SmartFarmer - IoT Enabled Smart Farming Application

Vel Tech Multi Tech. Dr. Rangarajan Dr. Sakunthala

Engineering College

Nalaiya Thiran - Project Report

Team ID: PNT2022TMID22317

Kaviya S – 113119UG03046

Keerthika J – 113119UG03048

DandoluLakshmithaReddy-113119UG03017

Swetha S-113119UG03107

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1. INTRODUCTION

1.1 Project Overview

India is agriculture sector, on either side, is losing ground every day, affecting the ecosystem's output capacity. In order to restore vitality and put agriculture back on a path of higher growth, there is a growing need to resolve the issue. A large-scale agricultural system necessitates a great deal of upkeep, knowledge, and oversight. The IoT is a network of interconnected devices that can transmit and receive data over the internet and carry out tasks without human involvement. Following the plant breeding and genetics revolutions, this Third Green Revolution is taking over the agricultural world based upon the combined application of ICT solutions such as precision equipment, the Internet of Things (IoT), sensors and actuators, geo-positioning systems, Big Data, Unmanned Aerial Vehicles (UAVs, drones), robotics, etc.Agriculture provides a wealth of data analysis parameters, resulting in increased crop yields. The use of IoT devices in smart farming aids in the modernization of information and communication. For better characteristics for data analysis with the goal of assisting users in making better agricultural decisions using IoT. The technique is intended to help farmers increase their agricultural output. Keywords: Soil, Rain, Sensors, IoT Smart Irrigation.

1.2 Purpose:

We have tried to focus on different scientific applications which could be put together in the agricultural field for better accuracy with better productivity using less manpower. Moreover, we include a method for monitoring the agricultural fields from any remote location and assess the basic condition of the field.This is the project from the motivation of the farmers working in the farmlands are solely dependent on the rains and bore wells for irrigation of their land. In recent times, the farmers have been using irrigation technique through the manual control in which the farmers irrigate the land at regular.By making farming more connected and intelligent, precision agriculture helps **reduce overall costs and improve the quality and quantity of products, the sustainability of agriculture and the experience for the consumer**. Increasing control over production leads to better cost management and waste reduction. To give the precise amount of data needed for crop which the farmer selects as their major cultivation product. Thus SmartFarmer with iot enabled smart farming application makes user simple and easier control of crop selection, cultivation and production.

2. LITERATURE SURVEY

Literature reviews **allow us to gain familiarity with the current knowledge in our chosen field, as well as the boundaries and limitations of that field**. Literature reviews also help us to gain an understanding of the theory(ies) driving the field, allowing us to place your research question into context.

2.1 Existing problem

a) Soil Monitoring Management was done as single project by ***Divya J., Divya M.,Janani V."*** IoT based Smart Soil Monitoring System for Agricultural Production" 2017. The purpose of this project is to create an embedded-based soil monitoring and irrigation system that will reduce manual field monitoring and provide information via a mobile app. The method is intended to help farmers increase their agricultural output. A pH sensor, a temperature sensor, and a humidity sensor are among the tools used to examine the soil. Based on the findings, farmers may plant the best crop for the land.

b) Irrigation management was done as a project with disadvantages ***by Dweepayan Mishra1 ,Arzeena Khan2 Rajeev Tiwari3 , Shuchi Upadhay,***"Automated Irrigation System-IoT Based Approach",2018. This research proposes a terrain-specific programmable water system that will save human work while simultaneously improving water efficiency and agricultural productivity. The setup is made up of an Arduino kit, a moisture sensor, and a Wi-Fi module. Data is acquired by connecting our experimental system to a cloud framework. After then, cloud services analyse the data and take the necessary actions.

c) Collection of yield data with new production of crops using data analytics was done by ***Zuraida Muhammad, Muhammad Azri Asyraf Mohd Hafez***. The Internet of Things (IoT) is increasingly being utilised to connect objects and collect data. As a result, the Internet of Things' use in agriculture is crucial. The idea behind the project is to create a smart agriculture system that is connected to the internet of things.

d) ***CH.Nishanthi, D.Naveen, CH.Sai Ram, K.Divya, R.Ajaykumar***.The agriculture industry is developed a lot with the help of technology; it became data-centered and smarter. The rapid growth of the Internet of Things based technologies reshaped many industries, including agriculture. Such a radical change dismantles existing farming practices and creates new opportunities along with some challenges.

2.2 References

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[9]PaparaoNalajala, P Sambasiva Rao, Y Sangeetha, Ootla Balaji, K Navya," Design of a Smart Mobile Case Framework Based on the Internet of Things", Advances in Intelligent Systems and Computing,

2.3 Problem Statement Definition

IoT-based agriculture system helps the farmer in monitoring different parameters of his field like soil moisture, temperature, and humidity using some sensors. Farmers can monitor all the sensor parameters by using a web or mobile application even if the farmer is not near his field. Watering the crop is one of the important tasks for the farmers. They can make the decision whether to water the crop or postpone it by monitoring the sensor parameters and controlling the motor pumps from the mobile application itself.

