THIAGARAJAR COLLEGE OF ENGINEERING

MADURAI

Smart Farmer-IOT Enabled Smart Farming Application

IBM PROJECT: NALAIYATHIRAN

TEAM ID: PNT2022TMID21357

DONE BY: GOKULA KRISHNAN K (19D023)

ARUNAN K (19D011)

MICHEAL HALINS V (19D049)

RAHUL KUMAR K (19D069)

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

An IOT-based application is introduced to know about various data about their land remotely, where they can schedule some events for a month or a day. It also provides suggestions to users based on the crop they planted. In IOT based Agriculture
Smart Farming Technique Enables Farmers better to monitor the fields and maintain the humidity level accordingly.

1.2 PURPOSE

Reduces the wages for labors who work in the agricultural
field. It saves a lot of time. IoT can help improve customer
relationships by enhancing the customer's overall experience. Easily identify maintenance needs, build better products, send personalized communications, and more. IoT can also help e-commerce businesses thrive and increase sales. Increased production and optimization of all the processes related to agriculture and livestock-rearing increases production rates. Less Water usage.

The Data collected by sensors, in terms of humidity, temperature, moisture, and dew detections help in determining the weather pattern in Farms. So, cultivation is done for suitable crops.

2 LITERATURE SURVEY

2.1 EXISTING PROBLEM

- Controlling the device from longer distance from web application.
- Getting the weather data from weather station.
- Transfer of node data to the gateway at faster rate.
- Unavailability of data such as PH level, potassium, Nitrogen etc related to the soil.

2.2 PROBLEM STATEMENT DEFINITION

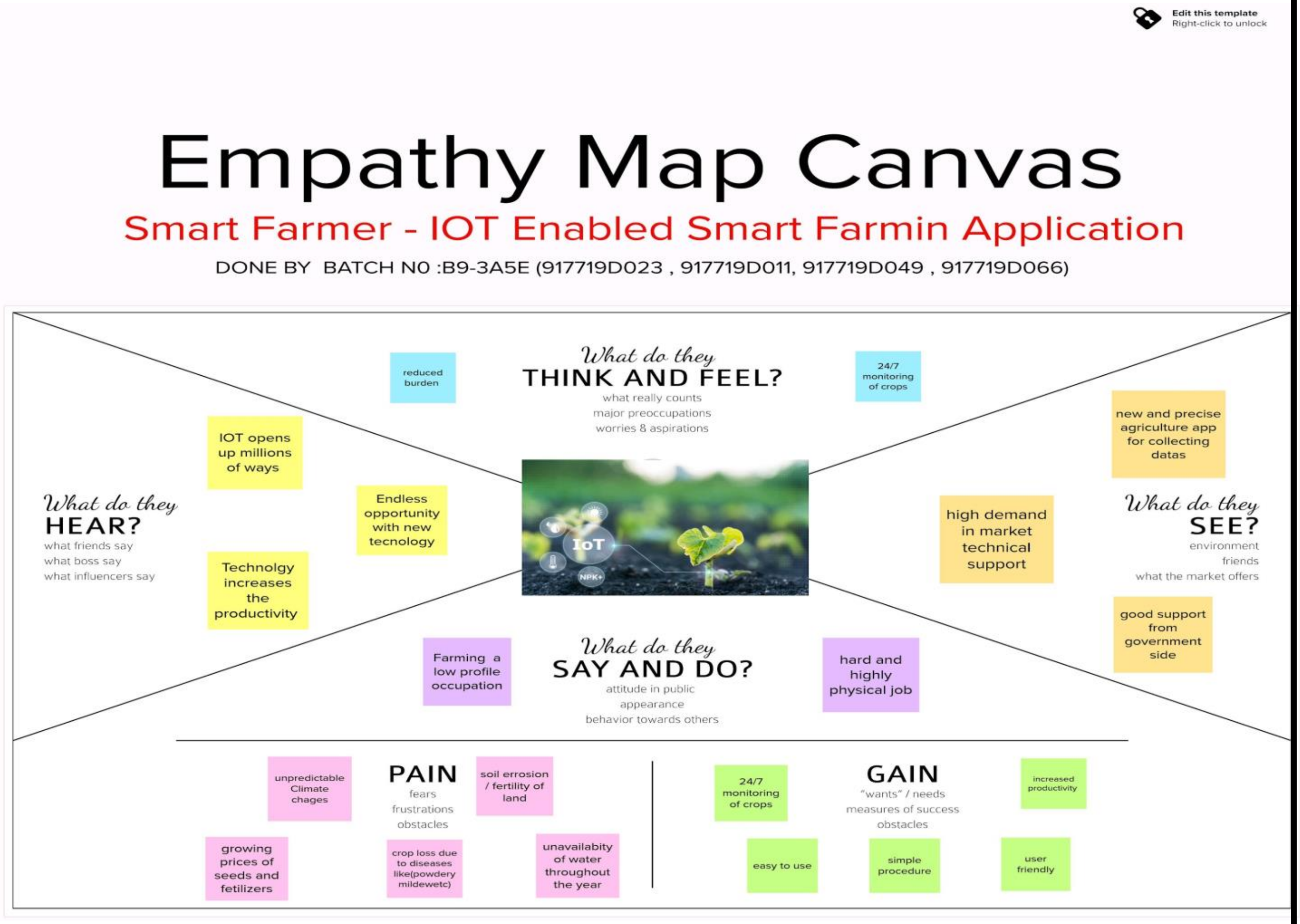
Watering the field is a difficult process; Farmers have to wait in the field until the water covers the whole farm field and sometimes, they may over irrigate it. The Second Challenge Faced in the Agricultural Sector are Lack of Information, High Adoption, Cost and Security Concerns, etc.

IoT sensor nodes collect information from the farming environment, such as soil moisture, air humidity, temperature, nutrient ingredients of soil, pest images, and water quality, and
then transmit collected data to IoT backhaul Giving farmers the remote access to their farms.

3 IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user’s behaviors and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user’s perspective along with his or her goals and challenges.


Edit this template
Right-click to unlock

Empathy Map Canvas

Smart Farmer - IOT Enabled Smart Farmin Application

DONE BY BATCH N0 :B9-3A5E (917719D023 , 917719D011, 917719D049 , 917719D066)

What do they
THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations

reduced burden

24/7 monitoring of crops

What do they
HEAR?
what friends say
what boss say
what influencers say

IOT opens up millions of ways

Endless opportunity with new tecnology

Technolgy increases the productivity

What do they
SEE?
environment
friends
what the market offers

new and precise agriculture app for collecting datas

high demand in market technical support

good support from government side

What do they
SAY AND DO?
attitude in public
appearance
behavior towards others

Farming a low profile occupation

hard and highly physical job

PAIN
fears
frustrations
obstacles

unpredictable Climate chages

soil errosion / fertility of land

growing prices of seeds and fetilizers

crop loss due to diseases like(powdery mildewetc)

unavailabity of water throughout the year

GAIN
“wants” / needs
measures of success
obstacles

24/7 monitoring of crops

increased productivity

easy to use

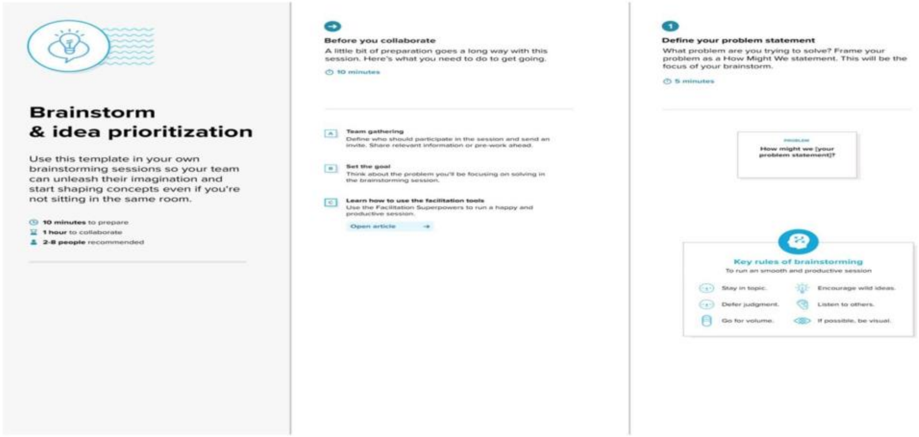
simple procedure

user friendly

3.2 IDEATION AND BRAINSTORMING

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out- of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich number of creative solutions. Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

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



Brainstorm & idea prioritization

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

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

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

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

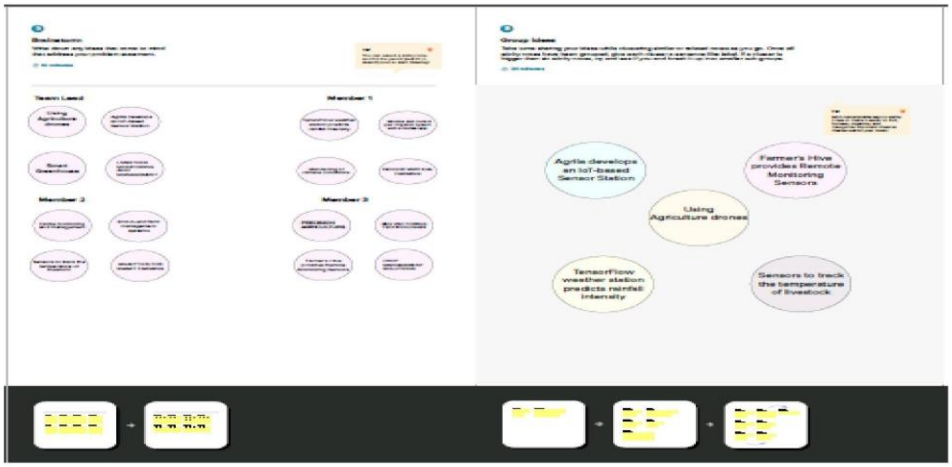
C **Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.
Open article →

