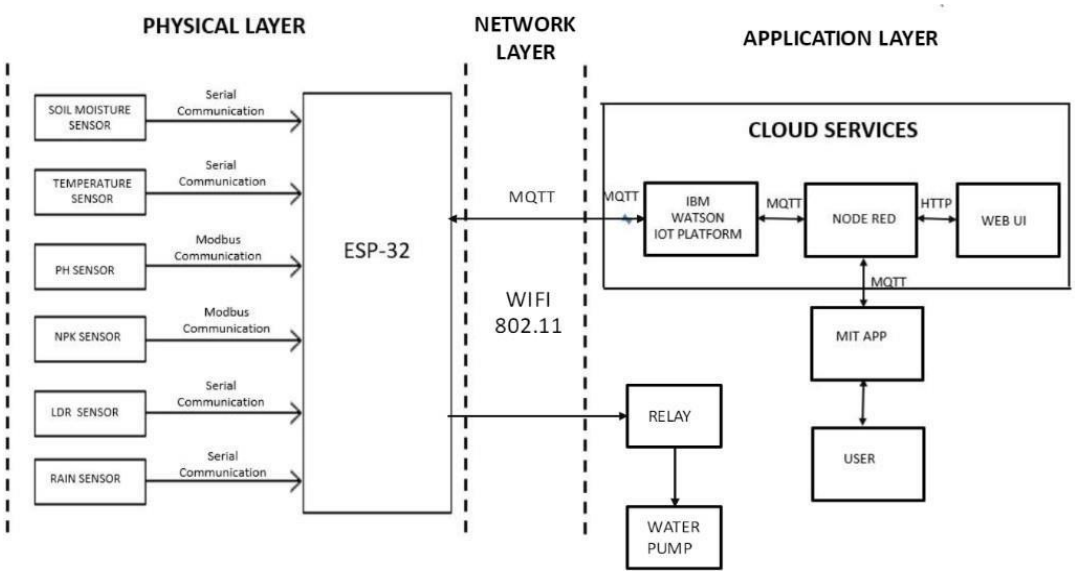


Fig 5.3 Technological Architecture

5.3 USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Farmer)	Registration	USN-1	As a user, I can register for the application by entering my mobile number & captcha and setting new password.	OTP generation	High	Sprint-1
		USN-2	As a user, I will receive OTP through SMS which I will enter in the application.	I can access my account / dashboard	High	Sprint-1
		USN-3	As a user, I can register for the application through Email/Gmail	Verification email generation	Medium	Sprint-3
		USN-4	As a user, I will receive OTP through email which I will enter in the application.	I can access my account / dashboard	Medium	Sprint-3
	Login	USN-5	As a user, I can log into the application by entering user name & password	I can access my account / dashboard	High	Sprint-1
	Forgot password	USN-6	As a user, I can reset my password using "forgot password" option.	OTP generation	Low	Sprint-4
		USN-7	As a user, I will receive OTP through email/SMS which I will enter in the application .	Set password window opened	Low	Sprint-4
		USN-8	As a user, I will enter a new password.	I can access my account / dashboard	Low	Sprint-4
		USN-9	As a User, I can access the dashboard in which user profile, sensor readings, crop variety suggestions, fertilizer recommendation, weather report and water level are displayed.	I can view the details in the dashboard of Smart Farming Application system.	High	Sprint-1
	Dashboard	USN-10	As a user, I can reach out to support staff using helpline chat in case of any queries. and receive service agent details in case of service requirement.	I will receive complaint acknowledgment and agent details	High	Sprint-2
		USN-11	As a user, I will receive alert notification in case of bad weather.	I will receive SMS & Dashboard notification	High	Sprint-1
		USN-12	As a user, I will receive notification in case of sensor fault / disruption in power supply ,and compliant will be filed automatically.	I will receive complaint acknowledgment & details.	High	Sprint-2
	Dashboard options	USN-13	As a user, I can remotely access the motor switch to control irrigation.	I can control motor switch remotely in the smart farming app.	High	Sprint-2
		USN-14	As a user, I can change my account password using the option provided.	I can reset my password	Low	Sprint-4
		USN-15	As a user, I can logout from my account using the option provided.	I will be redirected to the new user window	Medium	Sprint-4
Administrator	Dashboard	USN-16	As an admin, I can access the server, check for errors in sensor reading and forwards details to helpline admin.	I can access the database.	High	Sprint-2
		USN-17	As an admin, I can manage and organize customer details.	I can access the customer details.	High	Sprint-2
		USN-18	As an admin, I can manage payment details& dues and launch software updates	I will manage accounts.	Medium	Sprint-4

Service Agent	Service log	USN-19	As a service agent, I can login using username and password and entering the captcha.	I can access the service pending log.	High	Sprint-3
		USN-20	As a service agent, I can view the list of service calls pending and the corresponding case details in the dashboard.	I can provide services to the customer.	High	Sprint-3
		USN-21	As a service agent, I will generate error clearance report and forward it to the admin.	The complaint will be cleared from my pending log.	High	Sprint-3
Helpline admin	Complaint Management	USN-22	As a helpline admin, I can access server, check for errors/ helpline query notifications/ complaints etc., and maintain service agent availability record.	I will record new complaints.	High	Sprint-2
		USN-23	As a helpline admin, I will assign a available service agent to the client when complaint is raised and forward the details of the service agent assigned.	Agent will be assigned to the task.	High	Sprint-3
		USN-24	As a helpline admin, I will add compliant details to the agent dashboard.	Agent dashboard gets updated.	High	Sprint-3
		USN-25	As a helpline admin, I can register new complaint on behalf of the incase of abnormal sensor conditions.	I will record the complaints.	High	Sprint-2

5.4 CUSTOMER JOURNEY MAP

Fig 5.4, 5.5 represents the customer journey map which explains the customer experience.