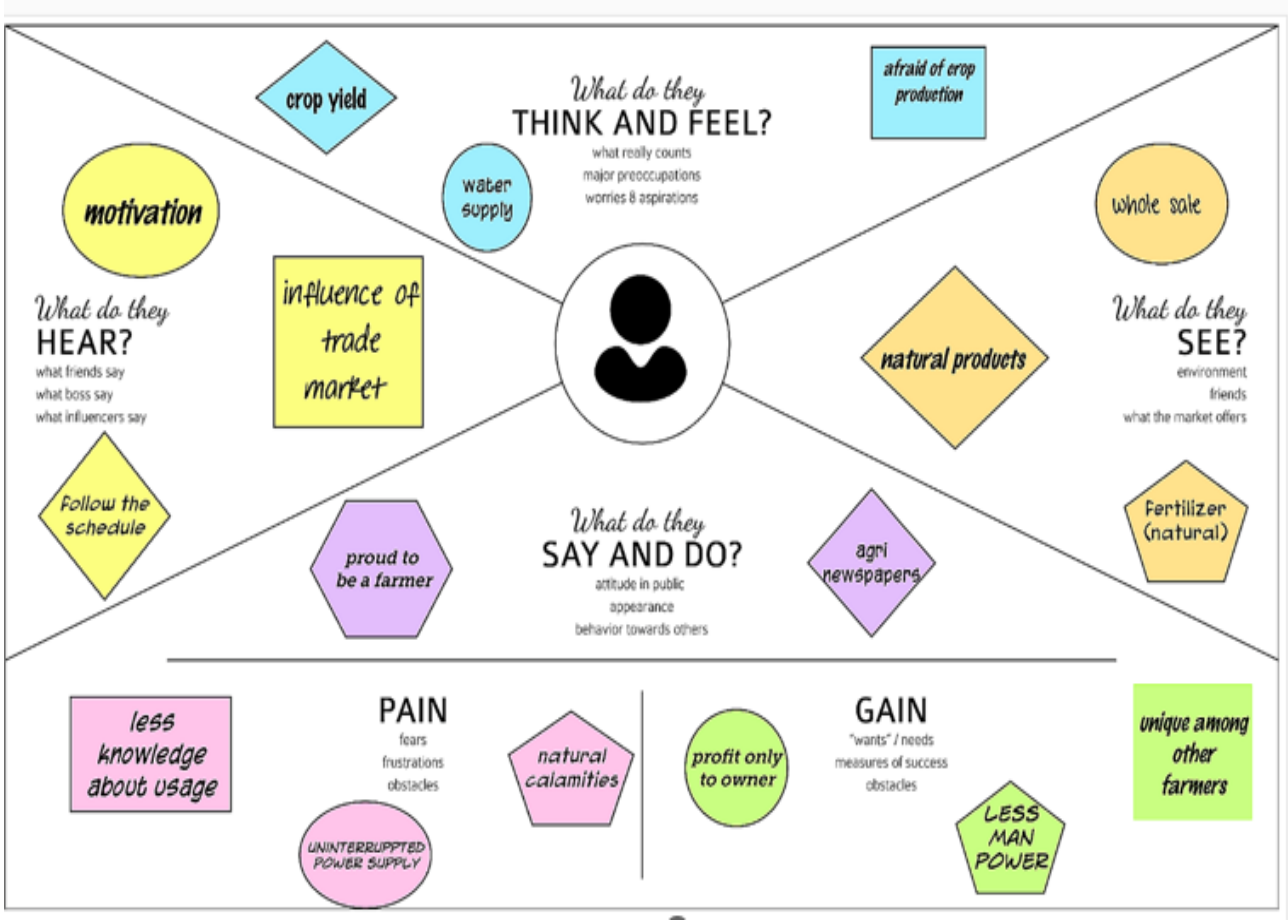
More Timely, More Accessible	**Strategic Precision Targeting for use by a select few, to a Need for Tactical Precision Targeting for every warfighter** • Sensor data rates continue to outstrip available data link bandwidths, exacerbated by jamming • Ground-based exploitation cells introduce too much latency for time-sensitive targeting • Warfighters don't believe they will get appropriate sensing support when they need it
Persistent, Accurate Surveillance	**Multiple platforms are needed for persistence** • Single sensor platforms don't collect adequate target information • Difficult targets in heavy clutter require interoperable platforms that can cooperatively find, classify and track targets (peer-to-peer)
Size, Weight, & Power Efficient	**Proliferation of sensors on platforms is begetting ever more costly tradeoffs in SWaP**

3. Ideation and Proposed Solution

Ideation is the process where you generate ideas and solutions through sessions such as Sketching, Prototyping, Brainstorming, Brain writing, Worst Possible Idea, and a wealth of other ideation techniques. Ideation is also the third stage in the Design Thinking process. Although many people might have experienced a "brainstorming" session before, it is not easy to facilitate a truly fruitful ideation session. In this article, we'll teach you some processes and guidelines which will help you facilitate and prepare for productive, effective, innovative and fun ideation sessions Ideation is often the most exciting stage in a Design Thinking project, because during Ideation, the aim is to generate a large quantity of ideas that the team can then filter and cut down into the best, most practical or most innovative ones in order to inspire new and better design solutions and products.

