SMART FARMER-IOT ENABLED SMART FARMING APPLICATION

SUBMITTED BY,
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1.INTRODUCTION:

1.1 Overview

In this project I have developed a mobile application using which a farmer can monitor the temperature, humidity, pressure and soil moisture parameters along with weather forecasting details. Based on these details he can water the crops by controlling the motors through the app .

1.2 Purpose

Agriculture plays a crucial role in the life of an economy. It is the backbone of our economic system, so improving the quality and way of production is crucial. Here comes the Smart Agriculture system. Smart agriculture helps in automated farming, collection of data from the field and then analyses it so that the farmer can make accurate decision in order to grow high quality crop.

IoT based Smart Farming improves the entire Agriculture system by monitoring the field in real-time. With the help of sensors and interconnectivity, the Internet of Things in Agriculture has not only saved the time of the farmers but has also reduced the extravagant use of resources such as Water and

Electricity.

2. Literature Survey:

2.1 Existing problem

Agriculture is extremely dependent on the climate. Temperature increases and carbon dioxide can boost some crop yields depending on the location; but other conditions must also exist, such as humidity, pressure, and water availability.

Although slight warming and more carbon dioxide in the atmosphere could benefit some plants to grow faster, severe warming, floods, and drought would reduce yields. Farmer need to spend a lot of time to maintain these.Heat is not the only extreme weather. Extreme cold can benefit farmers by freezing the soil deep beneath the ground. In parts of the upper Midwest, frost depths exceed 40 inches. A deep frost depth can aid farmers in diverse ways. The cold helps nitrogen that is applied in the fall from vaporizing during the winter. The cycle of freezing and thawing of water helps soften the soil after the thaw. Extreme cold and frozen soils also reduce the survival rate of some insects.

Severe weather other than heat and cold can cause loss and devastation to a farm. Most farmers can't avoid the results of extreme weather. Diverse extreme weather can affect farms in different ways. Because of this, it's important that farmers have a proper system and need a mobile application to monitor the weather changes and to control the motor.

2.2 Problem Solution

The author describes Today's different types of technologies, techniques and tools are used in the agriculture sector. To improve productivity, efficiency and reduce the time, cost and human intervention, there is a need for a new technology called the Internet of Things.

To automate the agricultural activities like water management, soil monitoring, crop management, livestock monitoring etc. different types of sensors are used. Smart Greenhouses protect the plants from extreme weather.

To control all these operations remote smart devices, computers connected with the internet, sensor, camera, micro-controller etc. are used. Growth in the agriculture sector affects the economic condition of the country. This paper focuses on the Role of IoT in Agriculture that defines Smart Farming.

Reference : Farooq, M. S., Sohail, O. O., Abid, A., & Rasheed, S. (2022). A survey on the role of IOT in agriculture for the implementation of smart livestock environment. IEEE Access, 10, 9483-9505.

2.3 Proposed Solution

s.no	Parameter	Description
1.	Problem Statement (Problem to be solved)	To deal with humidity, climate change and soil erosion. To satisfy the agricultural needs and expectations .To solve the Fear of investing in farm productivity.
2.	Idea / Solution description	By using Internet of Things we can estimate the humidity and conditions. IoT in agriculture can be helpful in tracking soil temperature, soil moisture, and soil nutrients to enhance crop productivity
3.	Novelty / Uniqueness	The IoT should increase the control over productivity and enable management of a greater number of resources through remote sensing. The smart farming should be much more efficient than our traditional farming.
4.		Smart farming makes it possible to increase the quality and minimize the environmental effect. It should support

	Social Impact/ Customer Satisfaction	livelihoods through food, habitat, and jobs and providing raw materials for food and other products.
5.	Business Model (Revenue Model)	The smart farming devices designed in such a way that should be profitable compared to traditional farming methods and the device should be reusable . The cost of the devices should be less compared to cost required for traditional farming. Hence the product must be profitable it does not make losses in any cases.
6.	Scalability of the Solution	The ability of the device's to increase or decrease in performance and cost in response to changes in application. The property of a device to handle a growing amount of works by adding resource to system.