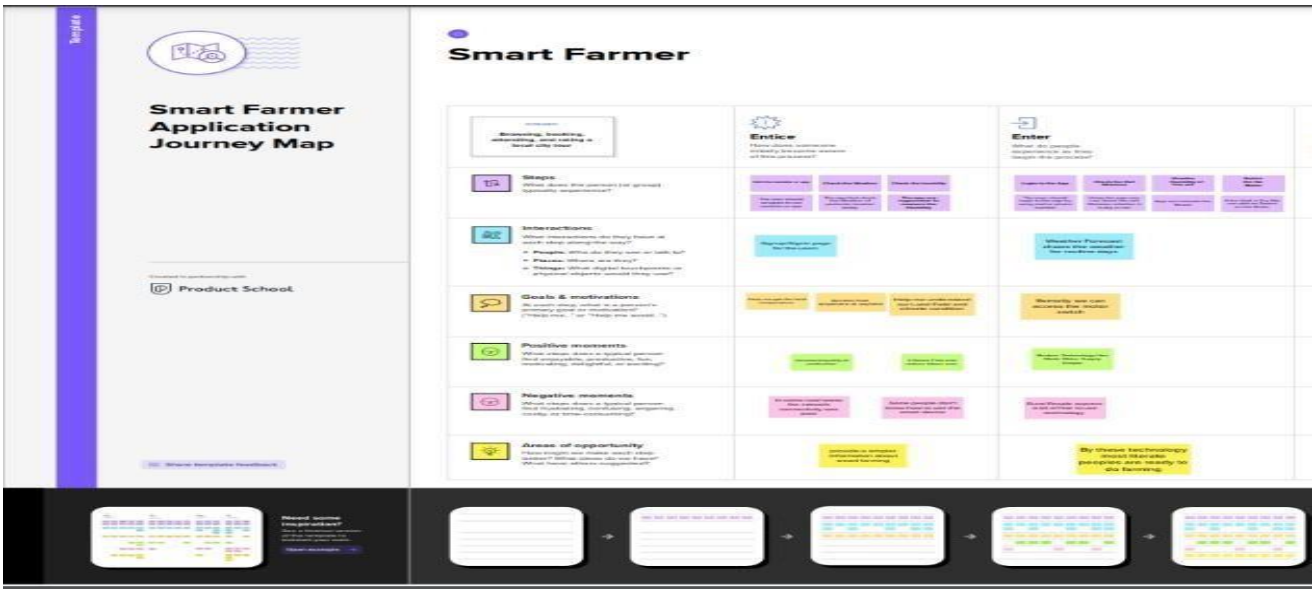


Fig 5.4 Customer Journey

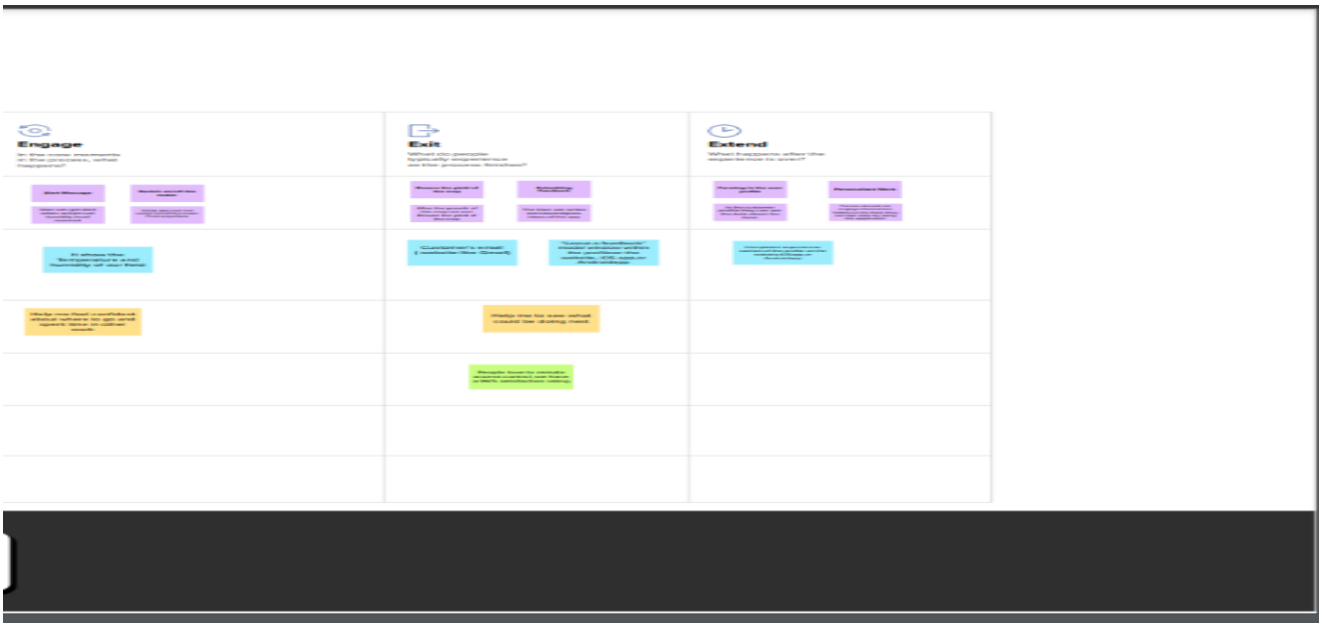


Fig 5.5 Customer Journey

CHAPTER 6

PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING AND ESTIMATION

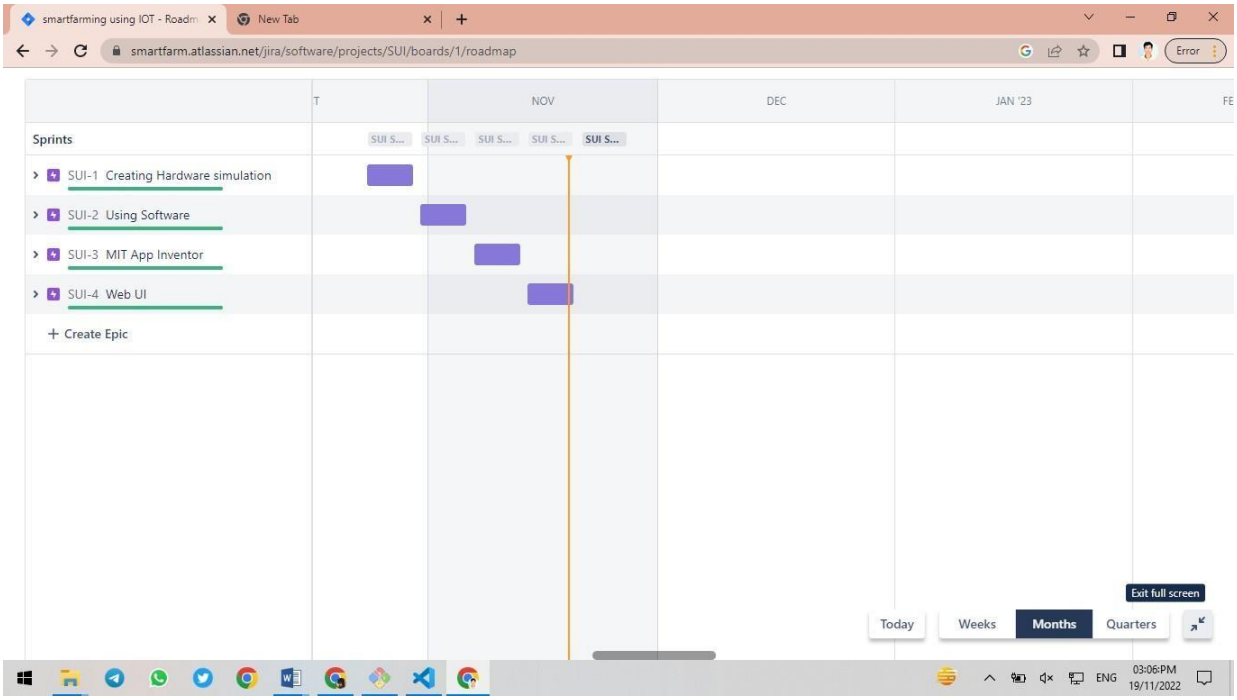
6.2 SPRINT DELIVERY SCHEDULE

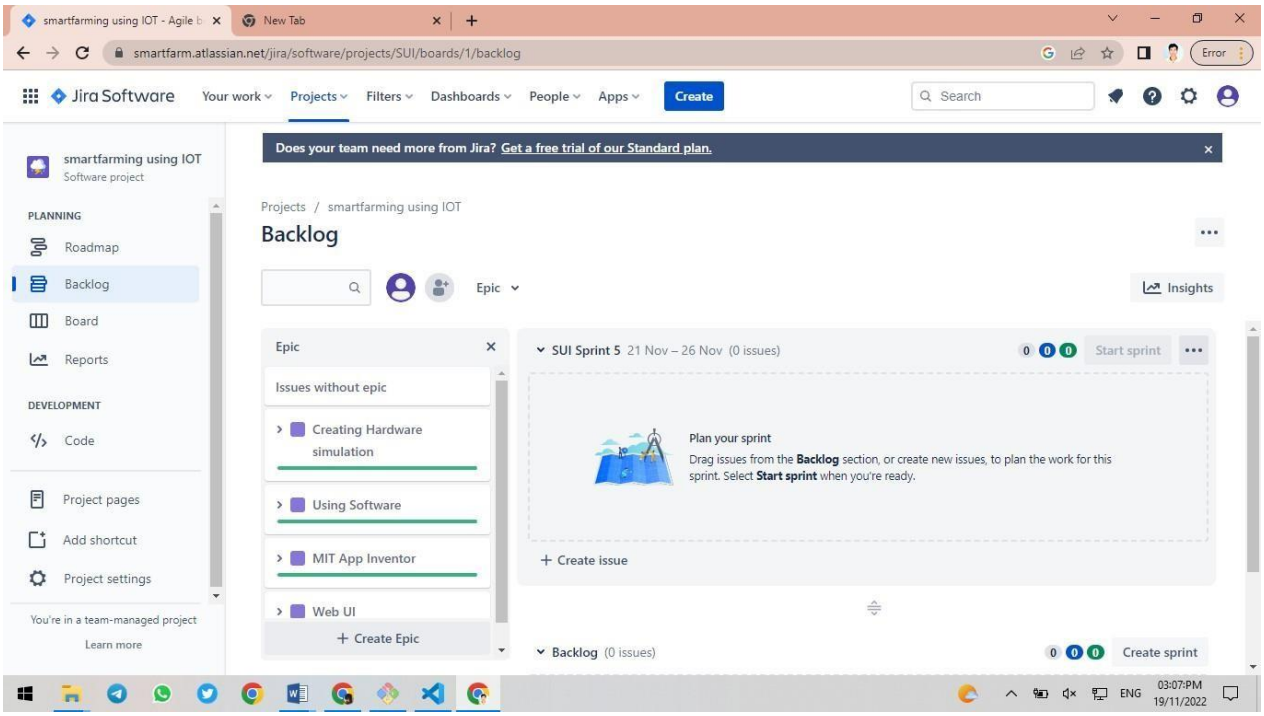
Table 6.1 represents the Sprint Delivery Schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint - 1	Creating Hardware Simulation	USN - 1	Connect Sensors and Wi - Fi modules by using Python code	2	High	Dhanasekar Arun. R Balaji. R Gokul. R