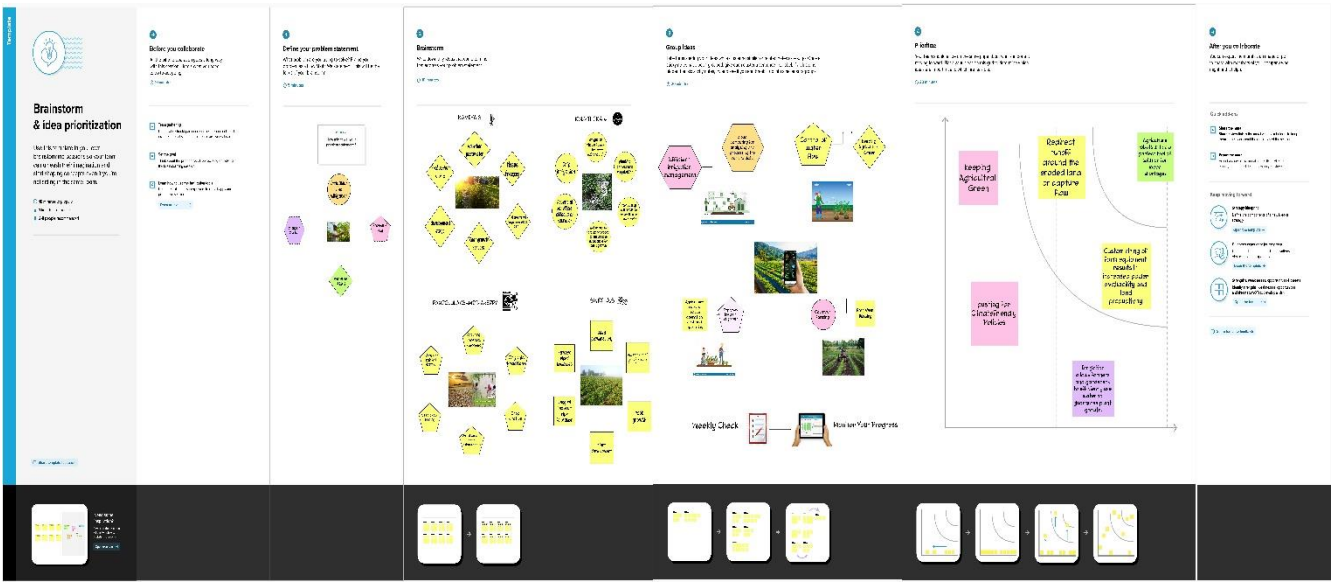
3.1 Empathy Map Canvas

An empathy map is **a collaborative tool teams can use to gain a deeper insight into their customers**. Much like a user persona, an empathy map can represent a group of users, such as a customer segment. The empathy map was originally created by Dave Gray and has gained much popularity within the agile community.



3.2 Ideation & Brainstorming

Ideation is **the process of forming ideas from conception to implementation, most often in a business setting**. Ideation is expressed via graphical, written, or verbal methods, and arises from past or present knowledge, influences, opinions, experiences, and personal convictions. Brainstorming is a method of generating ideas and sharing knowledge to solve a particular commercial or technical problem, in which participants are encouraged to think without interruption. Brainstorming is a group activity where each participant shares their ideas as soon as they come to mind. At the conclusion of the session, ideas are categorised and ranked for follow-on action.



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3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Aids the farmer in regulating motor pumps from a mobile application and monitoring several field factors, such as soil moisture, temperature, and humidity, using sensors.
2.	Idea / Solution description	We can offer a solution using the Smart Farming Application system, which was created for automating the irrigation system and using sensors to monitor the agricultural area.
3.	Novelty / Uniqueness	Gather information on the various types of soil and make predictions about the yield to determine which soils will be most effective for growing a particular crop.
4.	Social Impact / Customer Satisfaction	Customers and farmers will benefit from this application's improved understanding of key farming components like water, vegetation, and soil kinds.

5.	Business Model (Revenue Model)	We will provide free access to this app for the first month. After that, users will learn more about the app's effectiveness. Then, based on their convenience, users can use this application by purchasing a premium subscription for a month or a year.
6.	Scalability of the Solution	Our product has the potential to develop because smart farming is a new technology that is being developed.Reduce the strain on farmers; Easy to monitor and control; Adopt and understand new technology.

The project team shall fill in the following information in the proposed solution

Problem Statement (Problem to be solved) -

Aids the farmer in regulating motor pumps from a mobile application and monitoring several field factors, such as soil moisture, temperature, and humidity, using sensors.

Idea / Solution description -

We can offer a solution using the Smart Farming Application system, which was created for automating the irrigation system and using sensors to monitor the agricultural area.

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Scalability of the Solution -

Our product has the potential to develop because smart farming is a new technology that is being developed.

3.4 Problem Solution fit

Problem-solution fit is **a term used to describe the point validating that the base problem resulting in a business idea really exists and the proposed solution actually solves that problem**. Validate that the problem exists: When you validate your problem hypothesis using real-world data and feedback.

1.customer segment:	**5.customer:**	**8.Available solution:**
The primary clients for our task are: i) Farmers who need to Work on the yield of their harvests. ii) Ranchers who need to know the state of their harvests and it Natural circumstances so they can take the fundamental techniques right away.	Network availability would be the principal limitation as we use Wi-Fi which has major impediments like in inclusion, versatility and power utilization.	For smart farming, parcel of it based arrangements are there. However, ,one gigantic detriment of brilliant cultivating is that it requires a limitless or consistent web association to find success. This means that in rustic networks, particularly in the agricultural nations where we have mass crop creation, it is totally difficult to work this cultivating strategy.

2.Jobs to be done/Problem:	**6.Problem root cause:**	**9.Behaviour:**
The farmers will initially find it hard to use the device as they have to get familiar with the technologies. ii)They must be with their phone/laptop always so that they would be alarmed when they get the message/mail.	Technologies keep developing but still the farmers are not able to achieve their goals(i.e.) receiving the expected profit due to various reasons like the presence of excess water in the field, varying climatic conditions etc which affects the crop.	IoT applications help farmers to collect data regarding the location, well-being, and health of their crops. Weather stations equipped with smart sensors can collect weather data and send useful information to a farmer.