1 **Define your problem statement**
What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.
5 minutes

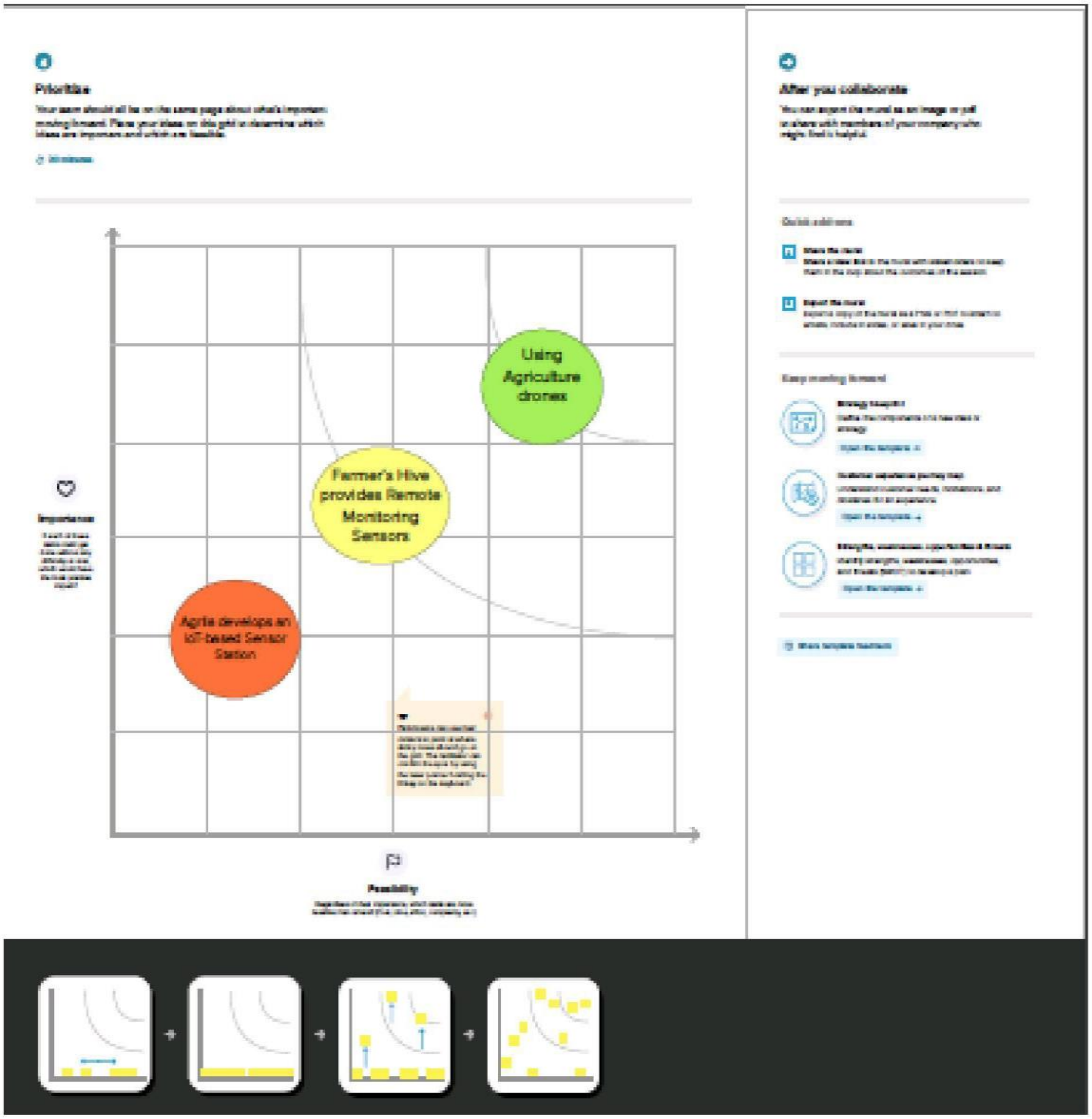
PROBLEM
How might we [your problem statement]?

Key rules of brainstorming
To run an smooth and productive session
Stay in topic.
Encourage wild ideas.
Defer judgment.
Listen to others.
Go for volume.
If possible, be visual.

Step-2: Brainstorm, Idea Listing and Grouping


Brainstorm
Group ideas
Team Lead
Member 1
Member 2
Member 3
Using Agriculture drones
Smart Greenhouse
Agrile develops an IoT-based Sensor Station
Farmer's Hive provides Remote Monitoring Sensors
Using Agriculture drones
TensorFlow weather station predicts rainfall intensity
Sensors to track the temperature of livestock

Step-3: Idea Prioritization



Prioritize

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

20 minutes

Importance

If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

Feasibility

Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the H key on the keyboard.

After you collaborate

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

Quick add-ons

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

Export the mural
Export a copy of the mural as a PNG or PDF to attach in emails, include in slides, or save in your drive.

Keep moving forward

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

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template →

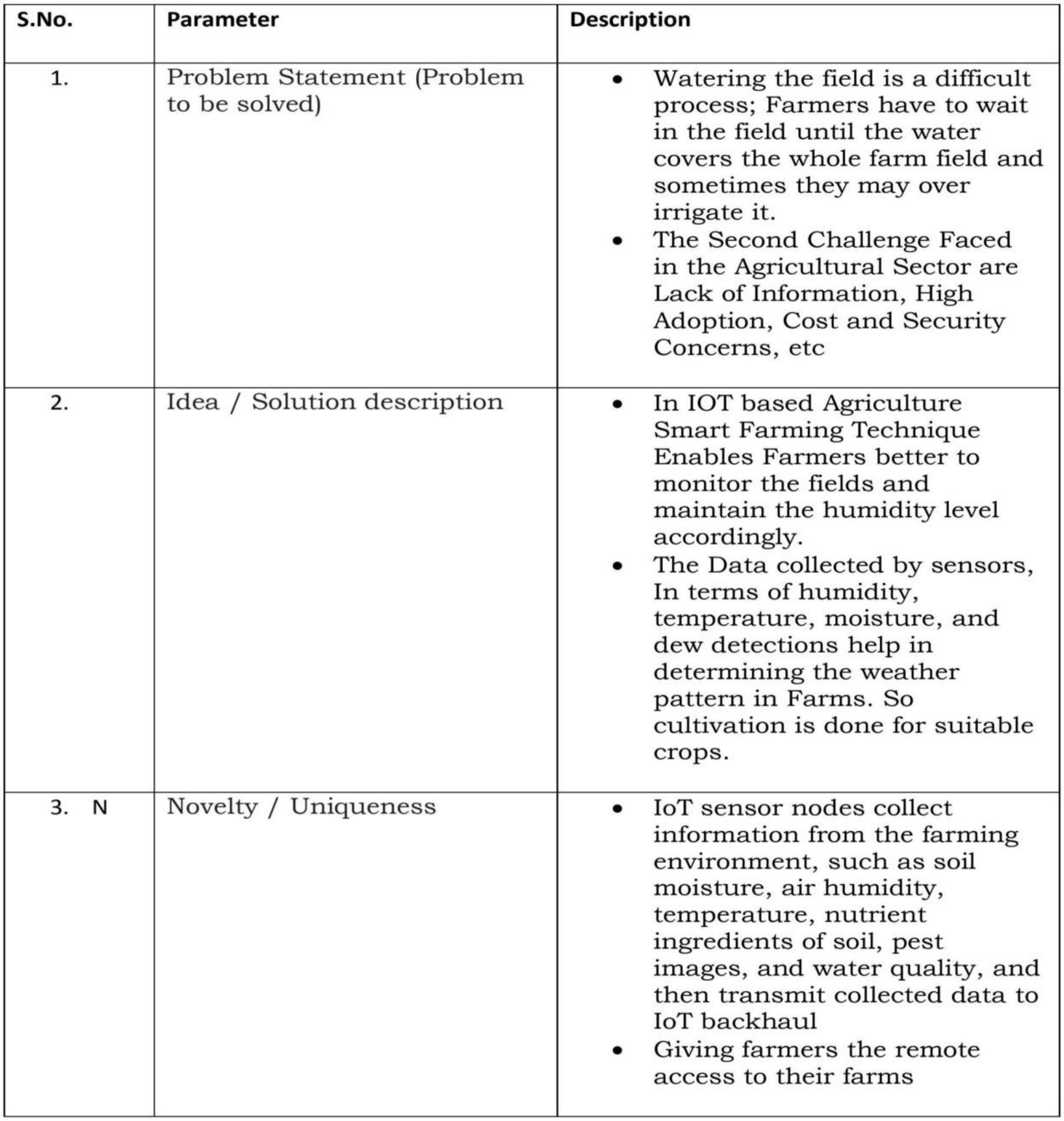
Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template →