Sprint - 2	Using Software	USN - 2	Creating device in the IBM Watson IOT platform, to making workflow of IOT scenarios using Node - RED service	2	High	Dhanasekar Arun. R Balaji. R Gokul. R
Sprint - 3	MIT App Inventor	USN - 3	Develop a mobile application for the Smart Farmer project using MIT App Inventor	2	High	Dhanasekar Arun. R Balaji. R Gokul. R
Sprint - 4	Web UI	USN - 4	To make the user to interact with software	2	High	Dhanasekar Arun. R Balaji. R Gokul. R

6.3 REPORTS FROM JIRA

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Roadmap
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Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
Learn more
Does your team need more from Jira? Get a free trial of our Standard plan.
Projects / smartfarming using IOT
Backlog
Epic
Insights
Epic
Issues without epic
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Using Software
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Web UI
+ Create Epic
SUI Sprint 5 21 Nov – 26 Nov (0 issues)
Start sprint
Plan your sprint
Drag issues from the Backlog section, or create new issues, to plan the work for this sprint. Select Start sprint when you're ready.
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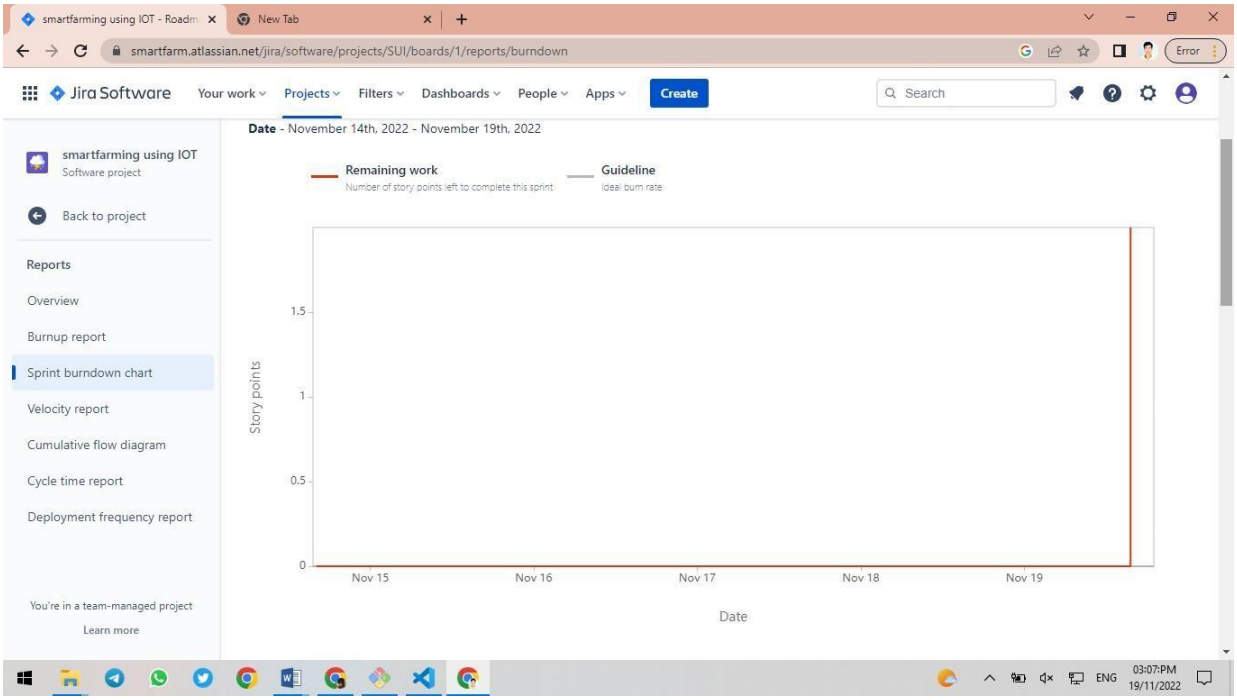
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Your work
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Filters
Dashboards
People
Apps
Create
Search
smartfarming using IOT
Software project
Back to project
Reports
Overview
Burnup report
Sprint burndown chart
Velocity report
Cumulative flow diagram
Cycle time report
Deployment frequency report
You're in a team-managed project
Learn more
Date - November 14th, 2022 - November 19th, 2022
Remaining work
Number of story points left to complete this sprint
Guideline
Ideal burn rate
Story points
1.5
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CHAPTER 7

CODING AND SOLUTIONING

7.1 FEATURE 1

```
import wiotp.sdk.device import time import os import datetime import random

myConfig = {
   "identity":{
      "orgId":"0e7wko",
      "typeId":"123",
      "deviceId":"1234"
      },
   "auth":{
      "token":"12345678"
      }
   }
client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None) client.connect()

def myCommandCallback(cmd):
   print("Message received from IBM IoT platform: %s" % cmd.data['command'])
m=cmd.data['command']     if(m=="motoron"):          print("Motor is Switched on")
elif(m=="motoroff"):          print("Motor is Switched off")       print(" ") while True:
   soil=random.randint(0,100)       temp=random.randint(-20,125)     hum=random.randint(0,100)
myData={'soil_moisture':soil,'temperature':temp,'humidity':hum}
client.publishEvent(eventId="status", msgFormat="json", data=myData, qos=0, onPublish=None)
print("Published data successfully: %s", myData)     time.sleep(2)     client.commandCallback =
myCommandCallback client.disconnect()
```