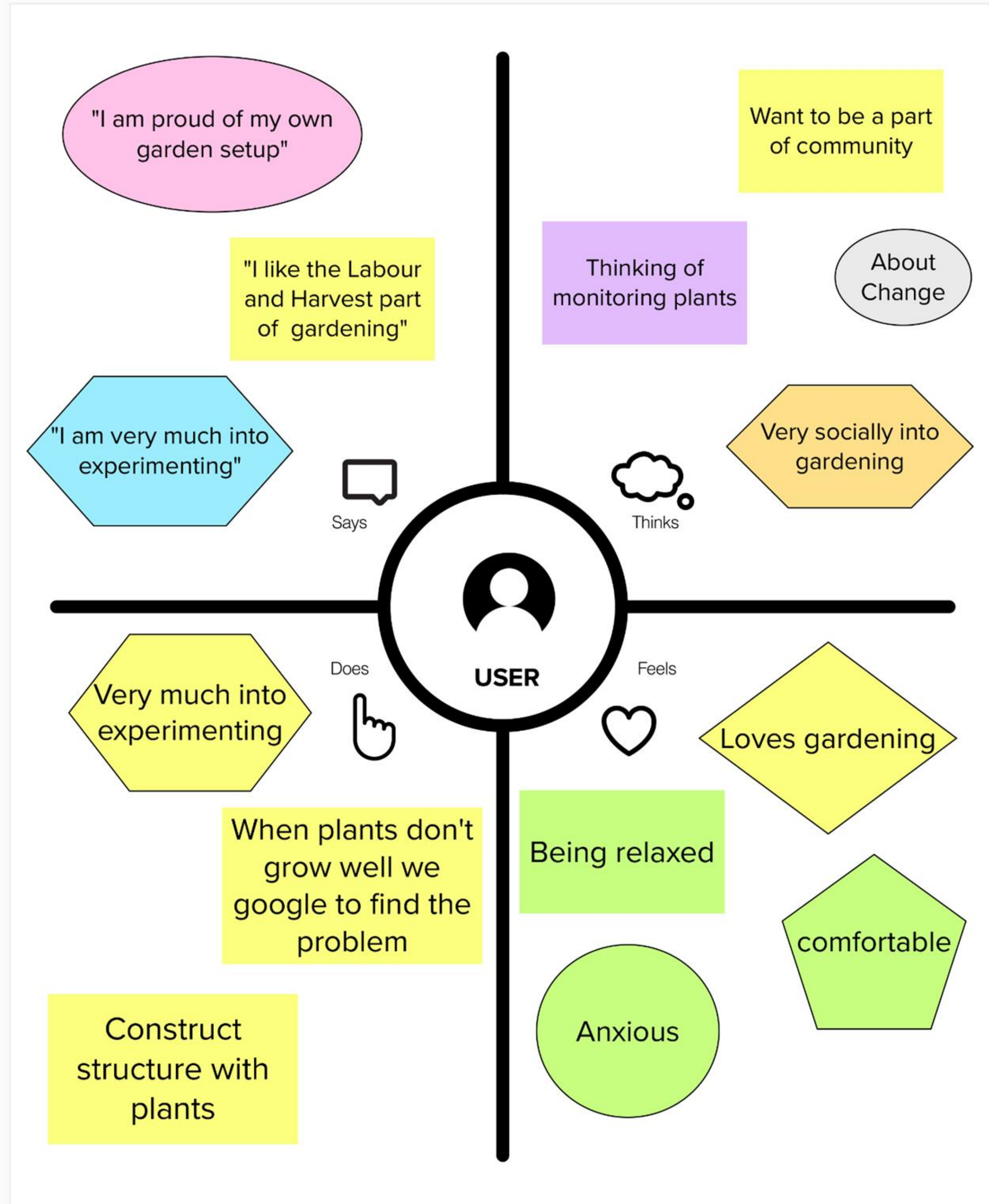
2.4 Problem Statement Definition

Customer Problem Statement Template: Kavinraja is a farmer, his brother completed Engineering course streamed in Electronic & Communication Engineering. His brother gave him the idea to improve agriculture with the help of the technology he learnt. It also helps him in reducing manpower. His brother is working on a new idea to improve the irrigation facility, soil fertility and crop rotation. This problem can be actively solved with the help of the application he is building.

I'm	I'm a farmer
I'm trying to	Increase the yield and reduce the labour
But	It increases cost as well as risk in managing.
Because	Of less income and higher expenditure
Which makes me feel	Angry and depressed

Example:

3.IDEATION AND PROPOSED SOLUTION



"I am proud of my own garden setup"
Want to be a part of community
"I like the Labour and Harvest part of gardening"
Thinking of monitoring plants
About Change
"I am very much into experimenting"
Very socially into gardening
Says
Thinks
USER
Does
Feels
Very much into experimenting
Loves gardening
When plants don't grow well we google to find the problem
Being relaxed
comfortable
Anxious
Construct structure with plants

3.2 Literature Survey

The author describes the increasing global population demands improved production to provide food in all sectors, especially in agriculture. Still, at certain periods, demand and supply will not match. Managing and sustaining capital and manpower is still a demanding challenge for improving agricultural production. Smart agriculture is a better option for growing food production, resource management, and labor.

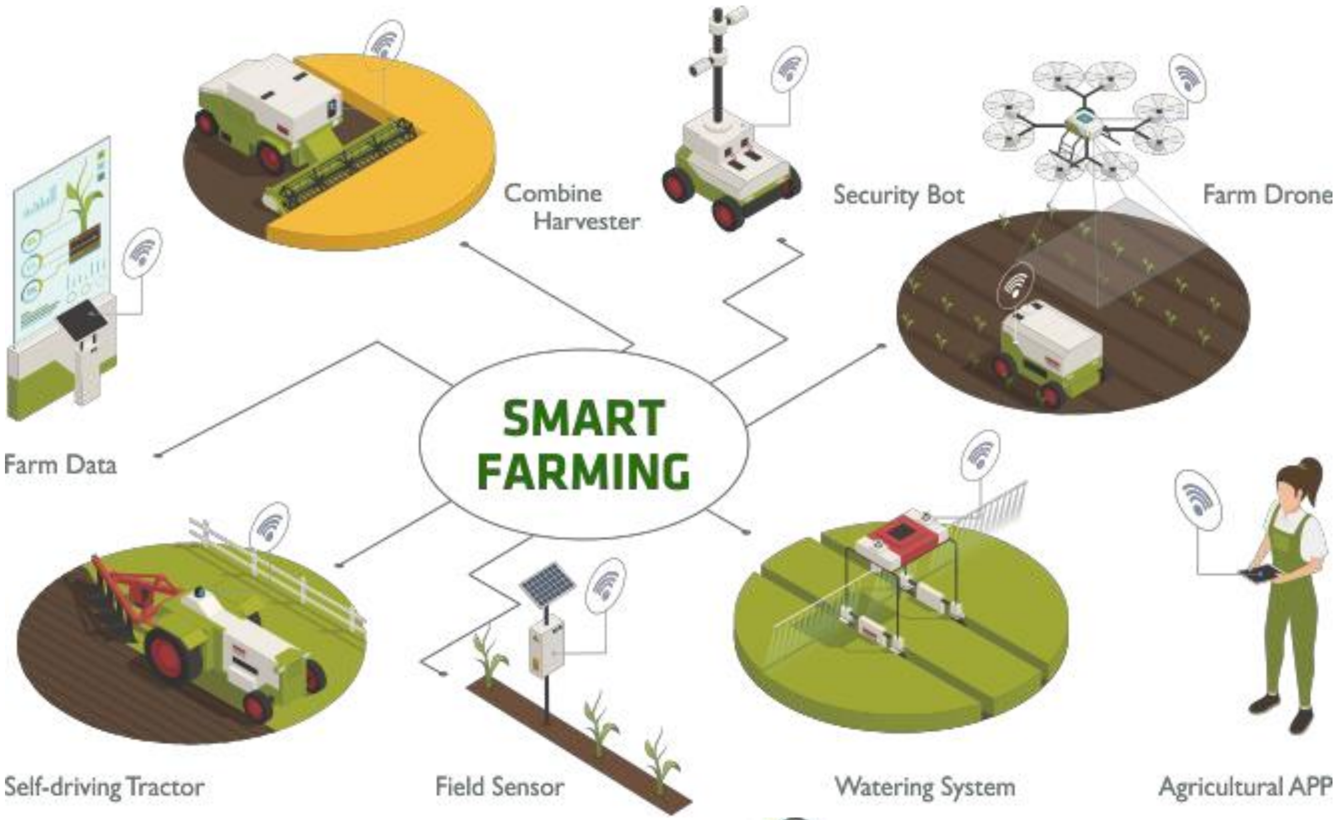
This research provides an overview of predictive analysis, Internet of Things (IoT) devices with cloud management, security units for multi-culture in the agriculture sector with considering farmer’s prior experiences.
And also highlights the challenges and complications expected while integrating modern technology in the traditional farming practice experience.

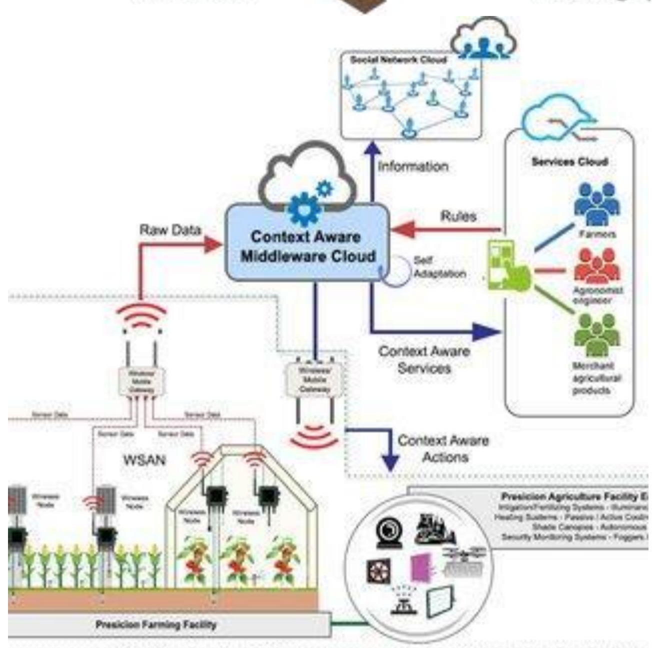
Based on the statistical and quantitative approaches gives betterrevolutionary changes in the current agriculture system. Besides, drone activation from IoT encounters crop status and stages, irrigation,plant leaves, diseases in the green field.