Share template feedback

Using Agriculture drones
Farmer's Hive provides Remote Monitoring Sensors
Agrie develops an IoT-based Sensor Station

3.3 PROPOSED SOLUTION

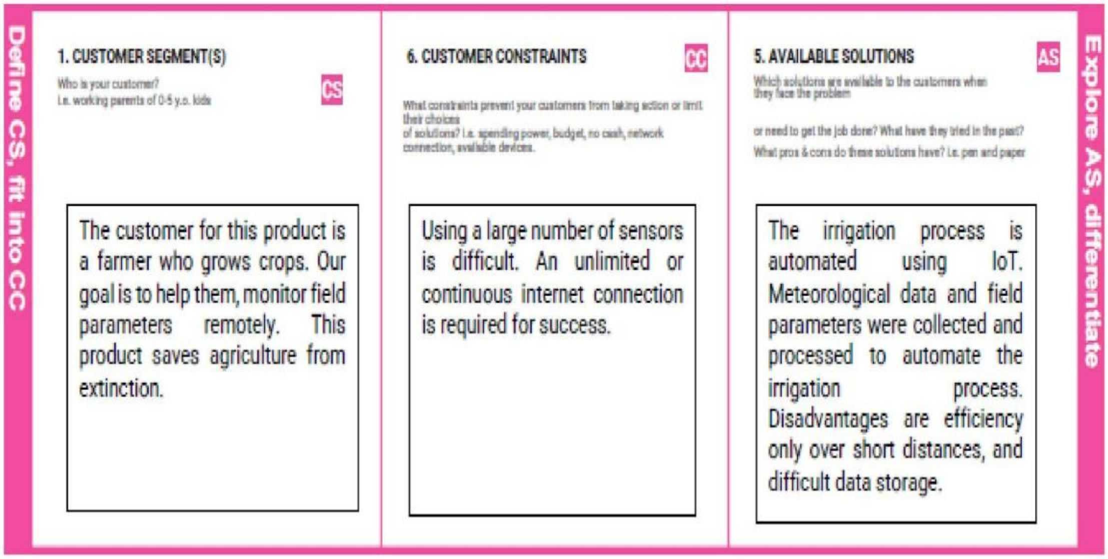
Project team shall fill the following information in proposed solution template.



S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	• Watering the field is a difficult process; Farmers have to wait in the field until the water covers the whole farm field and sometimes they may over irrigate it. • The Second Challenge Faced in the Agricultural Sector are Lack of Information, High Adoption, Cost and Security Concerns, etc
2.	Idea / Solution description	• In IOT based Agriculture Smart Farming Technique Enables Farmers better to monitor the fields and maintain the humidity level accordingly. • The Data collected by sensors, In terms of humidity, temperature, moisture, and dew detections help in determining the weather pattern in Farms. So cultivation is done for suitable crops.
3. N	Novelty / Uniqueness	• IoT sensor nodes collect information from the farming environment, such as soil moisture, air humidity, temperature, nutrient ingredients of soil, pest images, and water quality, and then transmit collected data to IoT backhaul • Giving farmers the remote access to their farms

4.	Social Impact / Customer Satisfaction	• Reduces the wages for labours who work in the agricultural field. • It saves a lot of time. • IoT can help improve customer relationships by enhancing the customer's overall experience. • Easily identify maintenance needs, build better products, send personalized communications, and more. • IoT can also help e-commerce businesses thrive and increase sales. • Increased production and optimisation of all the processes related to agriculture and livestock-rearing increases production rates. • Less Water usage
5.	Business Model (Revenue Model)	• Climate-smart agriculture is a pathway towards development and food security built on three pillars: increasing productivity and incomes, enhancing resilience of livelihoods and ecosystems and reducing and removing greenhouse gas emissions from the atmosphere
6.	Scalability of the Solution	• Smart Farming systems use modern technology to increase the quantity and quality of agricultural products. Livestock tracking and Geo fencing. Smart logistics and warehousing. Smart pest management. Smart Greenhouses

3.4 PROBLEM SOLUTION FIT



Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Who is your customer?
I.e. working parents of 0-5 y.o. kids

The customer for this product is a farmer who grows crops. Our goal is to help them, monitor field parameters remotely. This product saves agriculture from extinction.

6. CUSTOMER CONSTRAINTS CC

What constraints prevent your customers from taking action or limit their choices
of solutions? i.e. spending power, budget, no cash, network connection, available devices.

Using a large number of sensors is difficult. An unlimited or continuous internet connection is required for success.

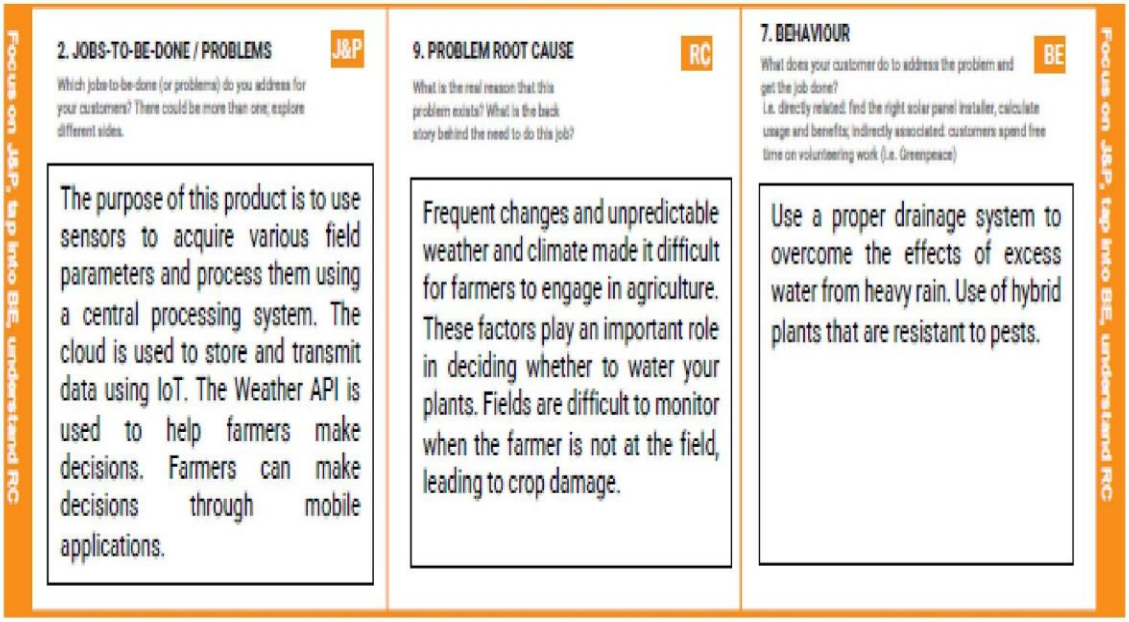
5. AVAILABLE SOLUTIONS AS

Which solutions are available to the customers when they face the problem

or need to get the job done? What have they tried in the past?
What pros & cons do these solutions have? i.e. pen and paper

The irrigation process is automated using IoT. Meteorological data and field parameters were collected and processed to automate the irrigation process. Disadvantages are efficiency only over short distances, and difficult data storage.

Explore AS, differentiate



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

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

Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.

The purpose of this product is to use sensors to acquire various field parameters and process them using a central processing system. The cloud is used to store and transmit data using IoT. The Weather API is used to help farmers make decisions. Farmers can make decisions through mobile applications.

9. PROBLEM ROOT CAUSE RC

What is the real reason that this problem exists? What is the back story behind the need to do this job?

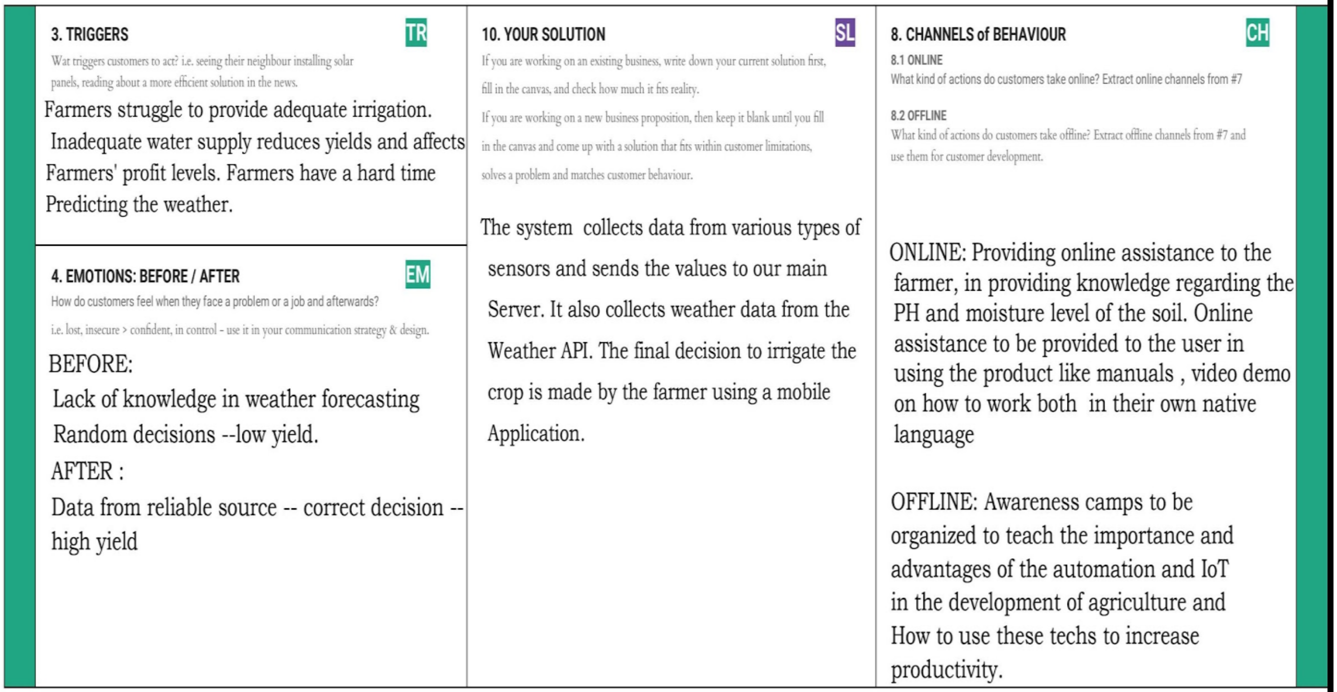
Frequent changes and unpredictable weather and climate made it difficult for farmers to engage in agriculture. These factors play an important role in deciding whether to water your plants. Fields are difficult to monitor when the farmer is not at the field, leading to crop damage.