3.Trigger:	7.Your solution:	10.channels of behavior:
Customers get triggered mainly because to save their crops and to prevent them from the damage as they feel depressed when they face the losses and it indirectly affects their family too. **4.Emotions:Before/After:** Before: Depressed ,loss of time ,Facing more losses After: Confident Gets chance to spend time efficiently.	To provide an alternate (i.e) to avoid the network problems we are also going to introduce the manual mode where the farmers can stop the water flow /provide limited amount of water flow into the field., Make it more user friendly(like appoint the help center team to guide them whenever they are facing any trouble with our app	Offline: The IoT-based smart farming not only helps in modernizing the conventional farming methods but also targets other agriculture methods like organic farming, family farming (complex or small spaces, particular cattle and/or cultures, preservation of particular or high-quality varieties, etc.), and enhances highly transparent farming. Online: IoT-based smart farming is also beneficial in terms of environmental issues. It can help the farmers to use water efficiently.

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8.Available solution:

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4. REQUIREMENT ANALYSIS

Requirement Analysis, also known as Requirement Engineering, is the process of defining user expectations for a new software being built or modified. In software engineering, it is sometimes referred to loosely by names such as requirements gathering or requirements capturing. Requirements analysis encompasses those tasks that go into determining the needs or conditions to meet for a new or altered product or project, taking account of the possibly conflicting requirements of the various stakeholders, analyzing, documenting, validating and managing software or system requirements.

4.1 Functional requirement

In IOT-based Smart farming system there are some requirements are needed. In that requirements,some of them mentioned below.Smart farming refers to managing farms using modern Information and communication technologies to increase the quantity and quality of products while optimizing the human labor required.

Among the technologies available for present-day farmers are:

- **Sensors**: soil, water, light, humidity, temperature management
- **Software**: specialized software solutions that target specific farm types or applications agnostic IoT platforms
- **Connectivity**: cellular, LoRa
- **Location**: GPS, Satellite
- **Robotics**: Autonomous tractors, processing facilities
  Data analytics: standalone analytics solutions, data pipelines for downstream solutions.

4.2 Non-Functional requirements

Functional Requirements	Non-Functional Requirements
Resource discovery	Scalability
Resource management	Real-time or timeliness
Data management	Availability
Event management	Security
Code management	Privacy
	Ease of deployment, maintenance, and use
	Interoperability
	Spontaneous interaction
	Multiplicity
	Adaptability and flexibility

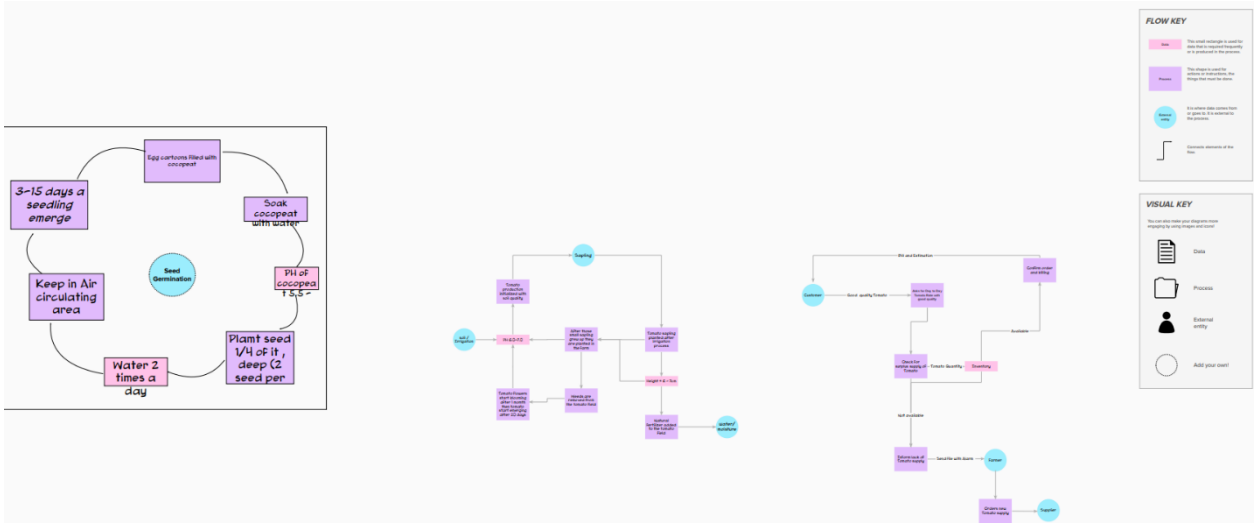
Type	Requirements	Support	Descriptions
Functional	Resource discovery	○	oneM2M supported
	Resource management	○	oneM2M supported
	Data management	○	oneM2M supported
	Event management	○	oneM2M supported
	Code management	○	oneM2M supported
Non-functional	Scalability	△	Implementation dependent
	Real-time or timeliness	○	Node.js supported
	Availability	△	Partially realized
	Security	△	Partially realized
	Privacy	×	Need to be developed
	Ease of deployment, maintenance, and use	○	oneM2M/Node.js supported
	Interoperability	○	oneM2M/Node.js supported
	Spontaneous interaction	△	Implementation dependent
	Multiplicity	×	Need to be developed
	Adaptability and flexibility	×	Need to be developed

5. PROJECT DESIGN

Project design is an early phase of a project where the project's key features, structure, criteria for success, and major deliverables are planned out. The aim is to develop one or more designs that can be used to achieve the desired project goals. Stakeholders can then choose the best design for the execution of the project. The project design steps might generate various outputs, such as sketches, flowcharts, site trees, HTML screen designs, prototypes, photo impressions, and more. The project design includes everything from who is responsible for completing the project to a description of the project, its goals, outcomes and objectives. It describes when these goals, outcomes and objectives will be reached, and the major deliverables, products or features that will be completed