The sensors that are activated for various purposes in IoT are discussed. Modern agriculture with state-of-the-art IoT devices and concepts is the main objective of this research. The systematic evaluation provides current and future trends in the agriculture sector

Reference: Suma, V. (2021). Internet-of-Things (IoT) based Smart Agriculture in India? An Overview. *Journal of ISMAC*, *3*(01), 1-15.

3.3 Solution Architecture





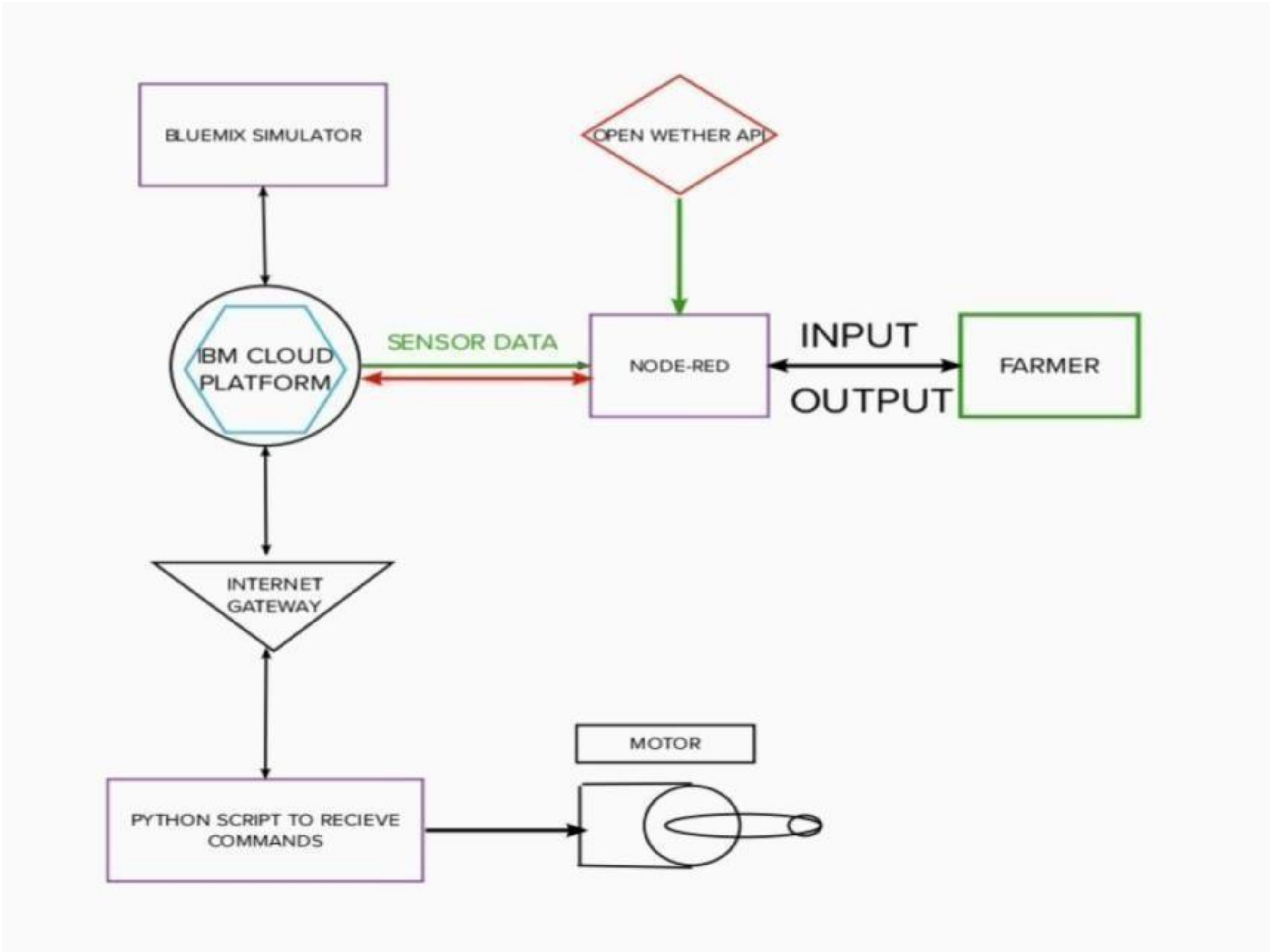
3.4 Problem Solution Fit

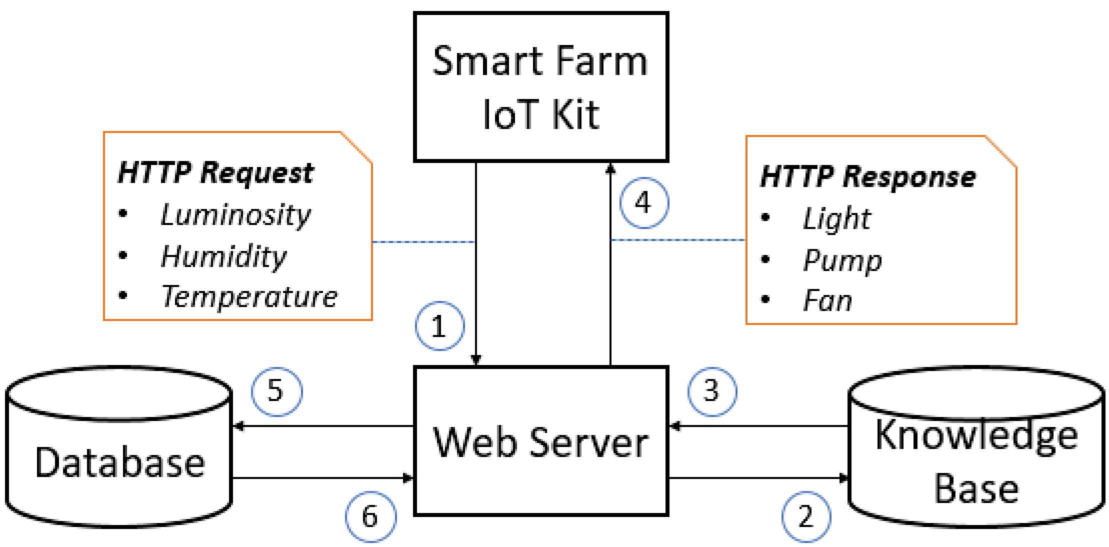
1.Customer segments:- The customer who are going to use this project includes Large Scale Farmers Small Scale Farmers	**6.Customer constrains:-** ___Lack of proper irrigation facilities, production machinery, and access to institutional credit, difficulties procuring inputs and storing products, and negative impacts of climate were identified as the major constraints to agricultural productivity	**5.Available solutions** Precision Agriculture, Crop Monitoring, Irrigation Management, Fertilizer Management Weather Forecasting are best solutions for provided for the farmers.
2.Jobs to be done :- Iot devices connects and interacts with each other,and the internet which means they can work together to send alert or automate other things such as sprinkler in an orchard	**9.Problem route cause:** ___By adopting Iot in the agricultural sector we get numerous benefits,but still, there are challenges faced by IoT in agricultural sectors.	**7.Behavior:-** The customer wants to make the revolutionary propagation in the rating of the irrigation through the reliability of amount of water availability on the land.
3.Triggers:- Smart farming reduces the ecological footprint of farming 4.Emotions:- Turning the face of conventional agriculture methods by not only making it optimal but also making it cost efficient for farmers and reducing crop wastage	**10.Solution:-** Our solution for this project is the smart irrigation facilities using IoT based on moisture and temperature	8.Channels of behavior:- The channels of behavior recombine the ratio of the following Online Offline