CHAPTER 8

TESTING

8.1 TEST CASES

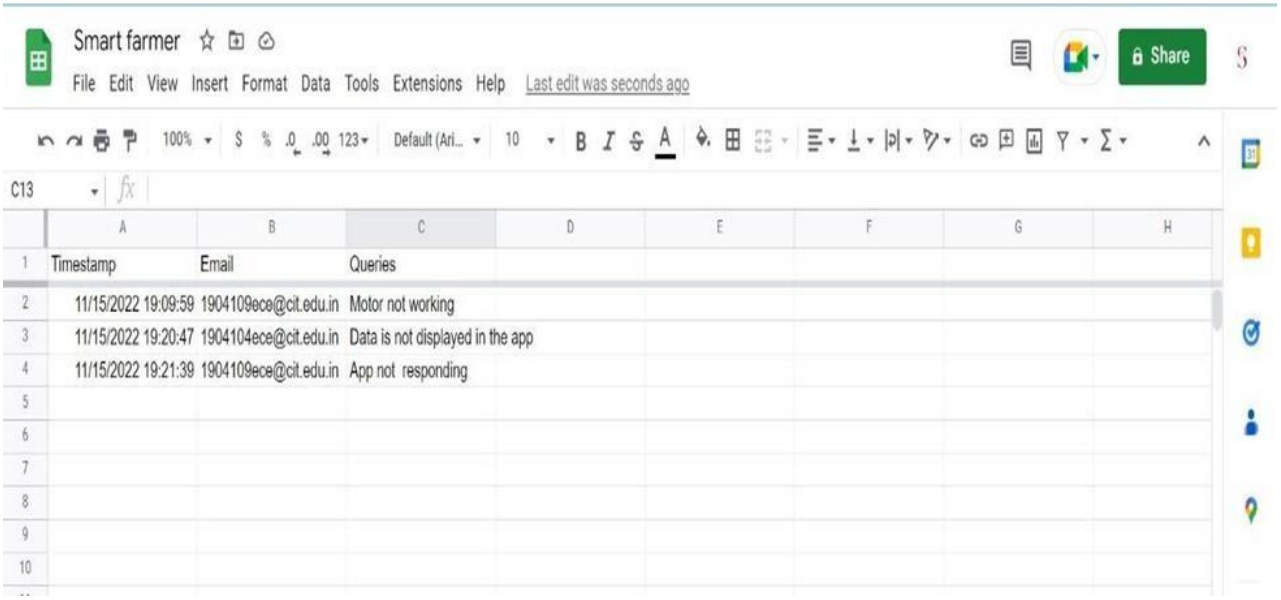


Fig 9.21 Queries received by admin from the farmers

CHAPTER 9

RESULTS

Fig 9.1,9.2 shows the Github Collaboration in the preparation phase

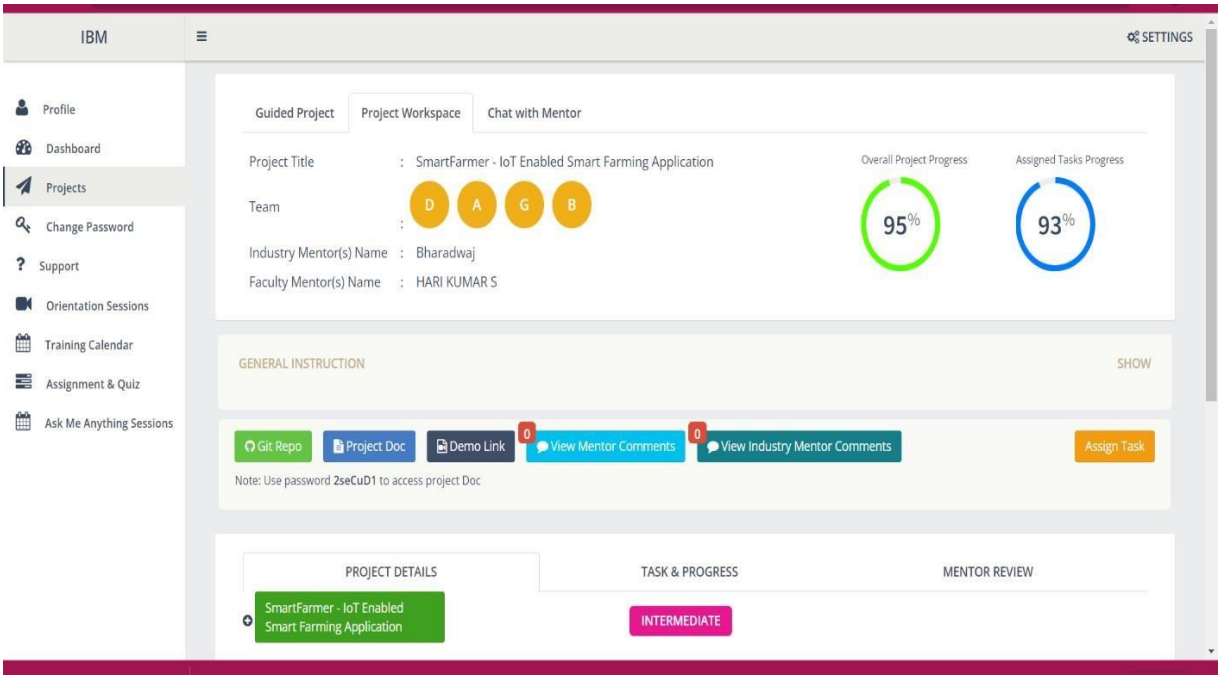


Fig 9.1 Github Colloboration

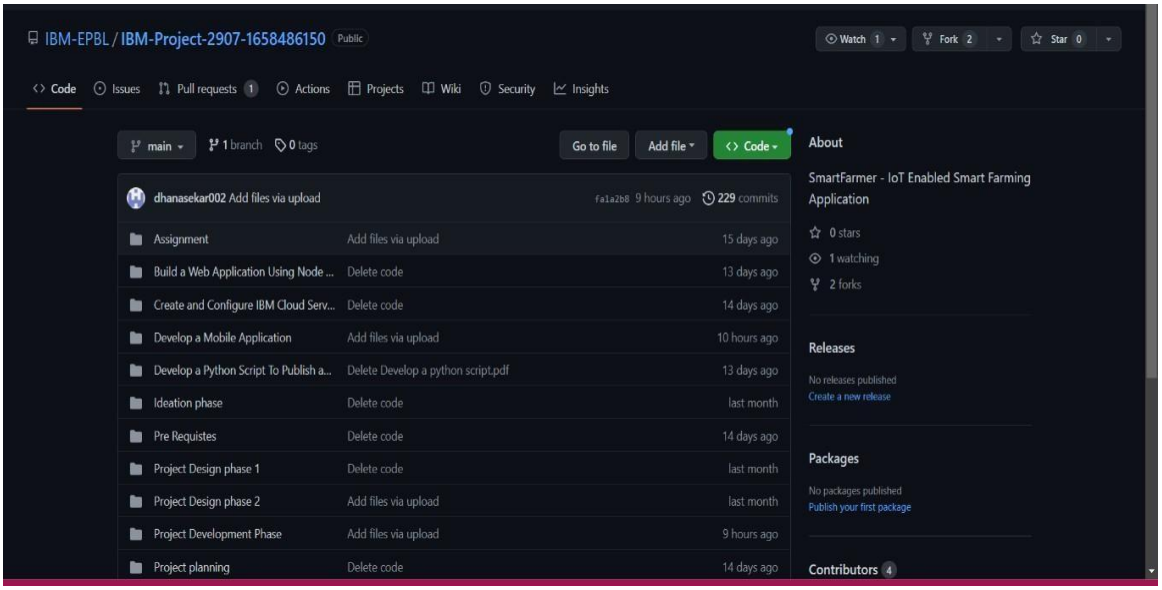


Fig 9.2 Github Colloboration