7. BEHAVIOUR BE

What does your customer do to address the problem and get the job done?
I.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)

Use a proper drainage system to overcome the effects of excess water from heavy rain. Use of hybrid plants that are resistant to pests.

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



3. TRIGGERS TR

Wat triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.

Farmers struggle to provide adequate irrigation. Inadequate water supply reduces yields and affects Farmers' profit levels. Farmers have a hard time Predicting the weather.

4. EMOTIONS: BEFORE / AFTER EM

How do customers feel when they face a problem or a job and afterwards?

i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

BEFORE:

Lack of knowledge in weather forecasting

Random decisions --low yield.

AFTER :

Data from reliable source -- correct decision -- high yield

10. YOUR SOLUTION SL

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.

If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.

The system collects data from various types of sensors and sends the values to our main Server. It also collects weather data from the Weather API. The final decision to irrigate the crop is made by the farmer using a mobile Application.

8. CHANNELS of BEHAVIOUR CH

8.1 ONLINE

What kind of actions do customers take online? Extract online channels from #7

8.2 OFFLINE

What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.

ONLINE: Providing online assistance to the farmer, in providing knowledge regarding the PH and moisture level of the soil. Online assistance to be provided to the user in using the product like manuals , video demo on how to work both in their own native language

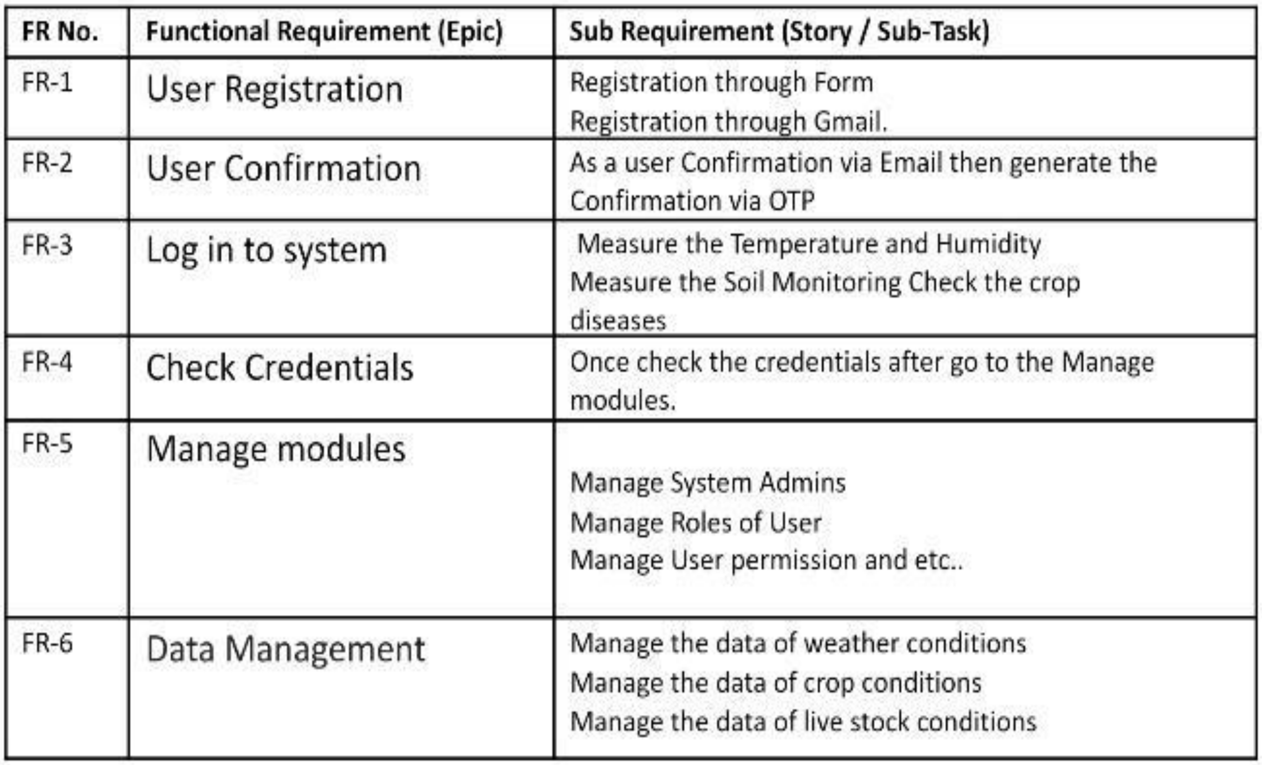
OFFLINE: Awareness camps to be organized to teach the importance and advantages of the automation and IoT in the development of agriculture and How to use these techs to increase productivity.

4. REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

Functional Requirements:

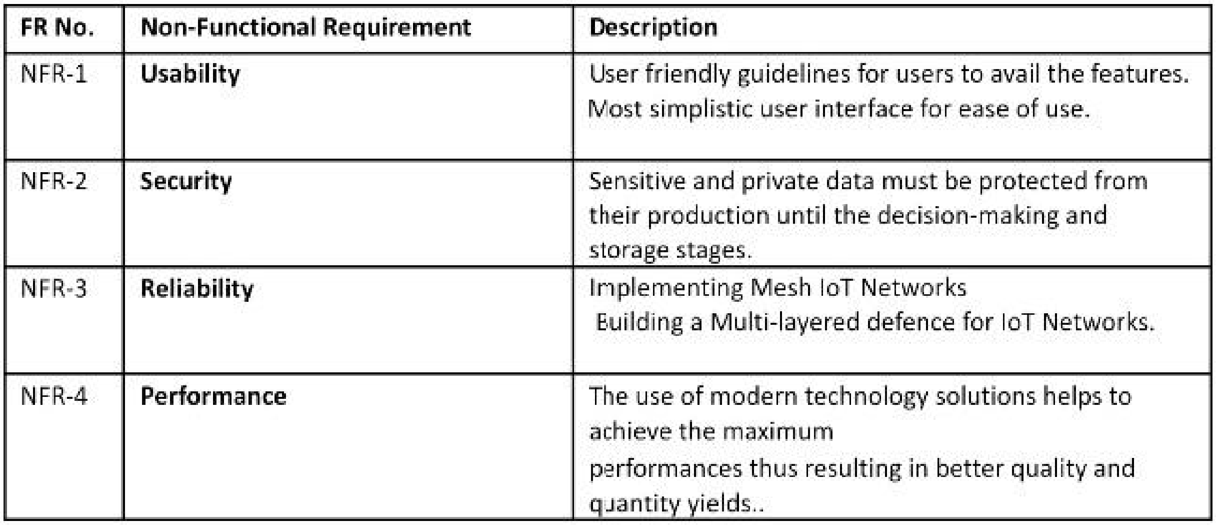
Following are the functional requirements of the proposed solution.



FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail.
FR-2	User Confirmation	As a user Confirmation via Email then generate the Confirmation via OTP
FR-3	Log in to system	Measure the Temperature and Humidity Measure the Soil Monitoring Check the crop diseases
FR-4	Check Credentials	Once check the credentials after go to the Manage modules.
FR-5	Manage modules	Manage System Admins Manage Roles of User Manage User permission and etc..
FR-6	Data Management	Manage the data of weather conditions Manage the data of crop conditions Manage the data of live stock conditions

4.2 NON-FUNCTIONAL REQUIREMENT

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

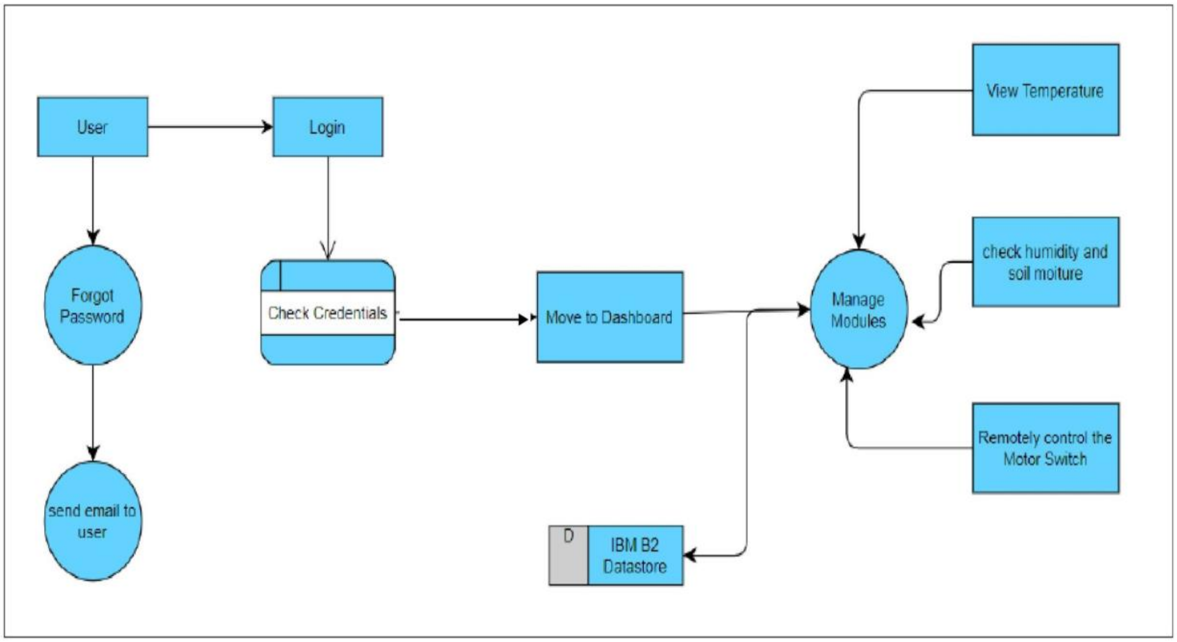


FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	User friendly guidelines for users to avail the features. Most simplistic user interface for ease of use.
NFR-2	**Security**	Sensitive and private data must be protected from their production until the decision-making and storage stages.
NFR-3	**Reliability**	Implementing Mesh IoT Networks Building a Multi-layered defence for IoT Networks.
NFR-4	**Performance**	The use of modern technology solutions helps to achieve the maximum performances thus resulting in better quality and quantity yields..

5.PROJECT DESIGN

5.1 DATA FLOW DIAGRAM

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



Data Flow Diagram

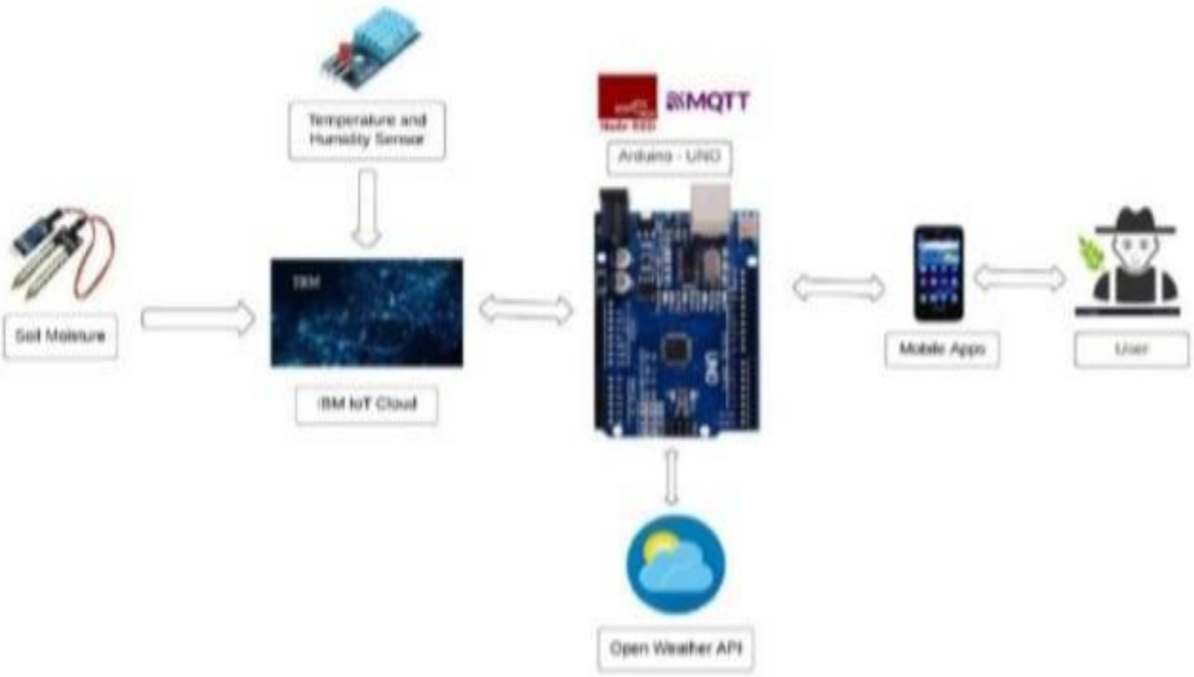
5.2 SOLUTION AND TECHNICAL ARCHITECTURE:

The different soil parameters (temperature, humidity, Soil Moisture) are sensed using different sensors (A sensor is a device that detects and responds to some type of input from the physical environment. The input can be light, heat, motion, moisture, pressure or any number of other environmental phenomena), and the obtained value is stored in the IBM cloud.

Arduino UNO (The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and the board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards) is used as a processing unit that processes the data obtained from sensors and weather data from the weather API.

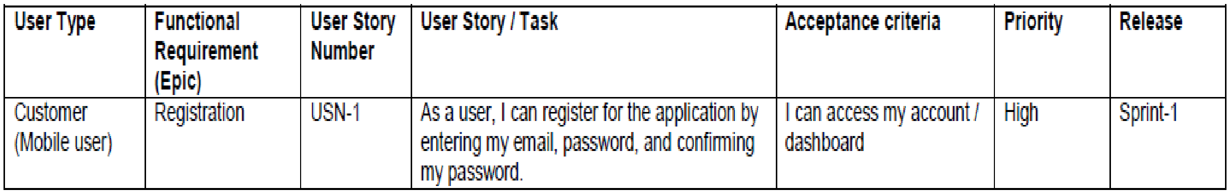
Node-red is used as a programming tool to wire the hardware, software, and APIs. The MQTT protocol is followed for communication. All the collected data are provided to the user through a mobile application that was developed using the MIT app inventor. The user could make a decision through an app, whether to water the crop or not depending upon the sensor values. By using the app, they can remotely operate the motor switch.

Example - Solution Architecture Diagram:

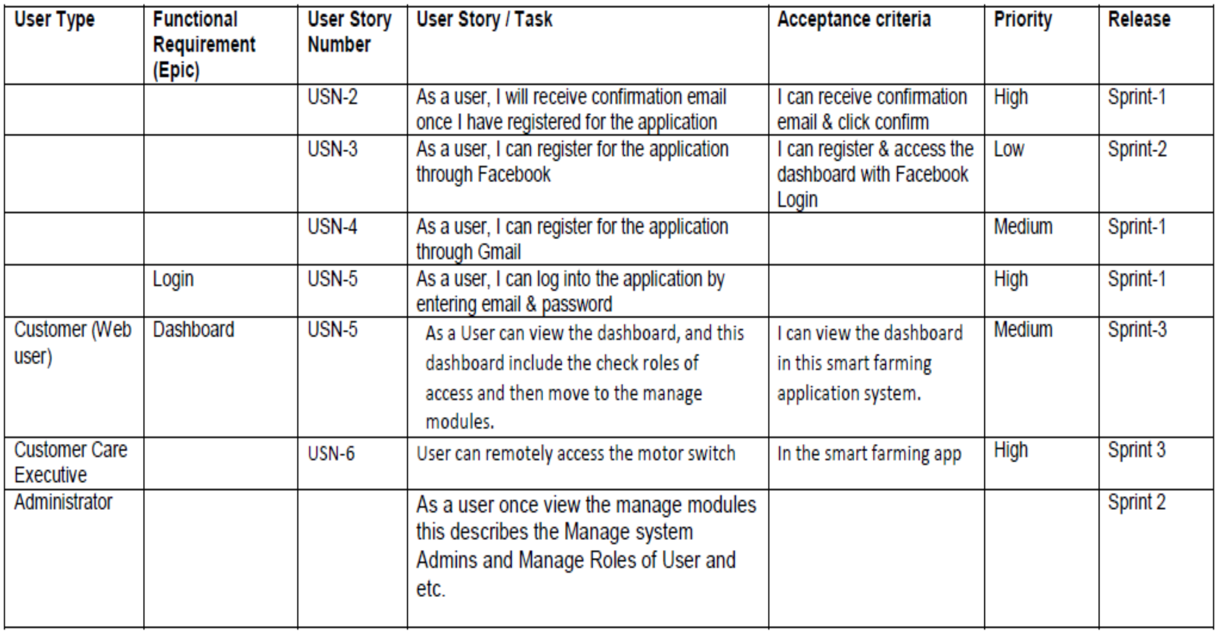


5.3 USER STORIES

Use the below template to list all the user stories for the product.