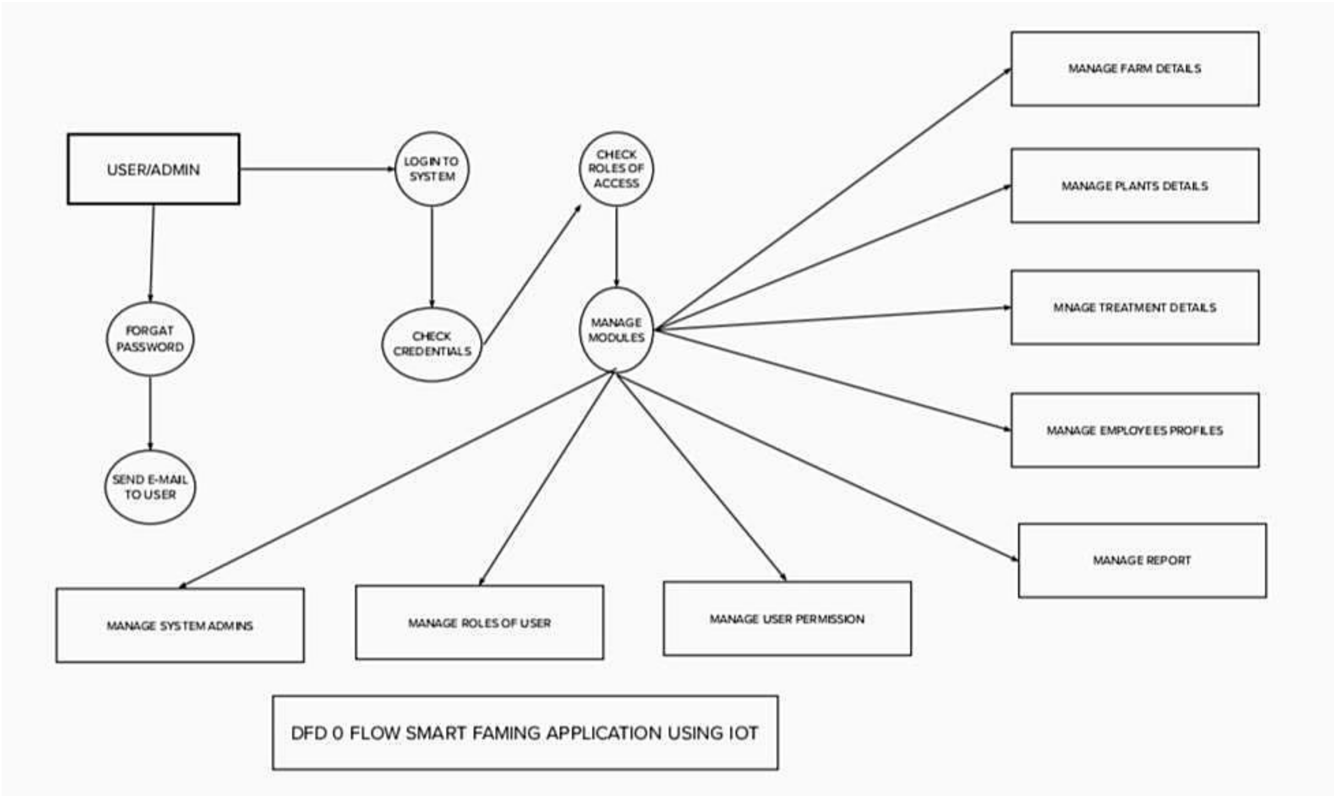
4.PROJECT DESIGN PHASE

4.1 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.


BLUEMIX SIMULATOR
OPEN WETHER API
IBM CLOUD PLATFORM
SENSOR DATA
NODE-RED
INPUT
OUTPUT
FARMER
INTERNET GATEWAY
MOTOR
PYTHON SCRIPT TO RECIEVE COMMANDS


Smart Farm IoT Kit
HTTP Request
Luminosity
Humidity
Temperature
HTTP Response
Light
Pump
Fan
1
2
3
4
5
6
Database
Web Server
Knowledge Base



The different soil parameters temperature, soil moistures and then humidity are sensed using
different sensors and obtained value is stored in the IBM cloud.
Arduino UNO is used as a processing Unit that process the data obtained from the sensors and
whether data from the weather API.
NODE-RED is used as a programming tool to write the hardware, software and APIs. The MQTT
protocol is followed for the 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, weather to water
the crop or not depending upon the sensor values. By using the app they can remotely operate to the motor switch.