Fig 9.3 shows the creation of IBM Watson Iot Platform

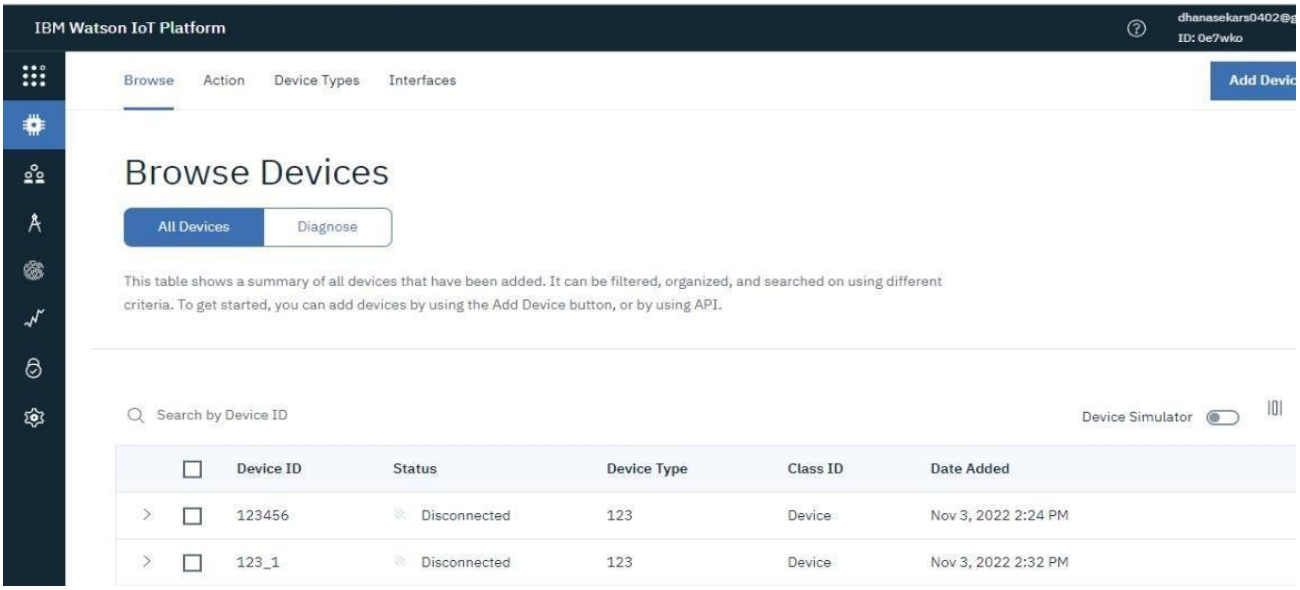


Fig 9.3 IBM Watson Iot Platform

Fig 9.4 shows the MIT APP Inventor

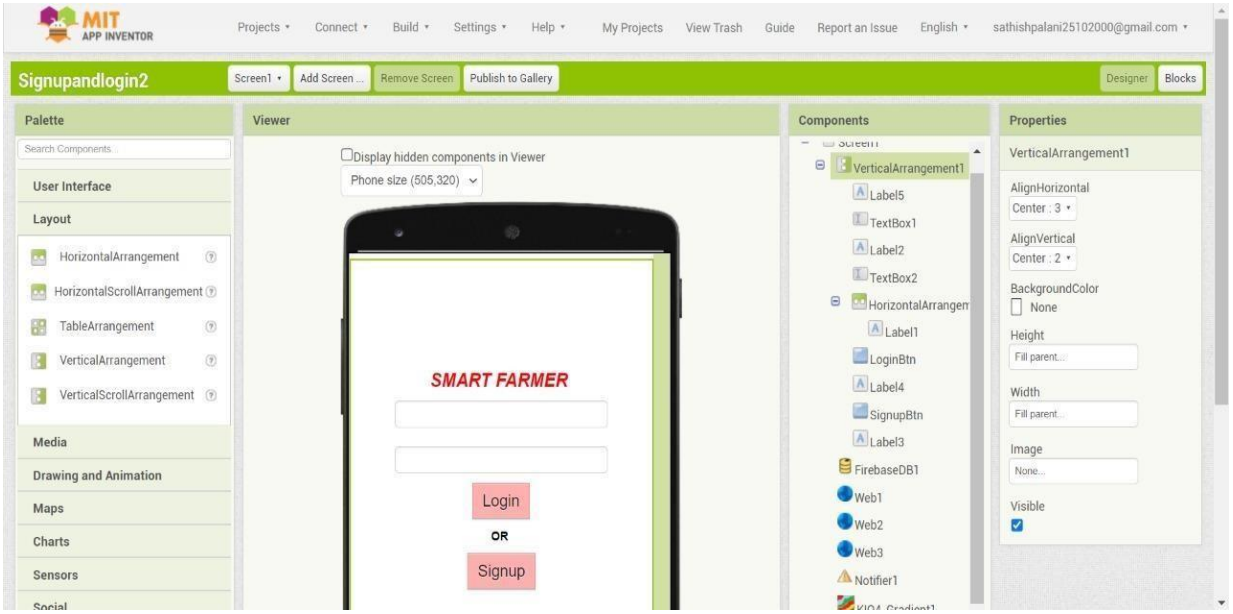


Fig 9.4 MIT APP Inventor

CREATE AND CONFIGURE IBM CLOUD SERVICES

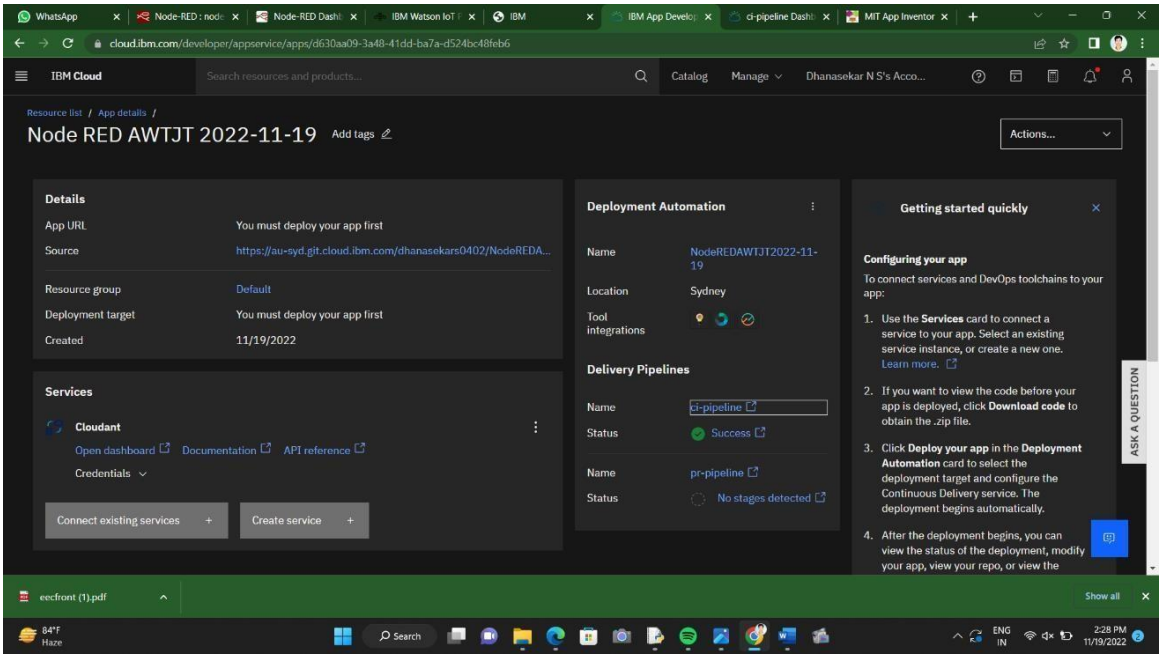


Fig 9.5 Node Red Installation