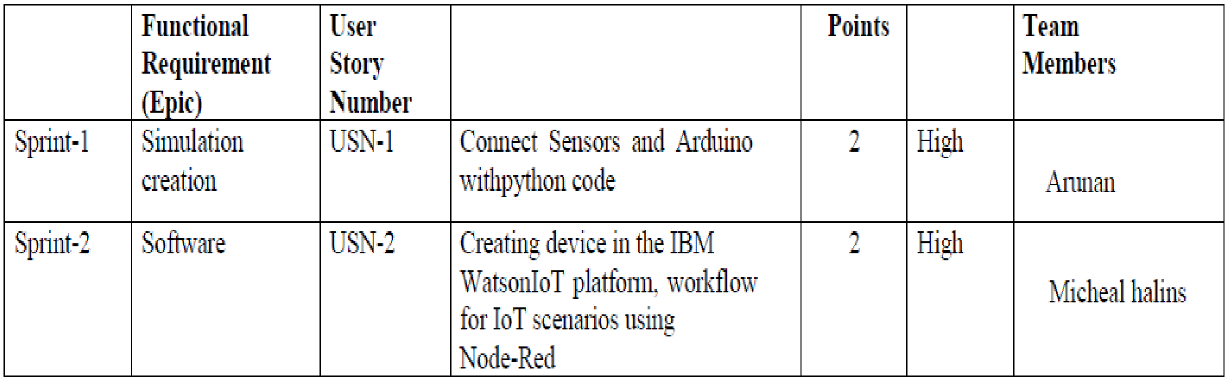
User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1



User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1
Customer (Web user)	Dashboard	USN-5	As a User can view the dashboard, and this dashboard include the check roles of access and then move to the manage modules.	I can view the dashboard in this smart farming application system.	Medium	Sprint-3
Customer Care Executive		USN-6	User can remotely access the motor switch	In the smart farming app	High	Sprint 3
Administrator			As a user once view the manage modules this describes the Manage system Admins and Manage Roles of User and etc.			Sprint 2

6.PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING AND ESTIMATION



	Functional Requirement (Epic)	User Story Number		Points		Team Members
Sprint-1	Simulation creation	USN-1	Connect Sensors and Arduino withpython code	2	High	Arunan
Sprint-2	Software	USN-2	Creating device in the IBM WatsonIoT platform, workflow for IoT scenarios using Node-Red	2	High	Micheal halins

Sprint-3	MIT App Inventor	USN-3	Develop an application for the Smart farmer project using MIT App Inventor	2	High	Rahulkumar
Sprint			User Story / Task	Story	Priority	
Sprint-3	Dashboard	USN-3	Design the Modules and test the app	2	High	Gokulakrishnan
Sprint-4	Web UI	USN-4	To make the user to interact withsoftware.	2	High	Gokulakrishnan

6.2 SPRINT DELIVERY AND SCHEDULE

	Total Story Points	n	Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	7 Days	2 Nov 2022	09 Nov 2022	20	29 Oct 2022
Sprint-2	20	9 Days	1 Nov 2022	10 Nov 2022		05 Oct 2022
Sprint-3	20	6 Days	06 Nov 2022	13 Nov 2022		12 Oct 2022
Sprint-4	20	6 Days	11 Nov 2022	17 Nov 2022		15 Oct 2022

Start Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let’s calculate the team’saverage velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

7.CODING AND SOLUTIONING

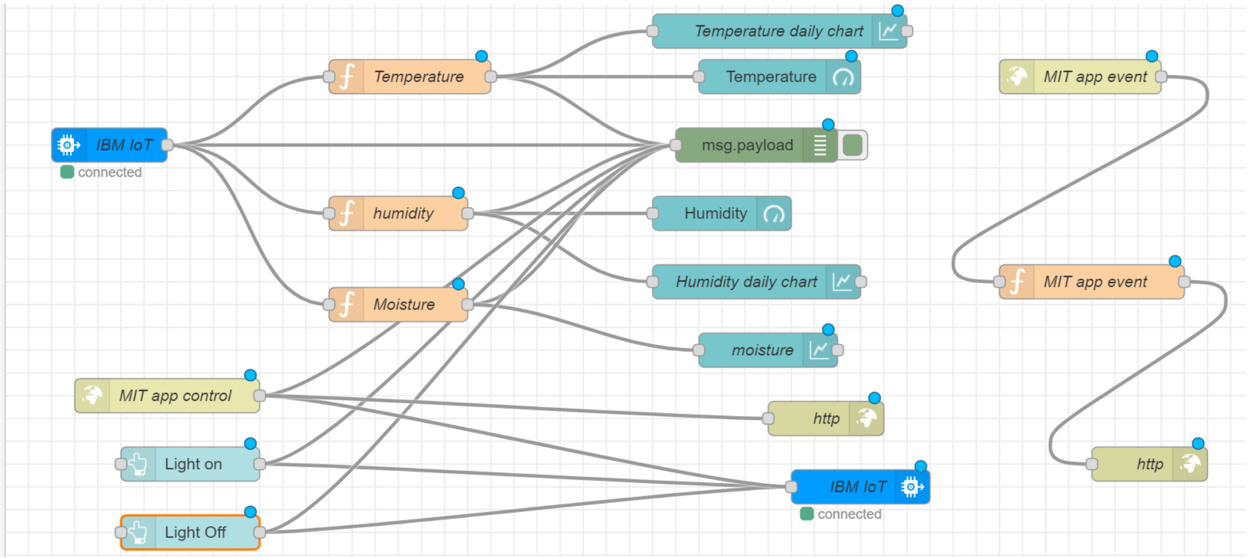
7.1 FEATURE 1

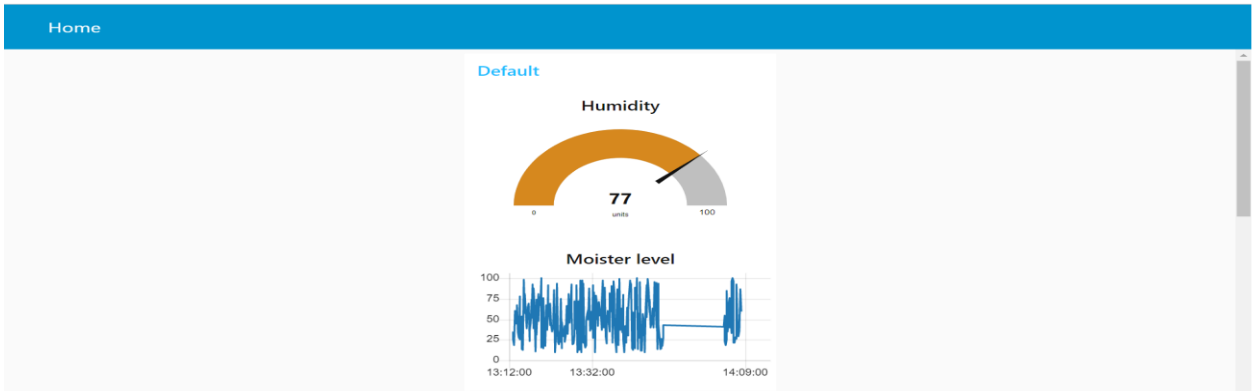
```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random

#Provide your IBM Watson Device Credentials
organization = "11k6qs"
deviceType = "abcd"
deviceId = "1234"
authMethod = "token"
authToken = "NAX7rDwisCAY4?TO*a"

# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="on":
        print ("led is on")
    elif status == "off":
        print ("led is off")
    else :
        print ("please send proper command")

try:
    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}
    deviceCli = ibmiotf.device.Client(deviceOptions)
    #..............................................

except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times
deviceCli.connect()

while True:
    #Get Sensor Data from DHT11

    temp=random.randint(-50,60)
    Humid=random.randint(60,100)
    mois = random.randint(10,100)

    data = { 'temp' : temp, 'Humid': Humid ,'mois' : mois}
    #print data
    def myOnPublishCallback():
        print ("Published Temperature = %s C" % temp, "Humidity = %s " % Humid, "Moisture = %s %%" % mois + "to IBM Watson")

    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback)
    if not success:
        print("Not connected to IoTF")
    time.sleep(10)
```