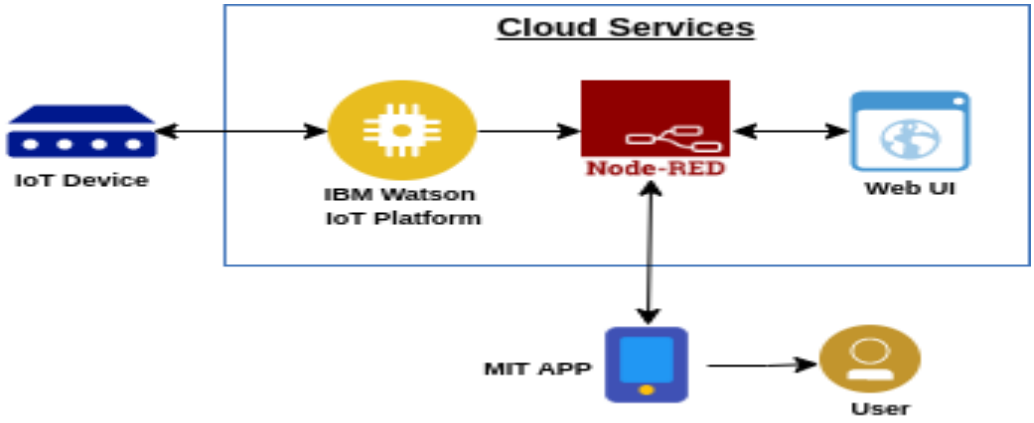
5.1 Data Flow Diagrams

A data flow diagram (DFD) is **a graphical or visual representation using a standardized set of symbols and notations to describe a business's operations through data movement**. They are often elements of a formal methodology such as Structured Systems Analysis and Design Method (SSADM).



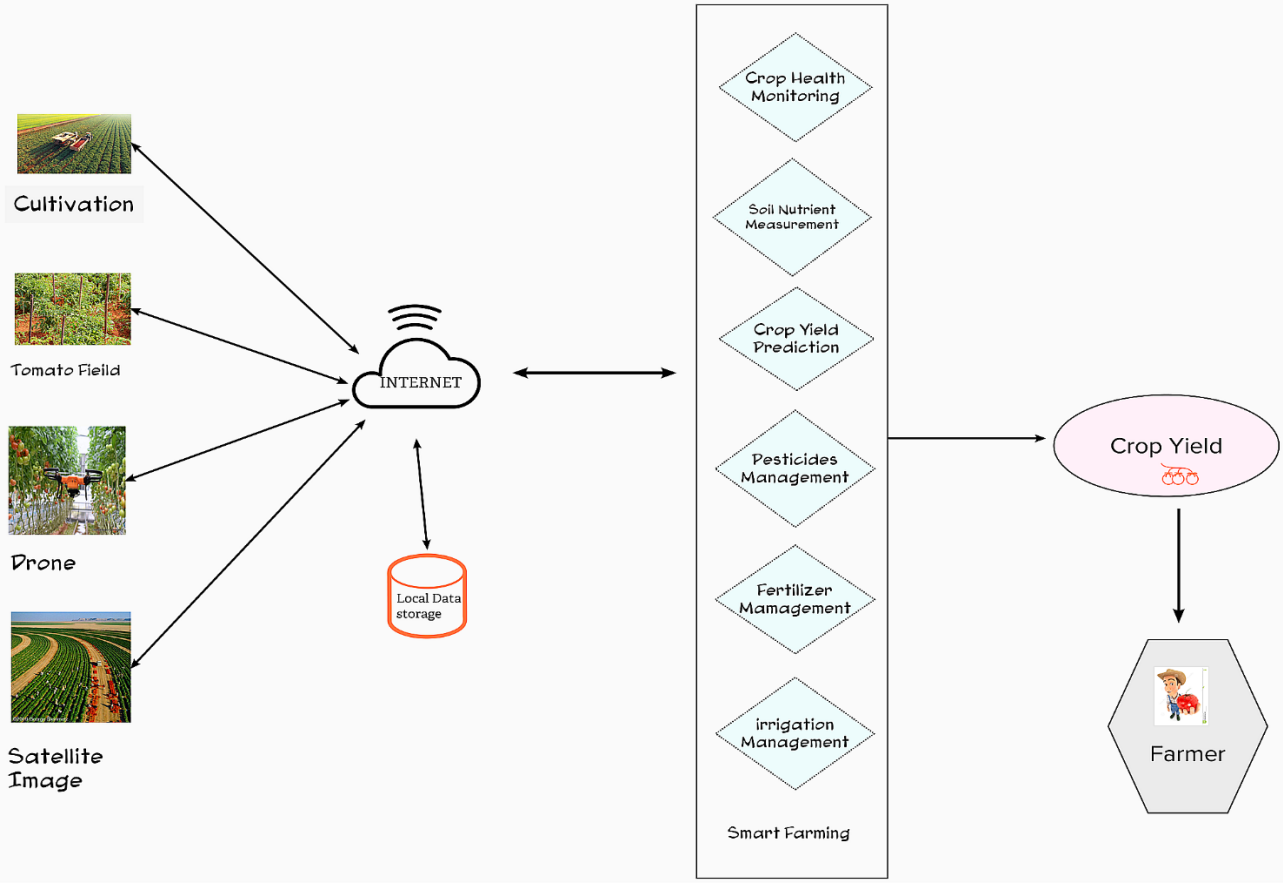
5.2 Solution & Technical Architecture

Technical Architecture



IoT architecture **consists of the devices, network structure, and cloud technology that allows IoT devices to communicate with each other**. A basic IoT architecture consists of three layers: Perception (the sensors, gadgets, and other devices) Network (the connectivity between devices)

Solution Architecture



An IoT architecture is **a mix of hardware and software components that interact together to make up a smart cyber-digital system**. Interoperating with one another, these components make up a base for an IoT solution to be built upon.