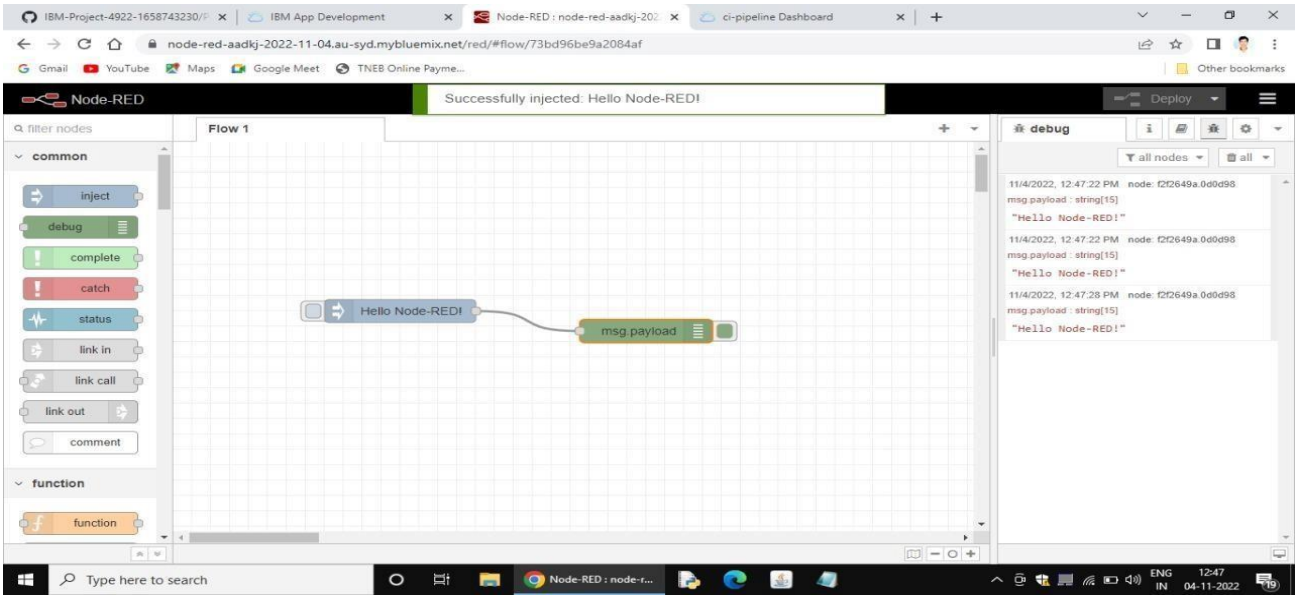


Fig 9.6 IBM IOT Installation and Deployment

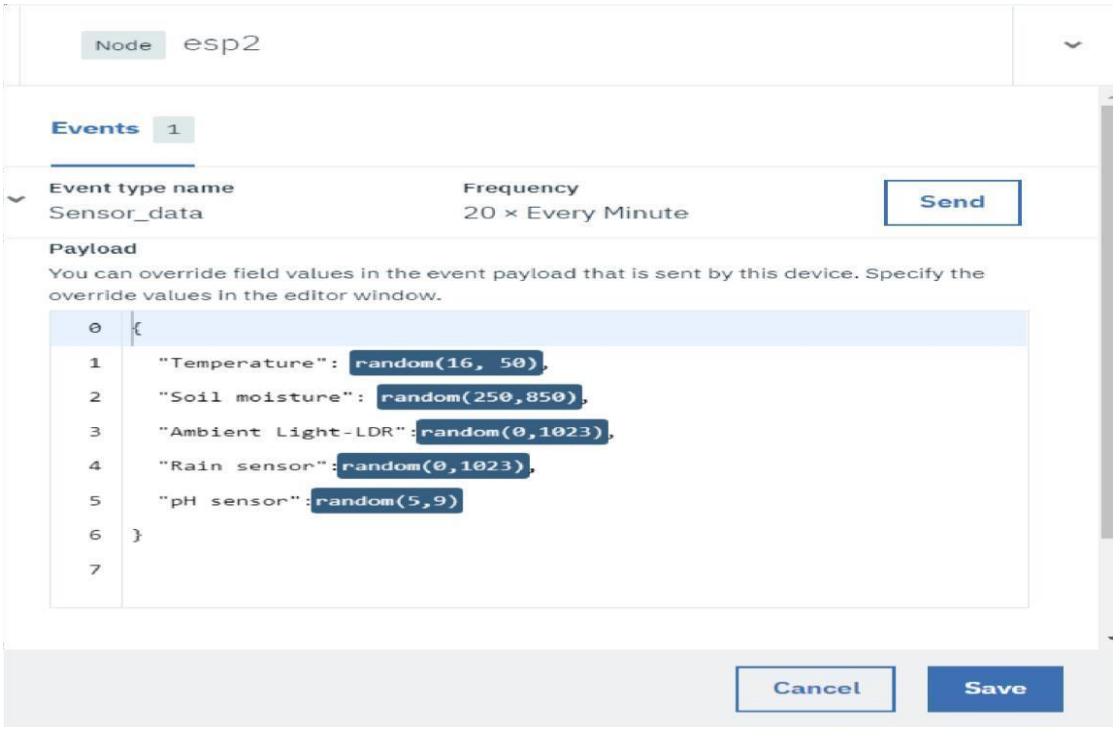


Fig 9.7 IBM Watson IoT Platform- Device simulation

Fig 9.8 IBM Watson IoT Platform- Device simulation

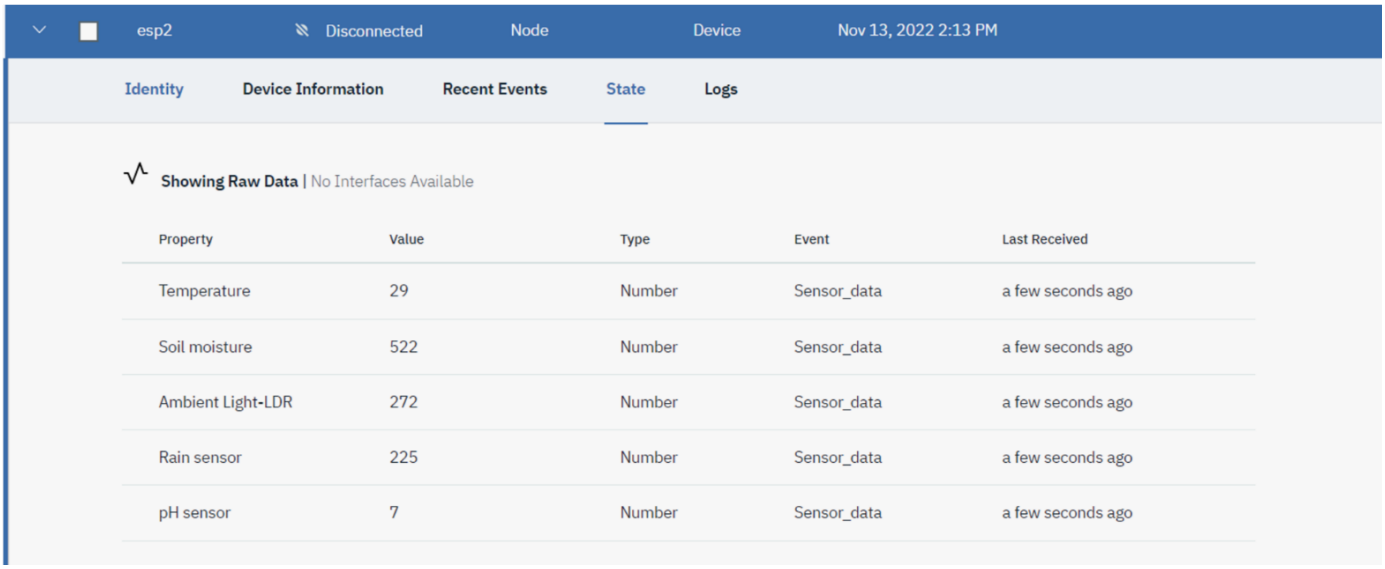


Fig 9.9 IBM Watson IoT Platform- Device simulation