4.2 Customer Journey Map

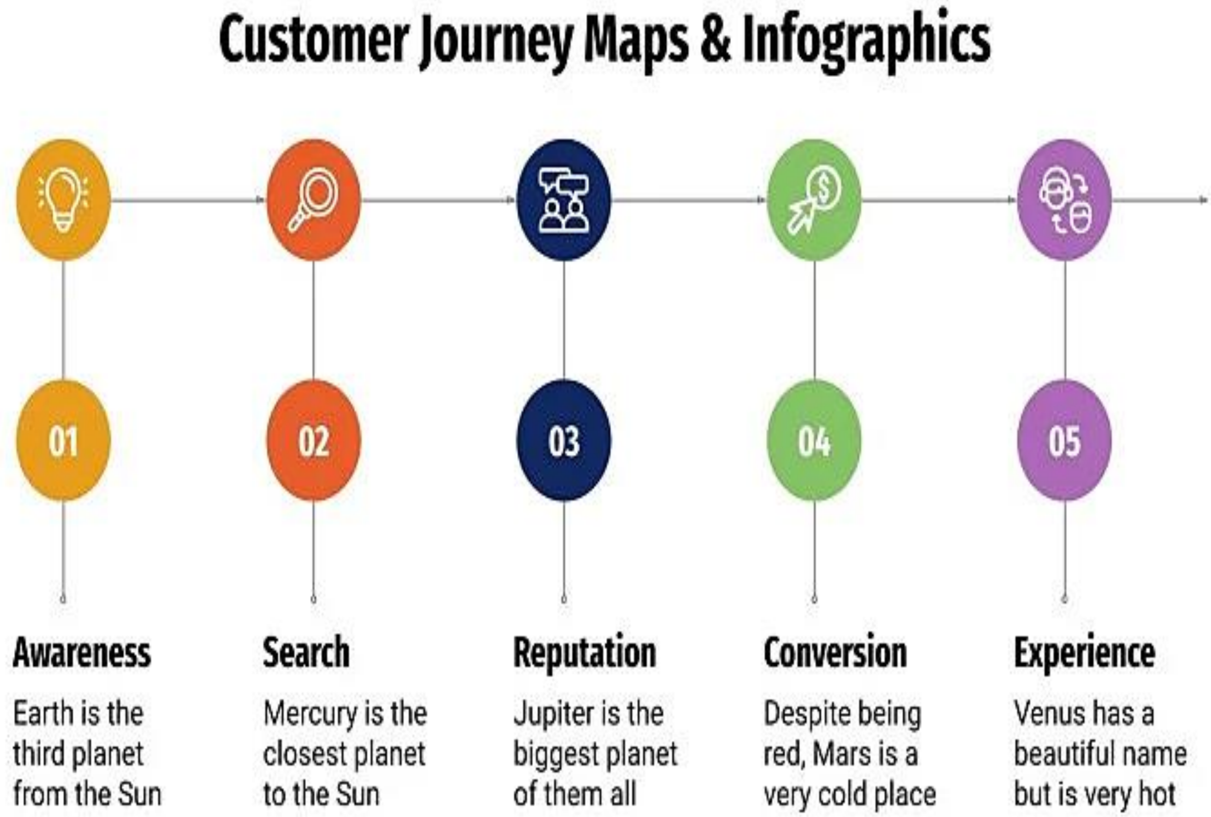
Awareness

Appeal

Ask

Act

Advocacy



4.3 Solution Requirements

4.3.1 Functional Reqirements

Functional requirements are **product features or functions that developers must implement to enable users to accomplish their tasks**. So, it's important to make them clear both for the development team and the stakeholders. Generally, functional requirements describe system behavior under specific conditions.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)

1	IoT devices	Sensors and Wi-Fi module.
2	Software	Web UI, Node-red, IBM Watson, MIT app

4.3.2 Non Functional Requirements

The non-functional requirements considered were cost, sensitivity, design complexity, storage capacity, development process, response criteria, and environmental impact.

Non-functional requirements or NFRs are a set of specifications that describe the system's operation capabilities and constraints and attempt to improve its functionality

Performance

Scalability

Portability

Compatibility

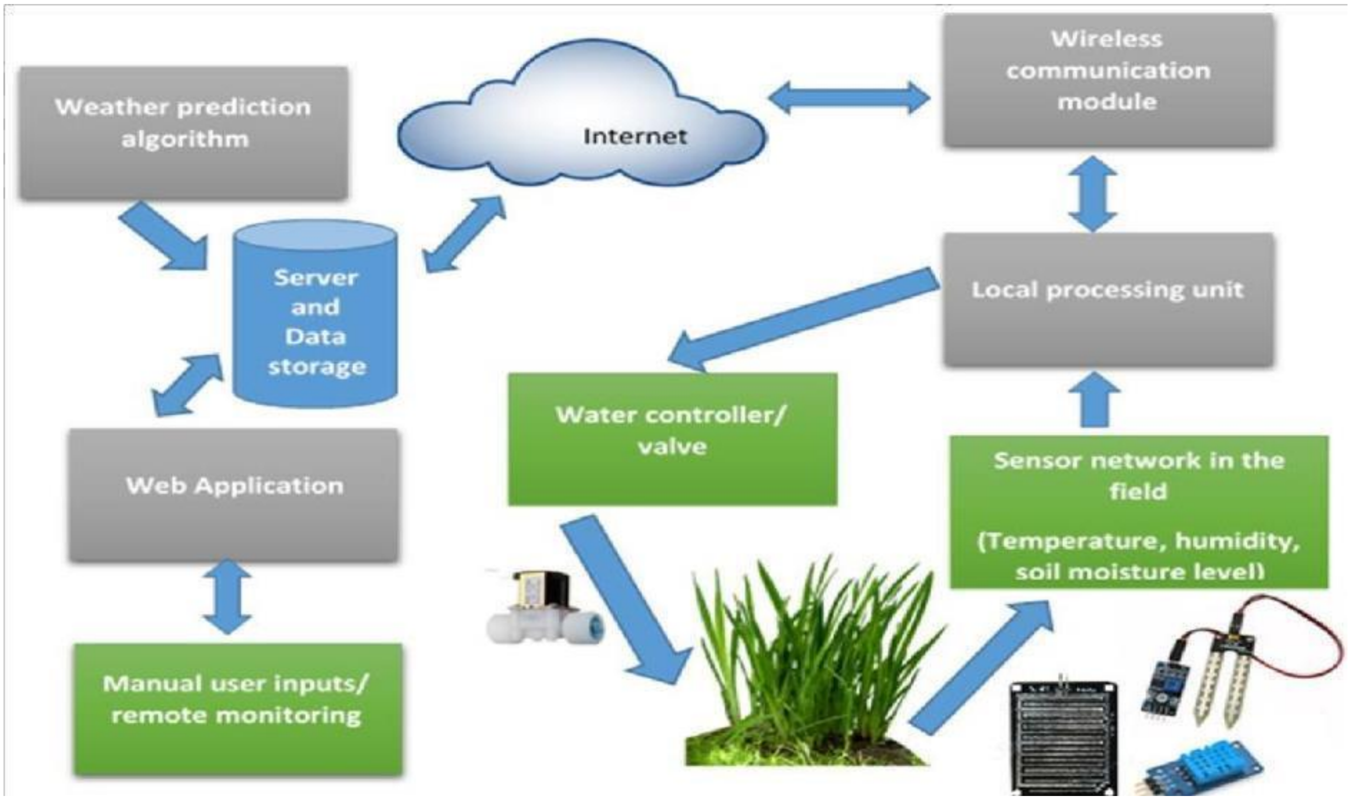
Reliability

Maintainability and Availability.

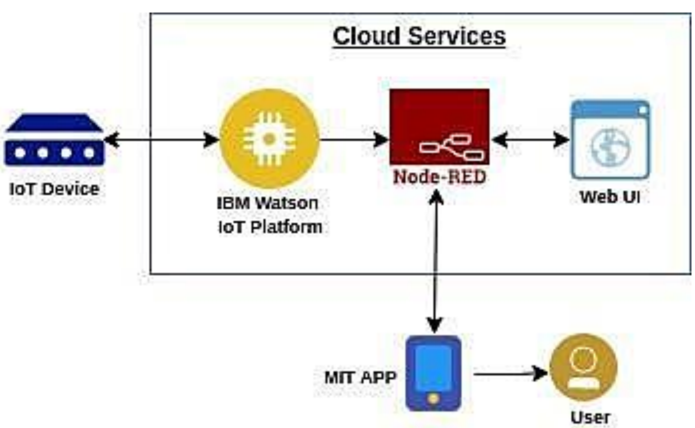
FR NO	Non-functional requirement	Description
1.	**Usability**	Time consumability is less, Productivity is high.
2.	**Security**	

		It has low level of security features due to integration of sensor data.
3.	**Reliability**	Data is more accurate and hence it is Reliable.
4.	**Performance**	Performance is high and highly productive.
5.	**Availability**	With permitted network connectivity the application is accessible
6.	**Scalability**	It is perfectly scalable many new constraints can be added