5.3 User Stories

The project team shall fill the User Stories in the following chart

User Type	Functional Requirement (Epic)	UserStory/Task	Acceptance criteria	Priority	Release
Developer	Mobile/web user Registration	As a client I can enlist the application by entering my email, secret word sothat vibe great	I can access my account / dashboard	High	Sprint - 1
Assistant Developer	Mobile/web user Login	As a client I can login the application by entering my email and secret phrase sothat am entering the application	I can receive confirmation email & click confirm	High	Sprint - 2
Customer Care Executive	Controls & Monitor	As a client I needs savoy application so that screen any place at whenever, As a client I need engine control so that stop water wastage	Controlled and monitored by sensor	Medium	Sprint - 3
Customer (End User)	Software connection	As an administrator I need to fulfil their clients so that associate and store in IBM I	Data Stored and simulated	High	Sprint - 4

6.PROJECT PLANNING & SCHEDULING

Planning and scheduling of your resource plays a key role in project management. It helps you understand the scope of the project ahead of time and manage/assign your resource accordingly. Besides, it provides an overview of who's responsible for delivering what and by when. A comprehensive process that outlines the project phases, tasks under each stage, and dependencies is known as project scheduling. It also considers skills and the number of resources required for each task, their order of occurrence, milestones, interdependencies, and timeline. Compare two scenarios– one, where your project details are all over the place, and second, where you maintain a centralized data repository of your project plan. This is what a project schedule does. It brings together all the project-related information in one place that opens doors for seamless communication between the project manager and stakeholders.

6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	UserStory Number	UserStory/Task	Story Points	Priority	TeamMembers
Sprint-1	Mobile/web user Registration	USN-1	As a client I can enlist the application by entering my email, secret word sothat vibe great	10	High	Keerthika.J
Sprint-1		USN-2	As a client I need affirmation mail forenrollment	10	Medium	Kaviya.S
Sprint-2	Mobile/web user Login	USN-3	As a client I can login the application by entering my email and secret phrase so that am entering the application	10	High	DandoluLakshmitha Reddy
Sprint-2		USN-4	As a client I can login to the applicationby entering my telephone number so can undoubtedly go into the dashboard	10	Low	Swetha.S
Sprint-3	Monitoring and controlling	USN-5	As a client I need brilliant application sothat screen the fields	3	High	DandoluLakshmithaReddy
Sprint-3		USN-6	As a client I need to realize the temperature level so that effectively realize water system timing	4	High	Swetha.S
Sprint-3		USN-7	As a client I need to check the moistness so that supportive to put water	4	Low	Keerthika.J
Sprint-3		USN-8	As a client I needs savoy application so that screen any place at whenever	5	Low	Kaviya.S
Sprint-3		USN-9	As a client I need engine control so that stop water wastage	4	High	DandoluLakshmitha

						Reddy
Sprint-4	Software connection	USN-10	As an administrator I need to fulfil their clients so that associate and store in IBM I	6	Medium	DandoluLakshmitha Reddy
Sprint-4		USN-11	As an administrator I need to make programming (hub red, IBM Watson) association so that re-enact the values	7	Medium	Swetha.S
Sprint-4		USN-12	As an administrator I need to test the application so that know it's work	7	High	Kaviya.S

6.2 Sprint Delivery Schedule

Sprint	**TotalStory Points**	**Duration**	**SprintStartDate**	**SprintEnd Date (Planned)**	**StoryPoints Completed (as onPlanned EndDate)**	**SprintRelease Date (Actual)**
Sprint-1	20	6Days	24Oct2022	29Oct2022	20	29Oct2022
Sprint-2	20	6Days	31Oct2022	05Nov2022	20	31Oct2022
Sprint-3	20	6Days	07Nov2022	12Nov2022	20	07Nov2022
Sprint-4	20	6Days	14Nov2022	19Nov2022	20	14Nov2022

Velocity:

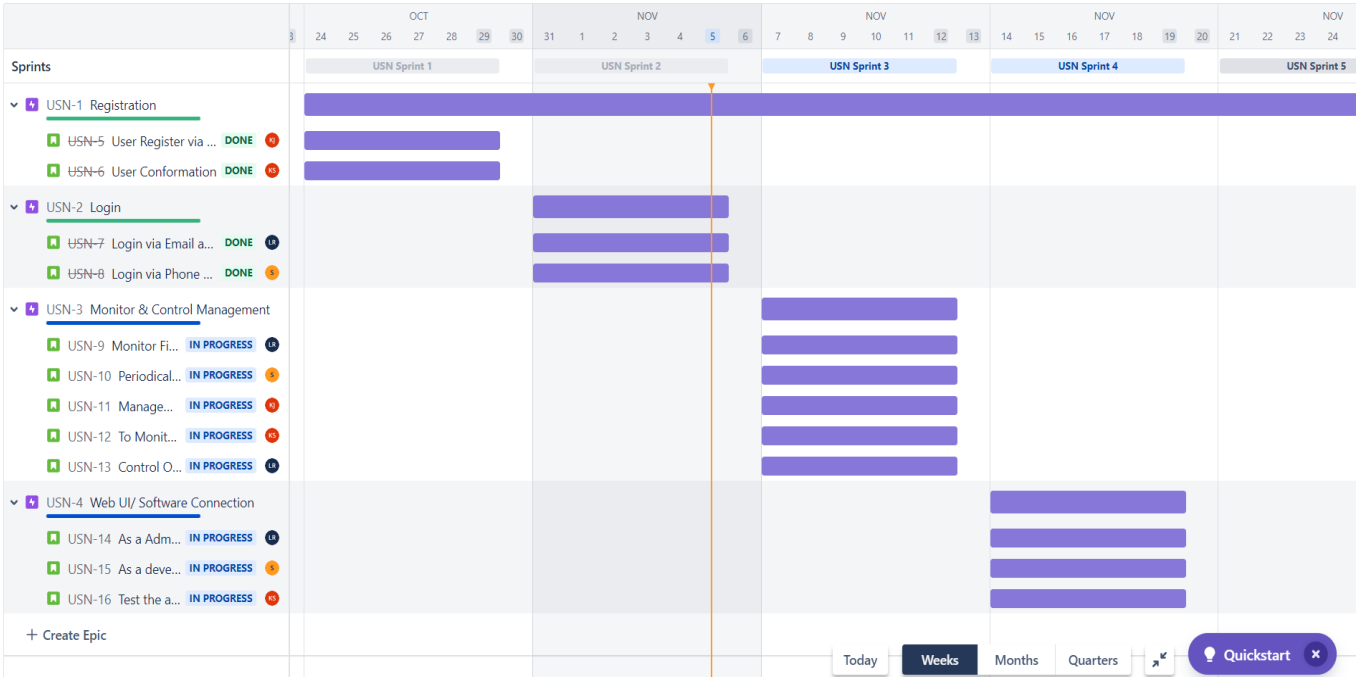
Imaginewehavea10-day sprint duration, and the velocity of the team is 20 (points per sprint).

Let’s calculate the team’s average velocity (AV)per iteration unit (story points per day)

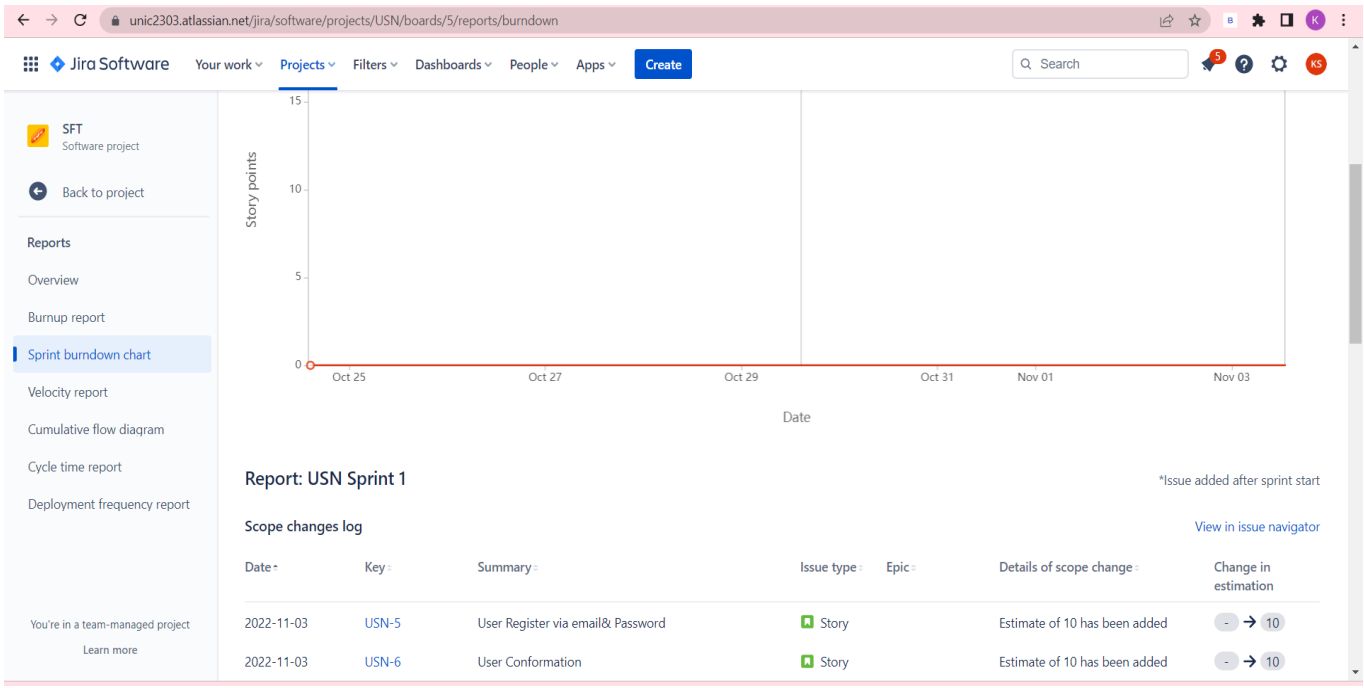
Average Velocity = Sprint Duration / Velocity = 20/6=3.33