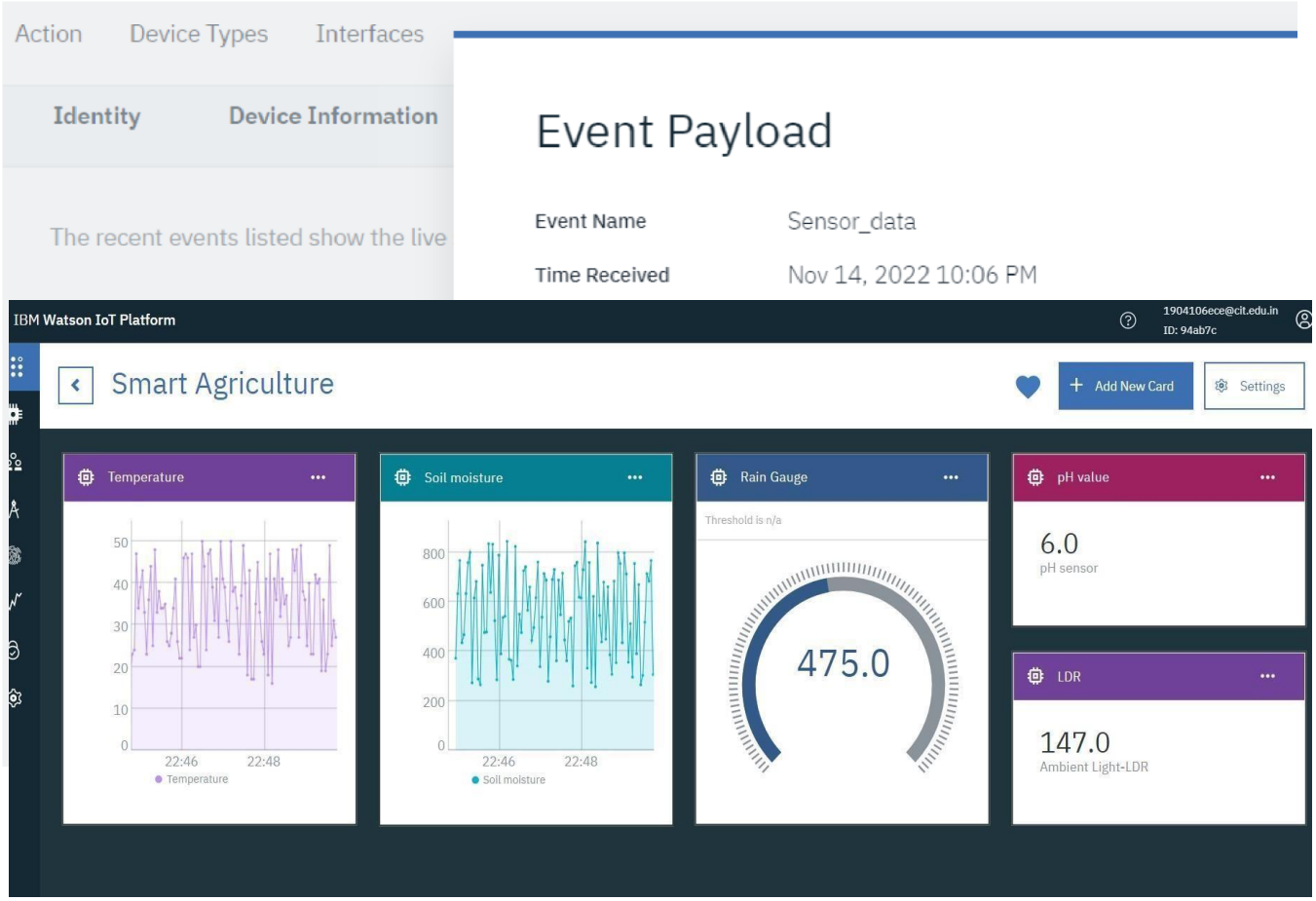


Fig 9.10

Fig 9.11

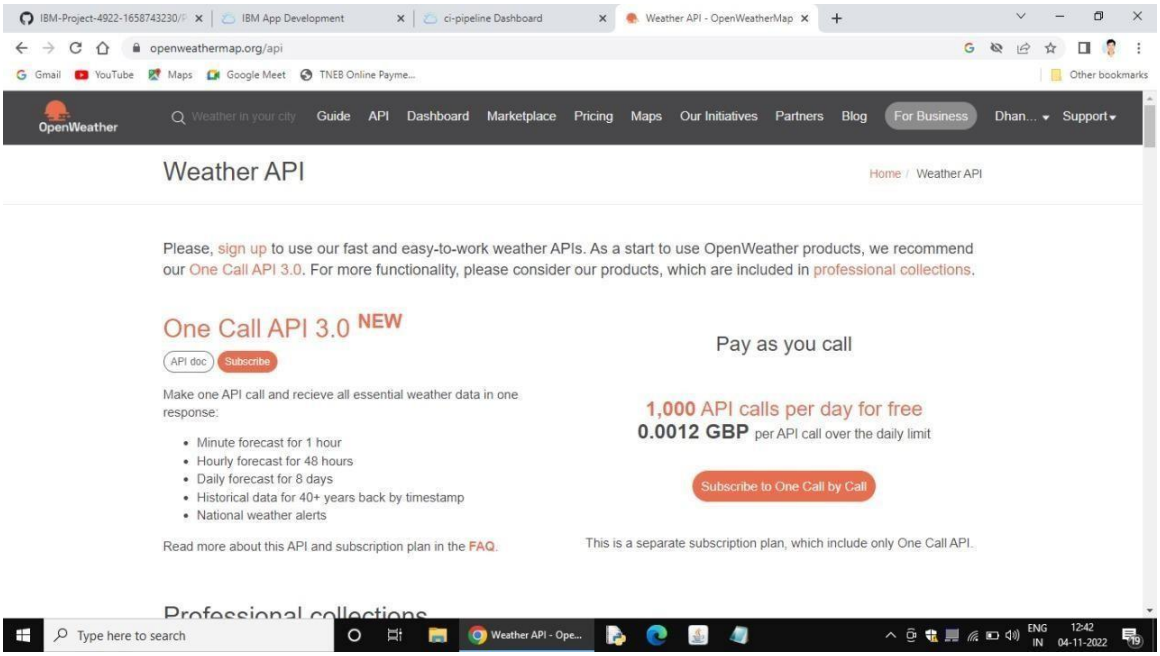
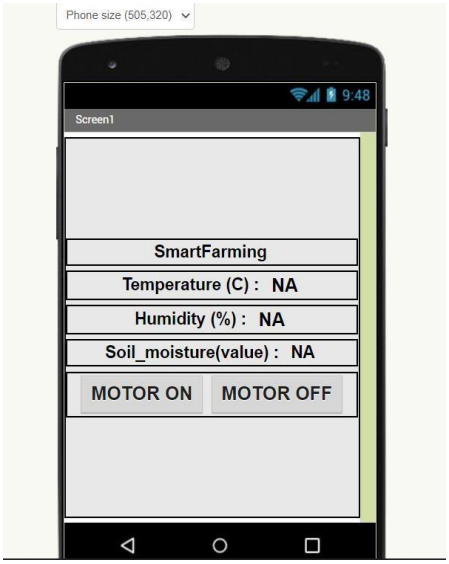


Fig 9.12 Fast2sms

DEVELOP A MOBILE APPLICATION



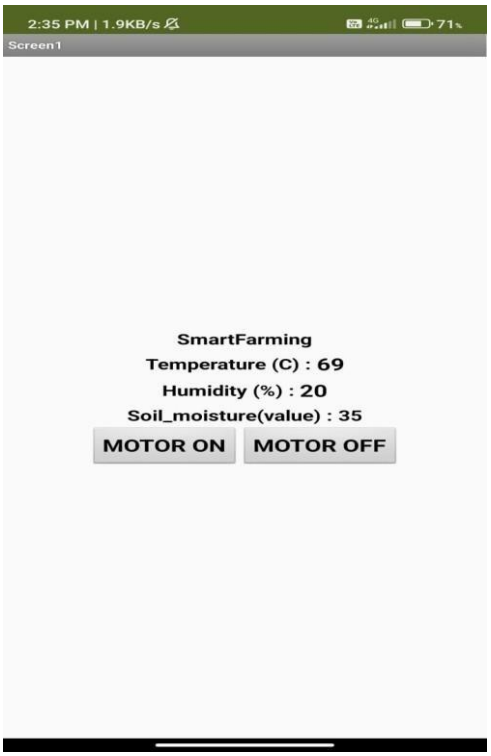
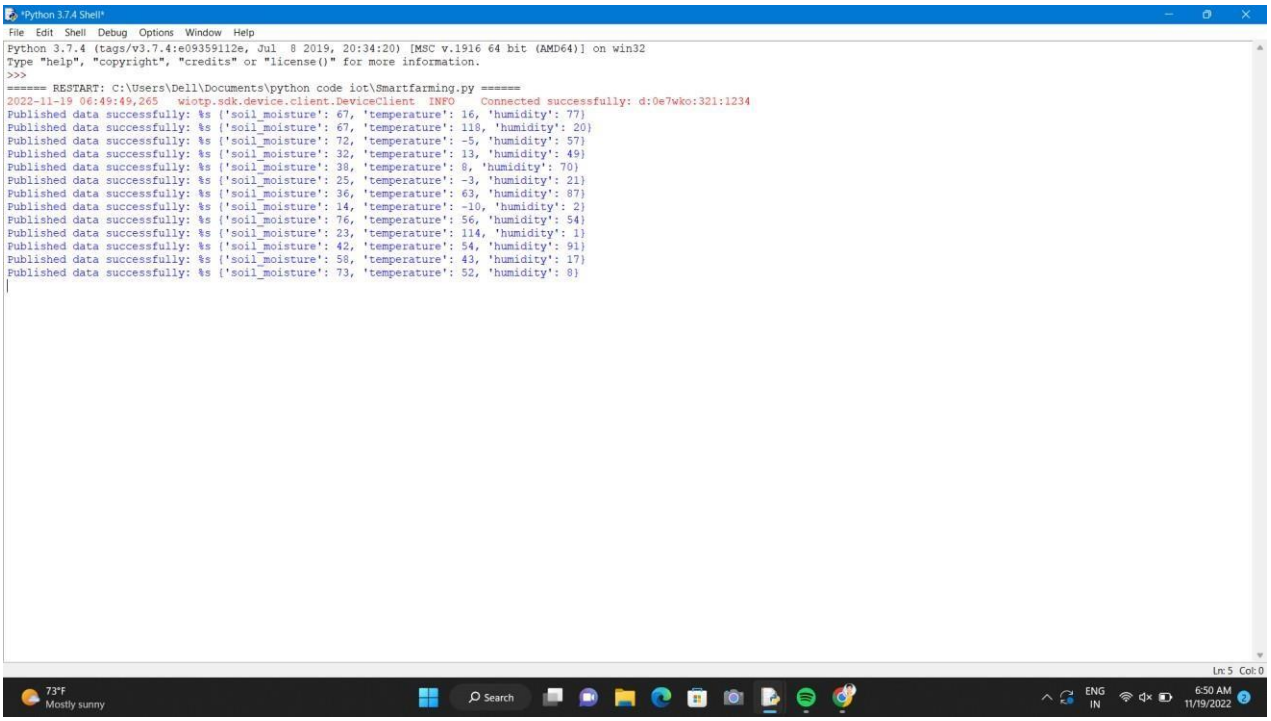
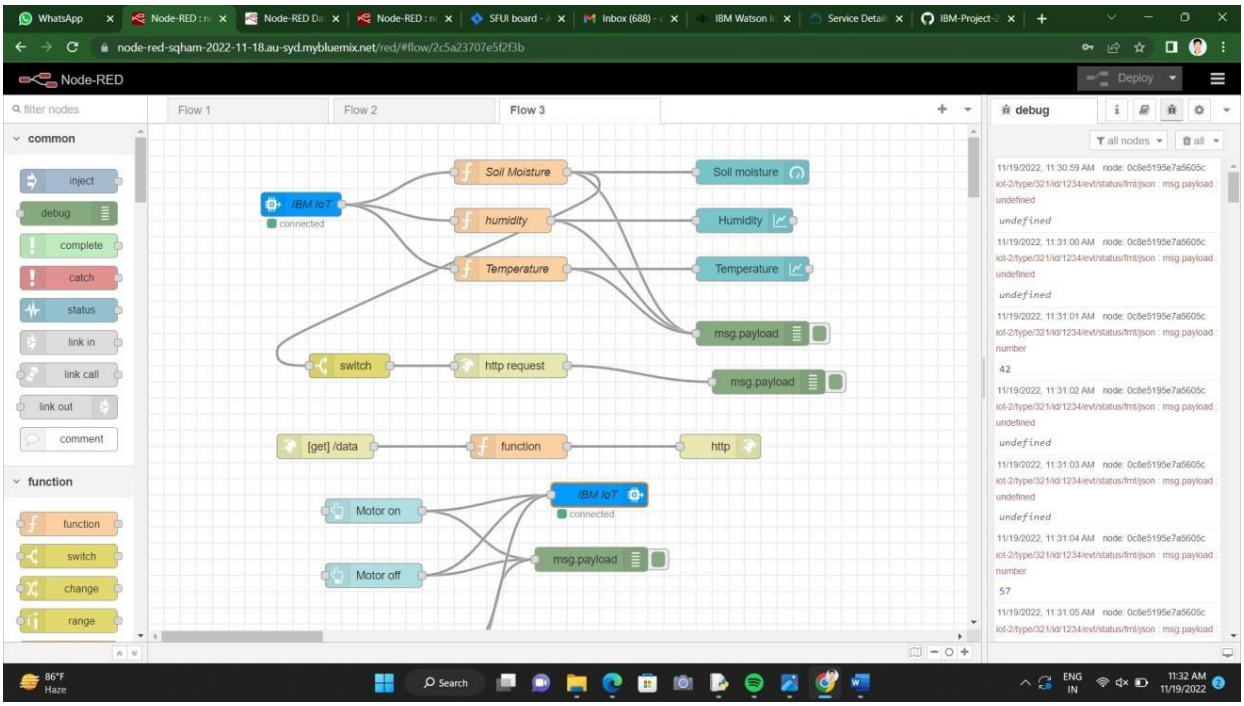
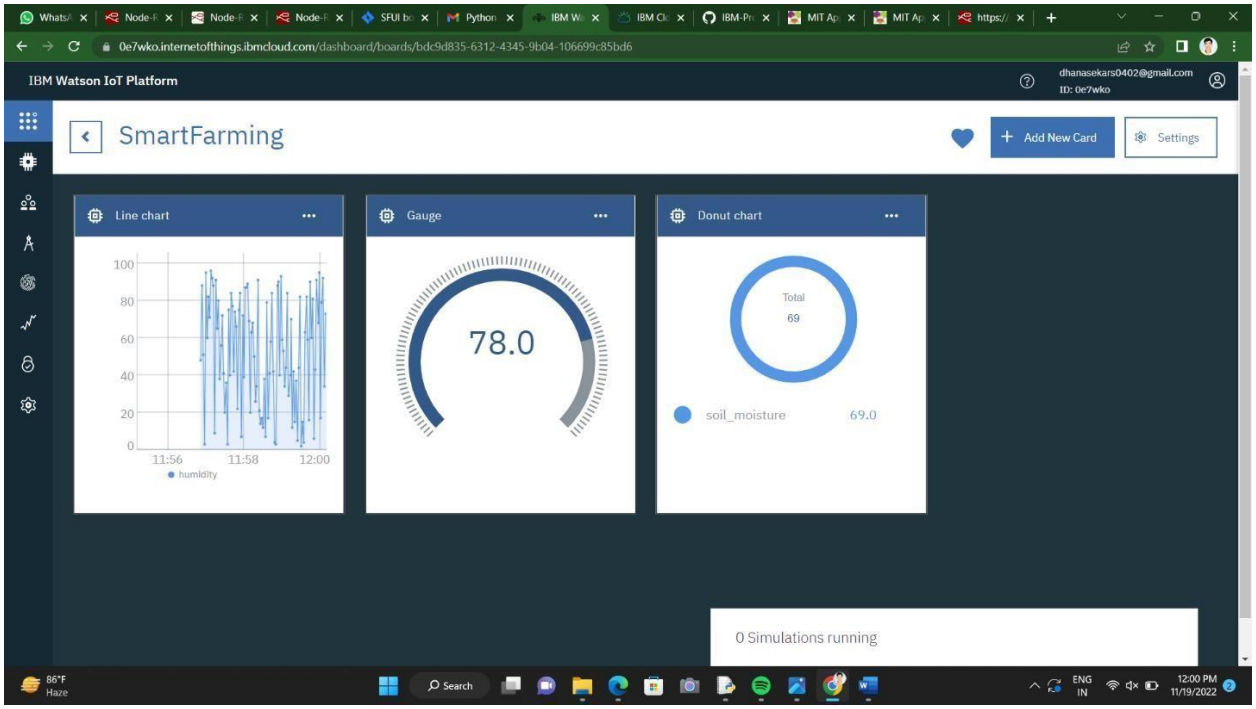