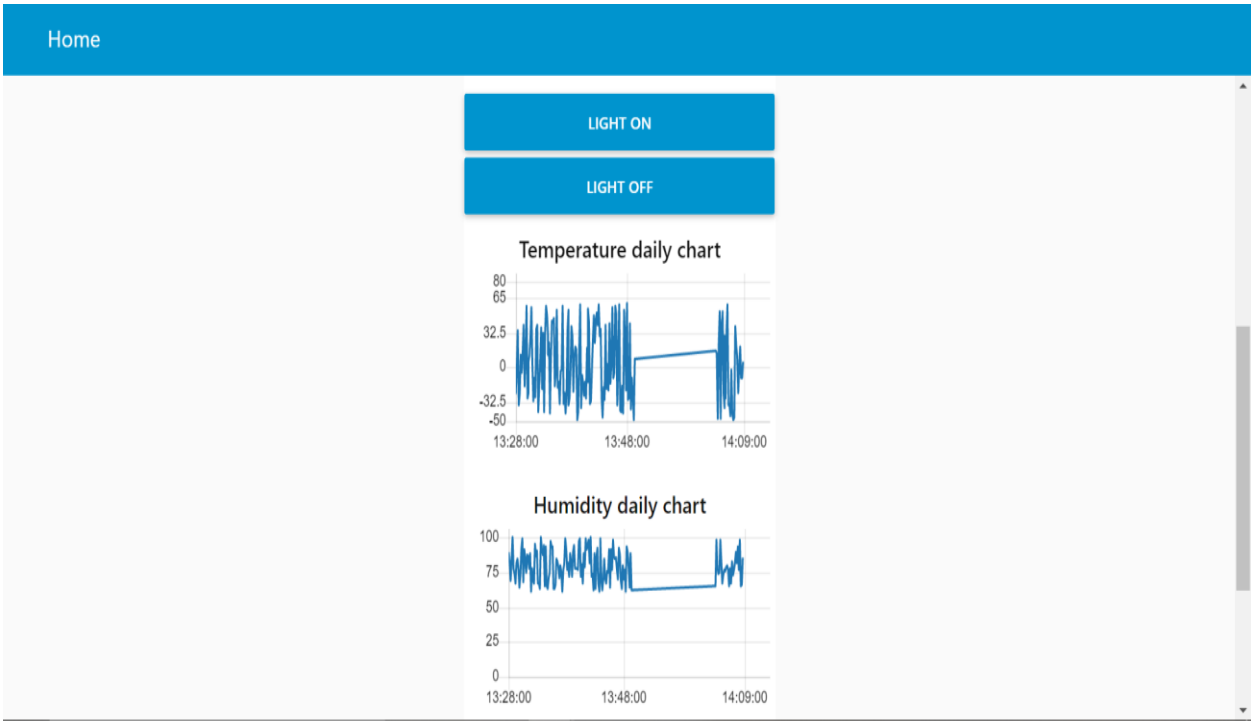
```
        deviceCli.commandCallback = myCommandCallback

# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

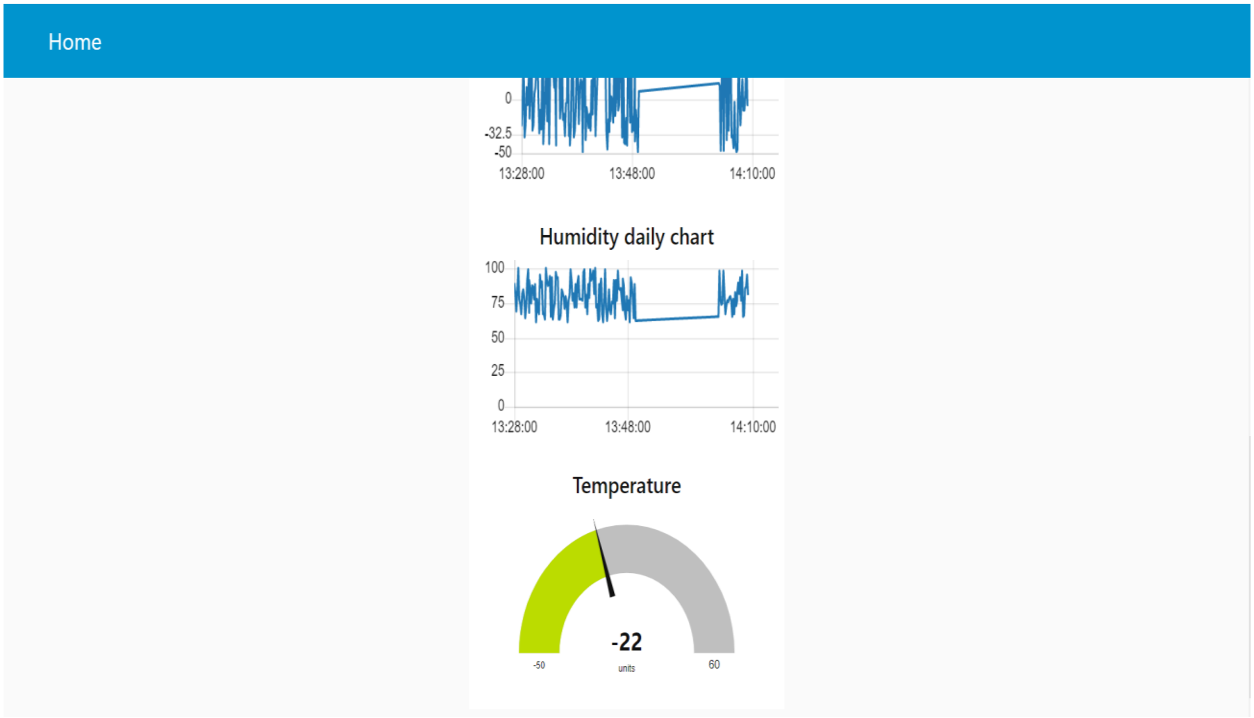
8. TESTING

8.1 TEST CASES

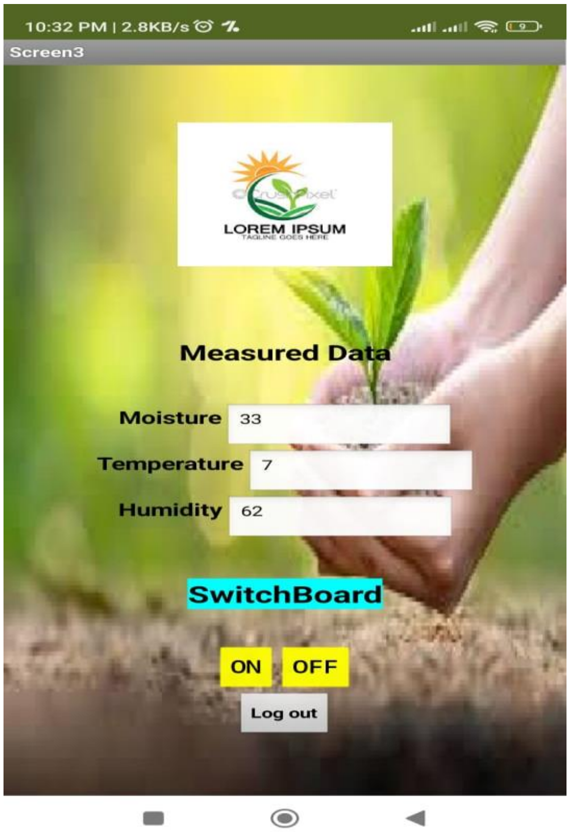





Home
LIGHT ON
LIGHT OFF
Temperature daily chart
80
65
32.5
0
-32.5
-50
13:28:00
13:48:00
14:09:00
Humidity daily chart
100
75
50
25
0
13:28:00
13:48:00
14:09:00


Home
0
-32.5
-50
13:28:00
13:48:00
14:10:00
Humidity daily chart
100
75
50
25
0
13:28:00
13:48:00
14:10:00
Temperature
-22
units
-50
60

8.2 USER ACCEPTENCE TESTING

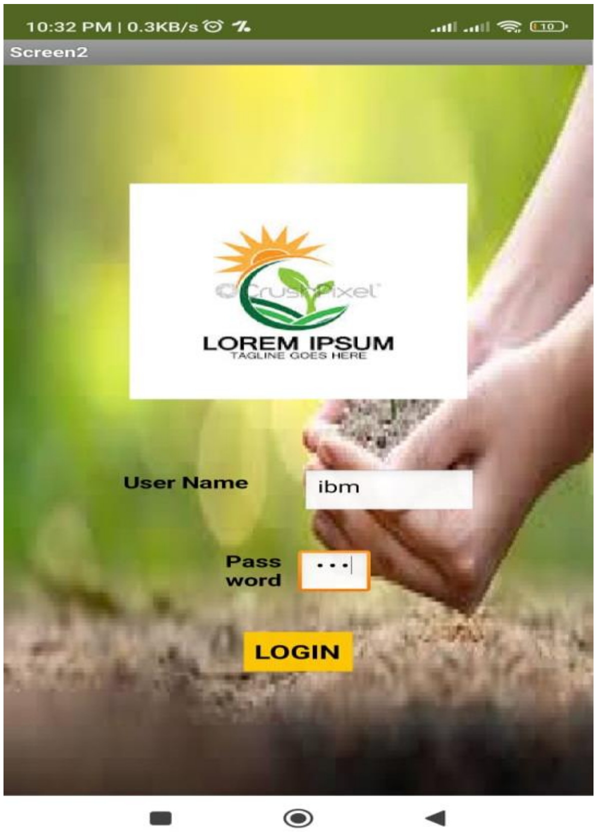


Measured Data

Moisture 33

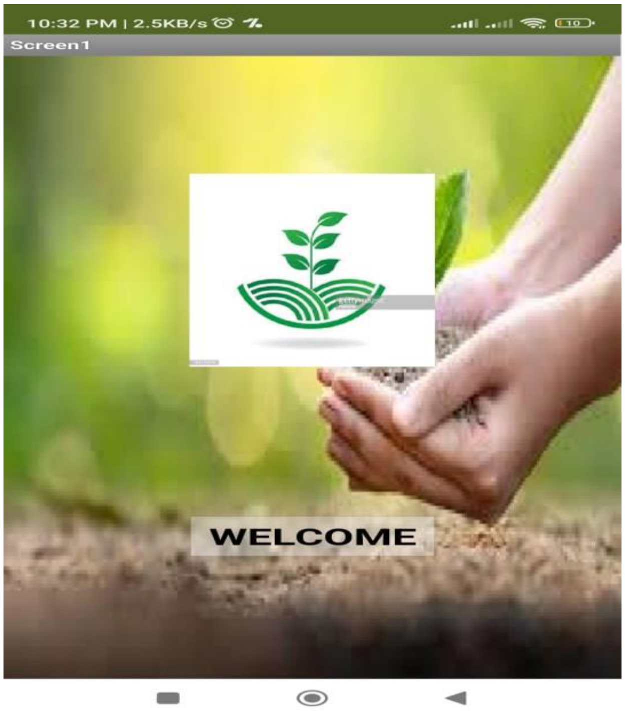
Temperature 7

Humidity 62



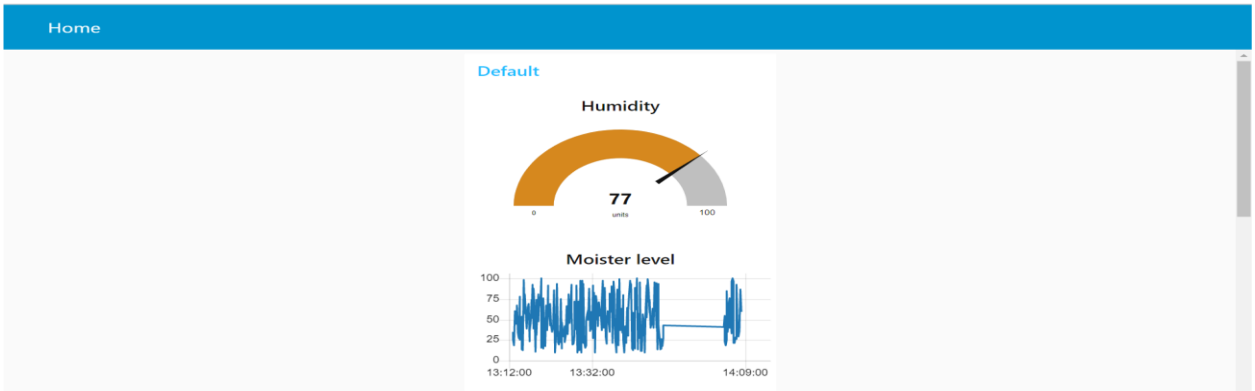
User Name ibm

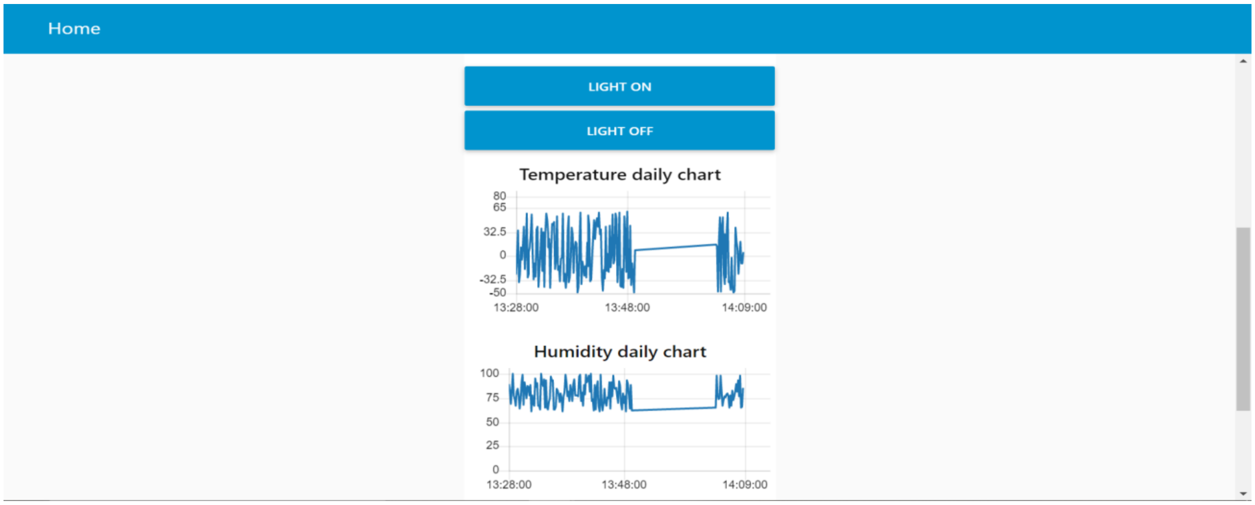
Pass word •••

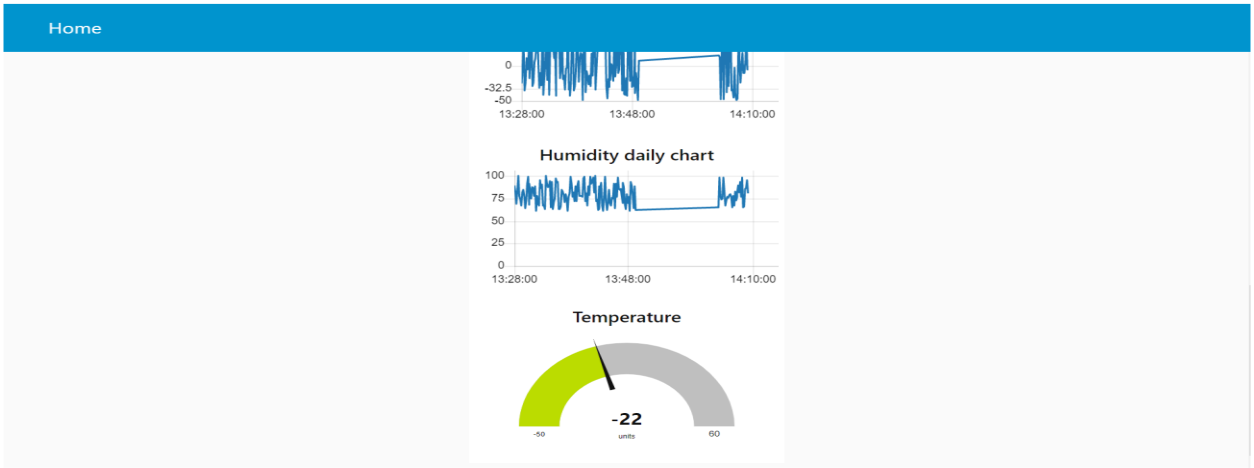


9.RESULTS

9.1 PERFORMANCE METRICS







10 ADVANTAGE AND DISADVANTAGE

10.1 ADVANTAGE

1. Communicating the device at larger distance through web application. It will play an important role in reducing the man power and travelling expenses of a farmer.

2. Monitoring the parameter like temperature, humidity etc will play an important role in improving the growth of the plant.

3. Integrating the weather station to the web browser will provide the details of status of the cloud, wind speed etc. It will allow the farmer to prevent their plants from natural calamities.

10.2 DISADVANTAGE

1. Since the real time sensor will be connected to the controller, the controller requires continuous supply of internet to transfer the data.

2. Non availability of weather prediction for long period of time. Since the long weather prediction require additional payment to open weather.

11. CONCLUSION

Farmers can benefit greatly from an IoT-based smart agriculture system. As a result of the lack of irrigation, agriculture suffers. Climate factors such as humidity, temperature, and moisture can be 28 adjusted dependents on the local environmental variables. This technology also detects animal invasions, which are a major cause of crop loss. This technology aids in the scheduling of irrigation based on present data from the field and records from a climate source. It helps in deciding the farmer to whether to do irrigation or not to do. Continuous internet connectivity is required for continuous monitoring of data from sensors. This also can be overcome by using GSM unit as an alternative of mobile app. By GSM, SMS can be sent to farmer’s phone.

12.FUTURE SCOPE

- The various data of soil nutrients is not added in the web browser, that can be added to the web application.
- Long range forecast is not available in the web application, it can also be added to provide accurate information about weather.
- Controlling the device through mobile application and voice will play important role in enhancing this project.
- Providing the GPS and GIS information will also improve productivity of the farmer.

13.Appendix Source

Code

A. PYTHON CODE