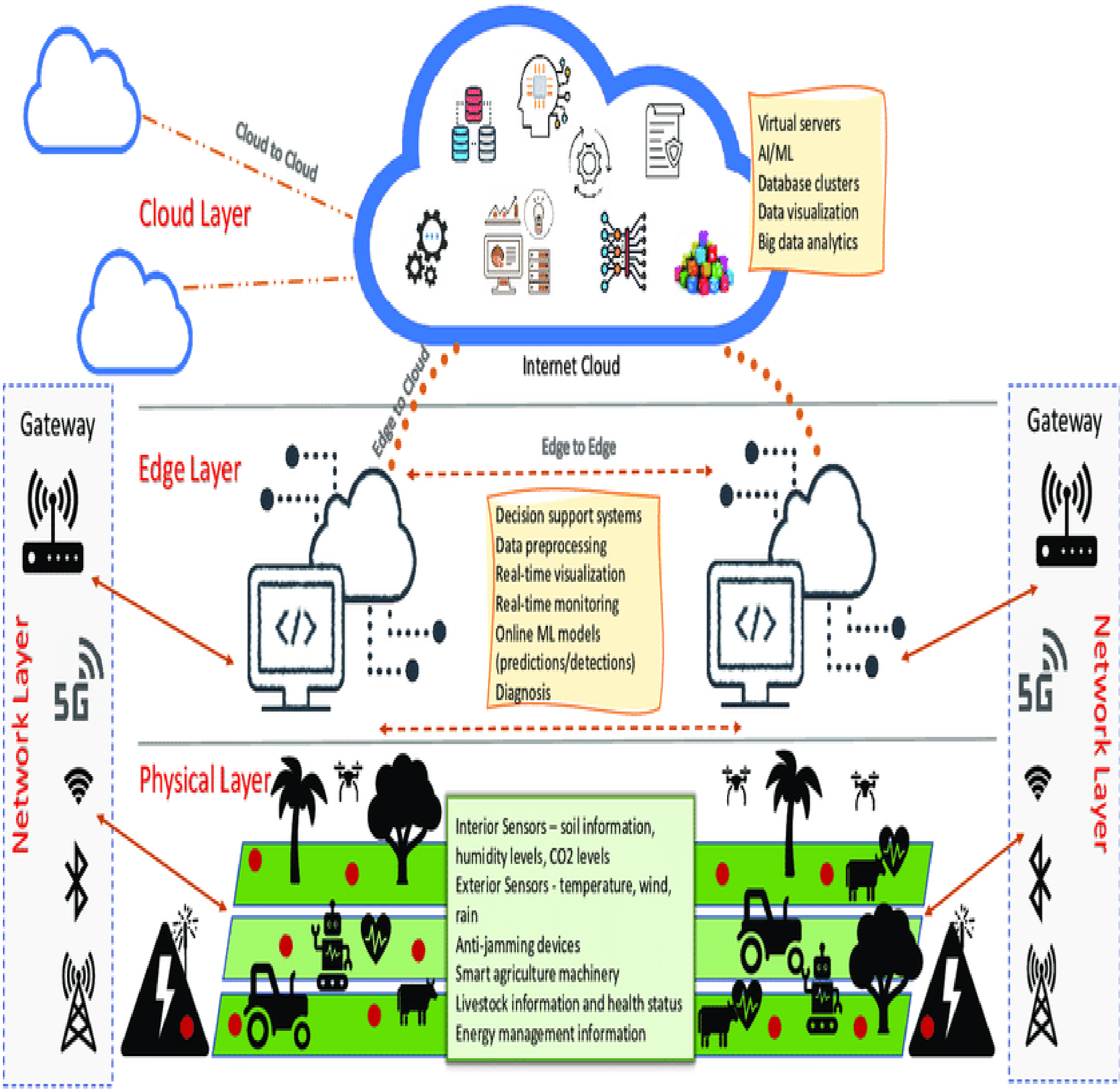
4.4 Technical Architecture



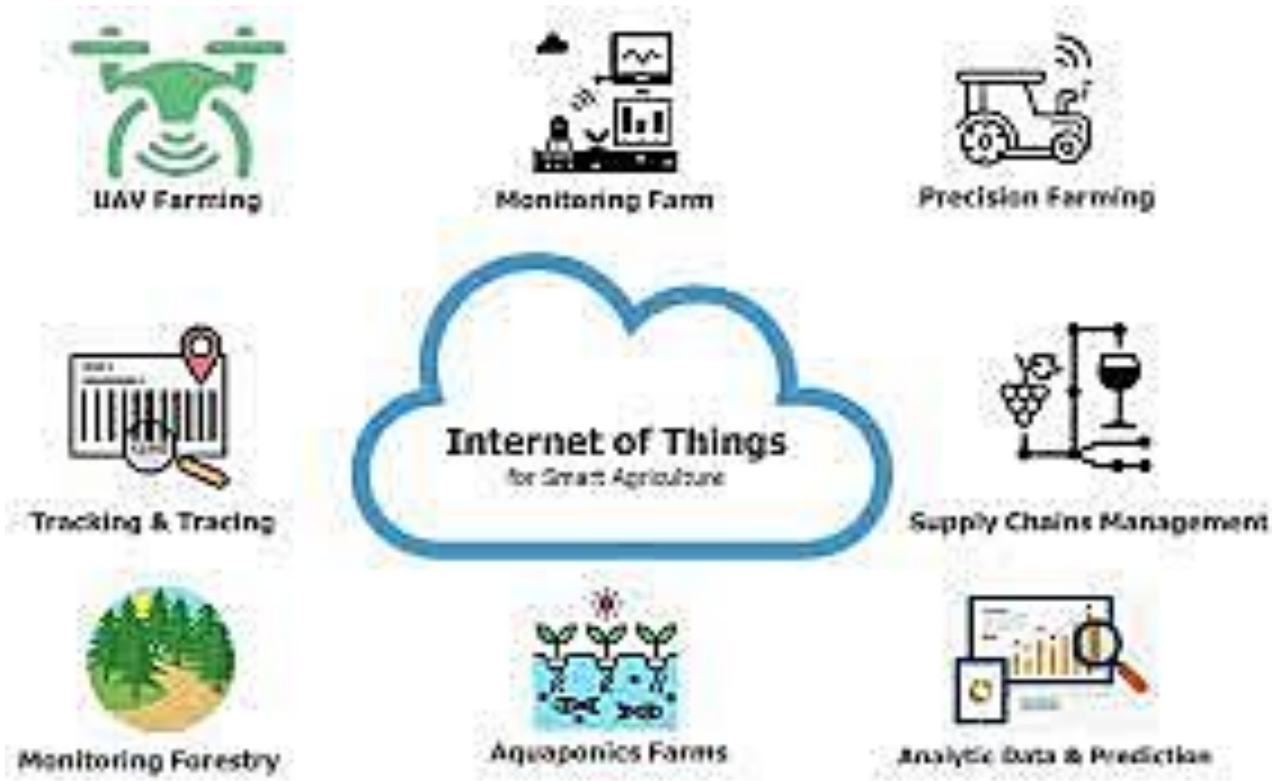
Weather prediction algorithm
Internet
Wireless communication module
Server and Data storage
Local processing unit
Water controller/ valve
Web Application
Sensor network in the field
(Temperature, humidity, soil moisture level)
Manual user inputs/ remote monitoring