Fig 9.18 Displaying the parameters in the Smart Farmer App

9.1 PERFORMANCE METRICS






IBM Watson IoT Platform
dhanasekars0402@gmail.com
ID: 0e7wko
SmartFarming
Add New Card
Settings
Line chart
Gauge
Donut chart
100
80
60
40
20
0
11:56
11:58
12:00
humidity
78.0
Total
69
soil_moisture
69.0
0 Simulations running
Search
ENG
IN
12:00 PM
11/19/2022

10.ADVANTAGES AND DISADVANTAGES

ADVANTAGES

Smart farmer is an emerging concept, because IoT sensors capable of providing information about their agriculture fields. Monitoring environmental factors is the major factor to improve the yield of the efficient crops. The Iot based Smart Farmer system has been designed and synthesized. The developed system is more efficient and beneficial for farmers. It gives the information about the temperature, humidity of the air in agricultural field. The application of such system in the field can definitely help to advance the harvest of the crops and global production

DISADVANTAGES

One huge disadvantage of smart farming is that it requires an unlimited or continuous internet connection to be successful. This means that in rural communities, especially in the developing countries where we have mass crop production, it is completely impossible to operate this farming method. In places where internet connections are frustratingly slow, sma farming will be an impossibility.

11.CONCLUSION

Farming are often created a lot of economical & correct with the implementation of IoT device. IOT are often employed in totally different domains of agriculture. Electricity and water square measure the most domains and their price will improve or break the agriculture profession. due to recent leaky irrigation system water wastage may be a far more than we predict and pump operates by victimisation electricity thus if {we can|we will|we square measure able to} management water wastage then we have a tendency to are mechanically dominant electricity wastage additionally.

Water volume are often measured by employing a good device with pump and length of flow may be measured.This project helps to reinforce quality and amount of production, save resources like water and electricity, economically economical crop that price less and build a lot of profit as in country like Republic of India farmers play a significant role in gross domestic product thus this fashion the general gross domestic product may be increased

12.FUTURE SCOPE

Innovators and investors in AgriTech area to launch, improve and scale impactful and commercially viable digital solutions for sodbuster farmers within the developing world
effective solutions for agricultural production, post-harvest and storage process, together with star pumping, cooling, chilling and drying. These technologies end in saved prices, increase yields native and native worth capture for farmers or local agro enterprises.

Our recommendation to businesses includes markets entry, product valuation, sales methods, market assessments, payment solutions, route-to-market methods and also the agricultural worth chain.

13.APPENDIX

SOURCE CODE

```
import wiotp.sdk.device
import time
import os
import datetime
import random

myConfig = {
    "identity":{
        "orgId":"nqhzg5",
        "typeId":"Node-red",
        "deviceId":"1234"
    },
    "auth":{
    "token":"12345678"
    }
    }
client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()

def myCommandCallback(cmd):
print("Message received from IBM IoT platform: %s" % cmd.data['command'])
m=cmd.data['command']
if(m=="motoron"):
print("Motor is Switched on")
elif(m=="motoroff"):
print("Motor is Switched off")
print(" ")
while True:
soil=random.randint(0,100)
temp=random.randint(-20,125)
hum=random.randint(0,100)
```

```
            myData={'soil_moisture':soil,'temperature':temp,'humidity':hum}
             client.publishEvent(eventId="status", msgFormat="json", data=myData, qos=0,
onPublish=None)
              print("Published data successfully: %s", myData)
            time.sleep(2)
             client.commandCallback = myCommandCallback
             client.disconnect()
```

GITUP & PROJECT DEMO LINK

GITUP LINK

https://github.com/IBM-EPBL/IBM-Project-2907-1658486150

DEMO LINK

https://youtu.be/F1Pikzpv98Q