```
import time
import sys
import ibmiotf.application # to install pip install ibmiotf
import ibmiotf.device
#Provide your IBM Watson Device Credentials
organization = "*****" #replace the ORG ID
deviceType = "****"#replace the Device type wi
```

```
deviceId = "*****"#replace Device ID
authMethod = "****"
authToken = "*****" #Replace the authtoken
def myCommandCallback(cmd): # function for Callback
print("Command received: %s" % cmd.data)
print(cmd.data['command'])
if cmd.data['command']=='Turned on Motor':
print("MOTOR ON IS RECEIVED")
elif cmd.data['command']=='Turned off Motor':
print("MOTOR OFF IS RECEIVED")
if cmd.command == "setInterval":
if 'interval' not in cmd.data:
print("Error - command is missing required information: 'interval'")
else:
interval = cmd.data['interval']
elif cmd.command == "print":
if 'message' not in cmd.data:
print("Error - command is missing required information: 'message'")
else:
output=cmd.data['message']
print(output)
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()
# Connect and send a datapoint "hello" with value "world" into the cloud
as an event of type "greeting" 10 times
while True:
deviceCli.commandCallback = myCommandCallback
# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

GITHUB LINK: https://github.com/IBM-EPBL/IBM-Project-21109-1659772706.

PROJECT DEMO LINK: https://github.com/IBM-EPBL/IBM-Project-21109-1659772706/tree/main/Demo%20link.