Cloud Services
IoT Device
IBM Watson IoT Platform
Node-RED
Web UI
MIT APP
User



Cloud to Cloud
Cloud Layer
Virtual servers
AI/ML
Database clusters
Data visualization
Big data analytics
Internet Cloud
Edge to Cloud
Gateway
Edge Layer
Edge to Edge
Decision support systems
Data preprocessing
Real-time visualization
Real-time monitoring
Online ML models
(predictions/detections)
Diagnosis
Gateway
5G
Network Layer
5G
Network Layer
Physical Layer
Interior Sensors – soil information,
humidity levels, CO2 levels
Exterior Sensors - temperature, wind,
rain
Anti-jamming devices
Smart agriculture machinery
Livestock information and health status
Energy management information



5.PROJECT PLANNING & SCHEDULING

5.1 Sprint Delivery Plan

Sprint	Functional requirement(epic)	User story Number	User Story/task	story points	priority
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High
Sprint-1		USN-3	As a user, I can register for the application through Gmail (Screen-2)	1	Medium

Sprint-1	Login	USN-4	As a user, I can login to the application through email & Password (Screen-2)	2	High
Sprint-2		USN-5	If I forgot my password or username, I can reset it again through my email	1	Low
Sprint-2	Web	USN-6	Accessing node-red dashboard	2	High
Sprint-2		USN-7	As a user, I can able view status of my field in web using the node-red link	1	Low
Sprint-3	Application	USN-8	Adding screen-3 in the application to display details of the screen.	1	High
Sprint-3		USN-9	Connecting node-red dashboard to my application to view the farm details, weather and automatic motor on/off & light on/off.	1	High
Sprint-3	Hardware	USN-10	Creating circuit connection for the project in Wokwi using ESP32.	2	High
Sprint-4	Python Script	USN-10	Writing python script and connect it to the hardware	1	High

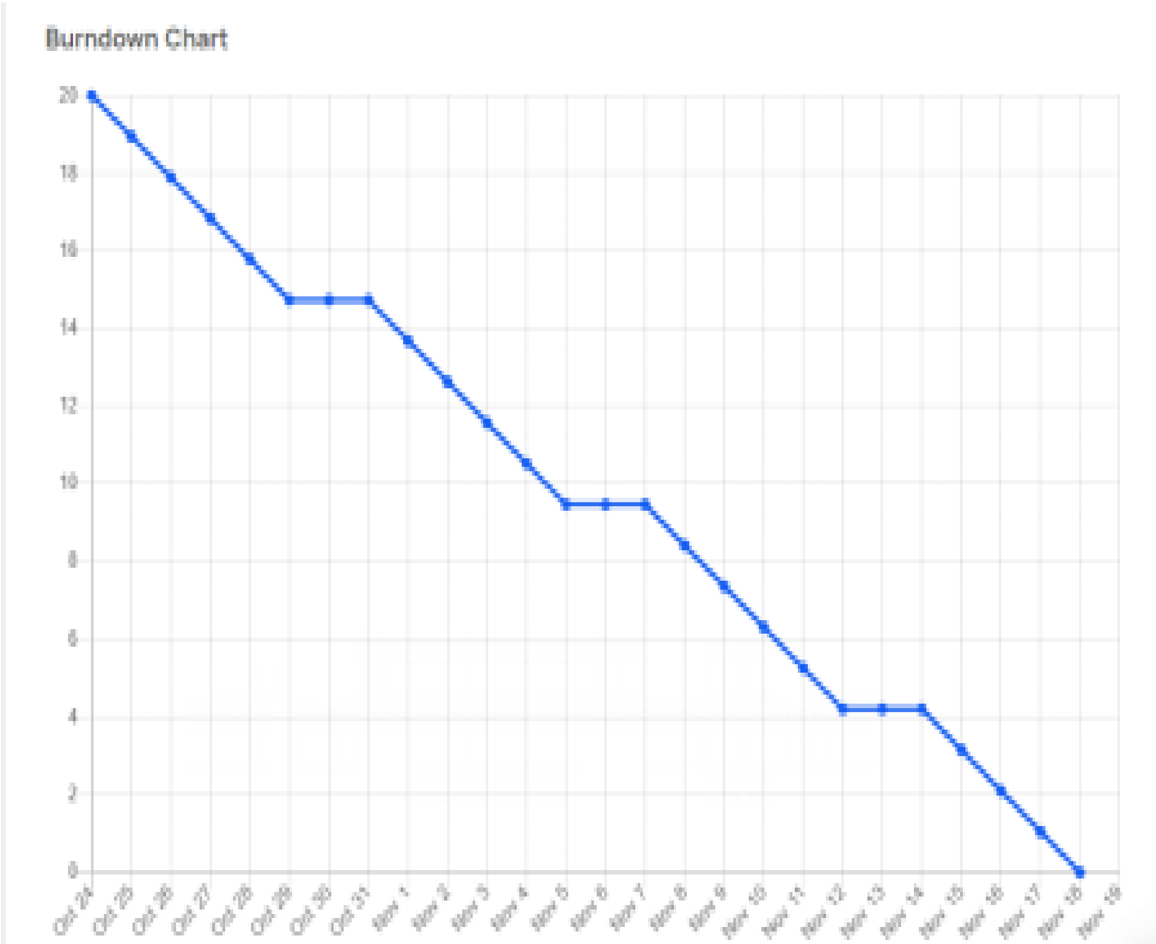
Sprint-4	Application	USN-11	Connecting Application to the Hardware and cloud	1	High
Sprint-4		USN-12	r and I can on/off motor and ligh	1	High

Project Tracker, Velocity & Burndown Chart: (4 Marks)

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	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

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’s average velocity (AV) per iteration unit (story points per day)



5.2 Milestone Activity List

TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the technical papers, research publications etc.	3 SEPTEMBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements	10 SEPTEMBER 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	17 SEPTEMBER 2022

Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	24 SEPTEMBER 2022
Problem Solution Fit	Prepare problem - solution fit document.	01 OCTOBER 2022
Solution Architecture	Prepare Solution architecture document.	01 OCTOBER 2022
Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	08 OCTOBER 2022
Functional Requirement	Prepare the functional requirement document.	15 OCTOBER 2022
Data Flow Diagrams	Draw the data flow diagrams and submit for review.	15 OCTOBER 2022

Technology Architecture	Prepare the technology architecture diagram.	15 OCTOBER 2022
Prepare Milestone & Activity List, Sprint Schedules	Prepare the milestones & activity list of the project.	22 OCTOBER 2022
Project Development - Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed code by testing it.	24 OCTOBER 2022 – 19 NOVEMBER 2022

6. CODING & SOLUTION

6.1 Web Application Using Node-RED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"id": "f1ebac02e2968dd6",
"type": "function",
"z": "931153a67f419cc7",
"name": "command function node",
"func": "msg.payload=msg.payload.command\nreturn msg;",
"outputs": 1,
"noerr": 0,
"initialize": "",
"finalize": "",
"libs": [],
"x": 450,
"y": 380,
"wires": [
[
"88109f6551c2547c",
"e17f84198e248fc6",
"685020225491f9c8"
]
]
},
{
"id": "b2ede069630b4886",
"type": "ibmiot",
"name": "", "keepalive": "60",
"serverName": "",
"cleansession": true,
"appId": "",
"shared": false
},
{
"id": "04aec9e1fb3d61bc",
"type": "ui_group",
"name": "Weather Monitoring",
"tab": "c784f3676be6e912",
"order": 1,
"disp": true,
"width": "6",
```

"collapse": false,
"className": ""
},
{
"id": "c784f3676be6e912",
"type": "ui_tab",
"name": "Control",
"icon": "dashboard",
"disabled": false,
"hidden": false
}
]

6.2 Python script on Iot platform

```
import wiotp.sdk.device
import time
import os
import datetime
import random
myConfig = {
"identity": {
"orgId": "u9qhfi",
"typeId": "Devicetypel",
"deviceId": "DeviceID1"
},
"auth": {
"token": ")hSb7_ZD+evl2fRhXi"
} }
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 ()
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 ("Published data Successfully: %s", myData)
 time.sleep (2)
client.commandCallback = myCommandCallback
client.disconnect ()
```

7 . TESTING

7.1 Test Cases

			NFT - Risk Assessment						
S.No	Modules	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Volume Changes	Risk Score	Justification
1	Node Red	New	Low	No Changes	Moderate	Time Complexity	>5 to 10%	ORANGE	As we have seen the changes
2	IoT simulator	New	High	No Changes	Moderate	Time Complexity	5%	ORANGE	seen changes
3	Devices	New	High	No Changes	High	none	10%	GREEN	No changes

NFT - Detailed Test Plan				
S.No	Project Overview	NFT Test approach	Assumptions/Dependencies/Risks	Approvals/SignOff
1	Connects simulator with node-red	good	Assumptions	Approvals

			End Of Test Report					
S.No	Project Overview	NFT Test approach	NFR - Met	Test Outcome	GO/NO-GO decision	Recommendations	Identified Defects (Detected/Closed/Open)	Approvals/SignOff
1	connects with web application and mobile application			Good performance	GO	None	Open	Approval

NFT - RA | DTP

7.2 User Acceptance Testing

The purpose of this document is to briefly explain the test coverage and open issues of the “SmartFarmer -IoT Enabled Smart Farming Application”project at the time of the release to UserAcceptance Testing (UAT). Increasing control over production leads to better cost management and waste reduction. The ability to trace anomalies in crop growth or livestock health, for instance, helps eliminate the risk of losing yields. Additionally, automation boosts efficiency. Smart farming reduces the ecological footprint of farming. Minimized or site-specific application of inputs, such as fertilizers and pesticides, in precision agriculture systems will mitigate leaching problems as well as the emission of greenhouse.This report shows the number of resolved or closed bugs at each severity level, and howthey were resolved.This report shows the number of cases that have passed, failed, and untested.

Defect Analysis

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	8	3	2	2	16
Duplicate	1	0	2	0	3
External	2	3	0	1	6
Fixed	9	2	3	17	31
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	1	4	1	1	7
Totals	21	12	9	22	66

Test Analysis

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	5	0	0	5
Client Application	30	0	0	30
Security	2	0	0	2
Outsource Shipping	2	0	0	2
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	1	0	0	1

8. RESULT:

8.1 Performance Metrics

Hence a helpful and useful system is built for farmers to assist them in farming and also prevent them from natural calamities. It also saves farmers time to maintain all these things as this is working on cloud he can turn on/off motor from anywhere so basically it helps farmers and make them relived thus helping our economy to grow.

9.ADVANTAGES & DISADVANTAGES:

Advantage:

• monitoring weather parameters such as temperature, pressure, humidity, soil moisture remotely controlling motors easily through buttons
• alert farmers in case of any calamities
• threshold values are set any anomalies will be reported to the farmer
• user friendly and efficient
• low cost

Disadvantage:

• sensors may sometime malfunction
• maybe inaccurate sometimes
• farmer needs internet connectivity
• farmer must have a phone and have basic knowledge to operate it

Applications:

• Monitoring of Climate Conditions -Probably the most popular smart agriculture gadgets are weather stations, combining various smart farming sensors. Located across the field, they collect various data from the environment and send it to the cloud. The provided measurements can be used to map the climate conditions, choose the appropriate crops, and take the required measures to improve their capacity (i.e. precision farming).• Greenhouse Automation-In addition to sourcing environmental data, weather stations can automatically adjust the conditions to match the given parameters. Specifically, greenhouse automation systems use a similar principle.

• Crop Management - One more type of IoT product in agriculture and another element of precision farming is crop management devices. Just like weather stations, they should be placed in the field to collect data specific to crop farming; from temperature and precipitation to leaf water potential and overall crop health, these can all be used to readily collect data and information for improved farming practices.

• Cattle Monitoring and Management-Just like crop monitoring, there are IoT agriculture sensors that can be attached to the animals on a farm to monitor their health and log performance. This works similarly to IoT devices for pet care.

• End-to-End Farm Management Systems-A more complex approach to IoT products in agriculture can be represented by the so-called farm productivity management systems. They usually include a number of agriculture IoT devices and sensors, installed on the premises as well as a powerful dashboard with analytical capabilities and in-built accounting/reporting features.

10.CONCLUSION:

Smart Farming and IoT-driven agriculture are paving the way for what can be called a Third Green Revolution.The Third Green Revolution is taking over agriculture. That revolution draws upon the combined application of data-driven analytics technologies, such as precision farming equipment, IoT, “big data” analytics, Unmanned Aerial Vehicles (UAVs or drones), robotics, etc.In the future this smart farming revolution depicts, pesticide and fertilizer use will drop while overall efficiency will rise. IoT technologies will enable better food traceability, which in turn will lead to increased food safety. It will also be beneficial for the environment, for example, more efficient use of water, or optimization of treatments and inputs.Therefore, smart farming has a real potential to deliver a more productive and sustainable form of agricultural production, based on a more precise and resource-efficient approach. New farms will finally realize the eternal dream of mankind.

11.FUTURE SCOPE:

With the exponential growth of world population, according to the UN Food and Agriculture Organization, the world will need to produce 70% more food in 2050, shrinking agricultural lands, and depletion of finite natural resources, the need to enhance farm yield has become critical. Limited availability of natural resources such as fresh water and arable land along with slowing yield trends in several staple crops, have further aggravated the problem. Another impeding concern over the farming industry is the shifting structure of agricultural workforce. Moreover, agricultural labor in most of the countries has declined. As a result of the declining agricultural workforce, adoption of internet connectivity solutions in farming practices has been triggered, to reduce the need for manual labor.IoT solutions are focused on helping farmers close the supply demand gap, by ensuring high yields, profitability, and protection of the environment. The approach of using IoT technology to ensure optimum application of resources to achieve high crop yields and reduce operational costs is called precision agriculture. IoT in agriculture technologies comprise specialized equipment, wireless connectivity, software and IT services.

12.APPENDIX

Git repo link : https://github.com/IBM-EPBL/IBM-Project-33345-1660218835
Demo link : https://youtu.be/nFgit-ieuCQ