6.3 Reports from JIRA

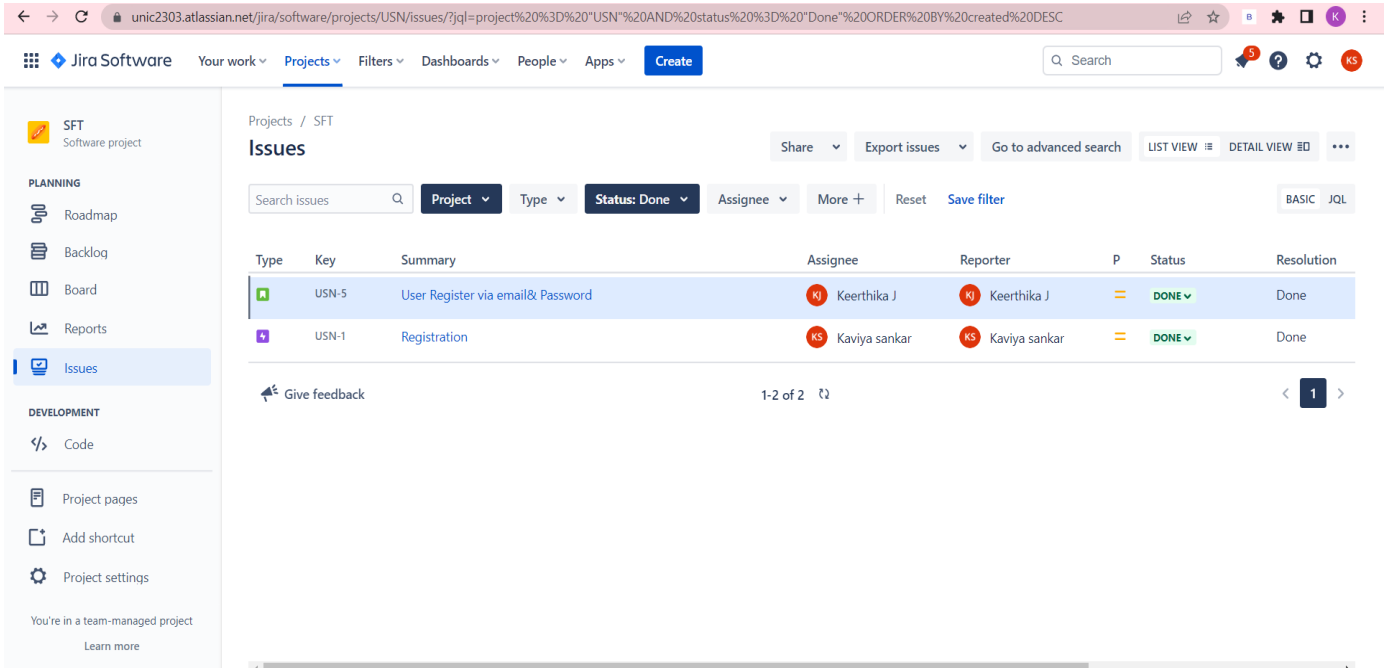
A torch outline is a graphical portrayal of work passed on to do versus time. It is frequently utilized in agile software development methodologies such as Scrum. In any case, torch outlines can be applied to any project containing quantifiable advancement after some time.



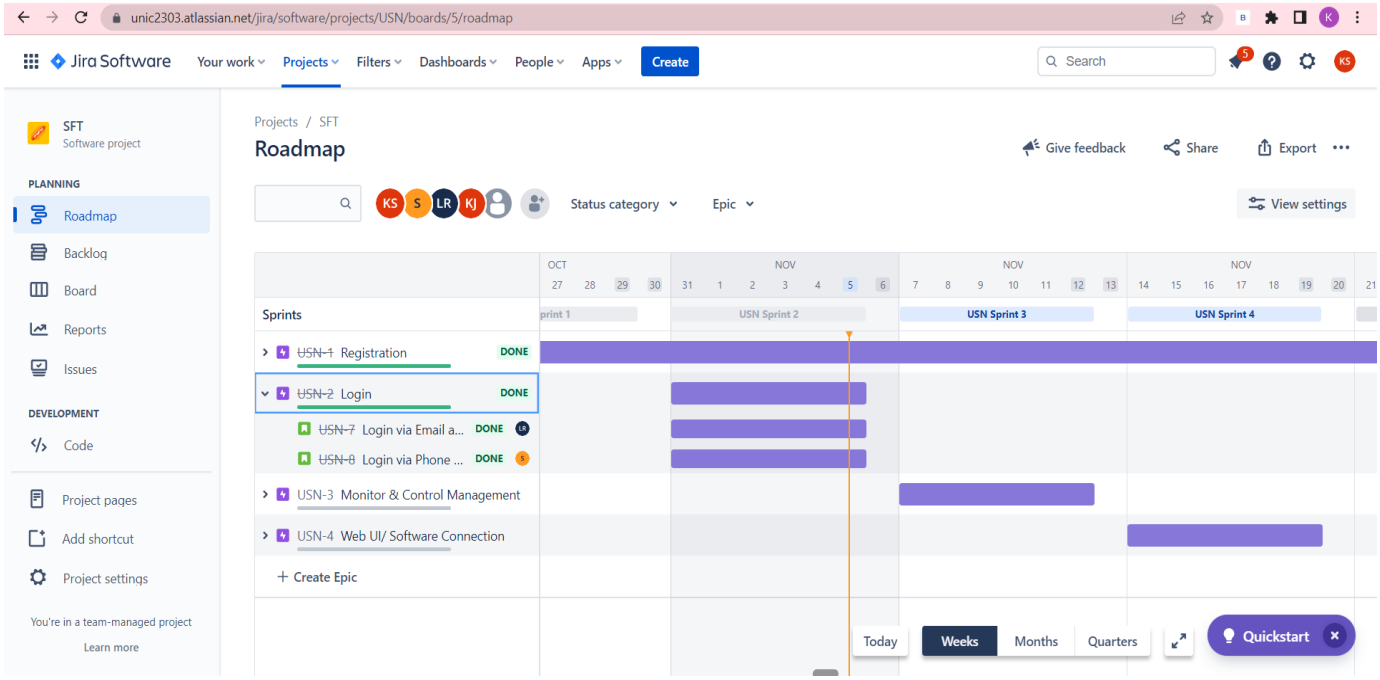
Creating RoadMap



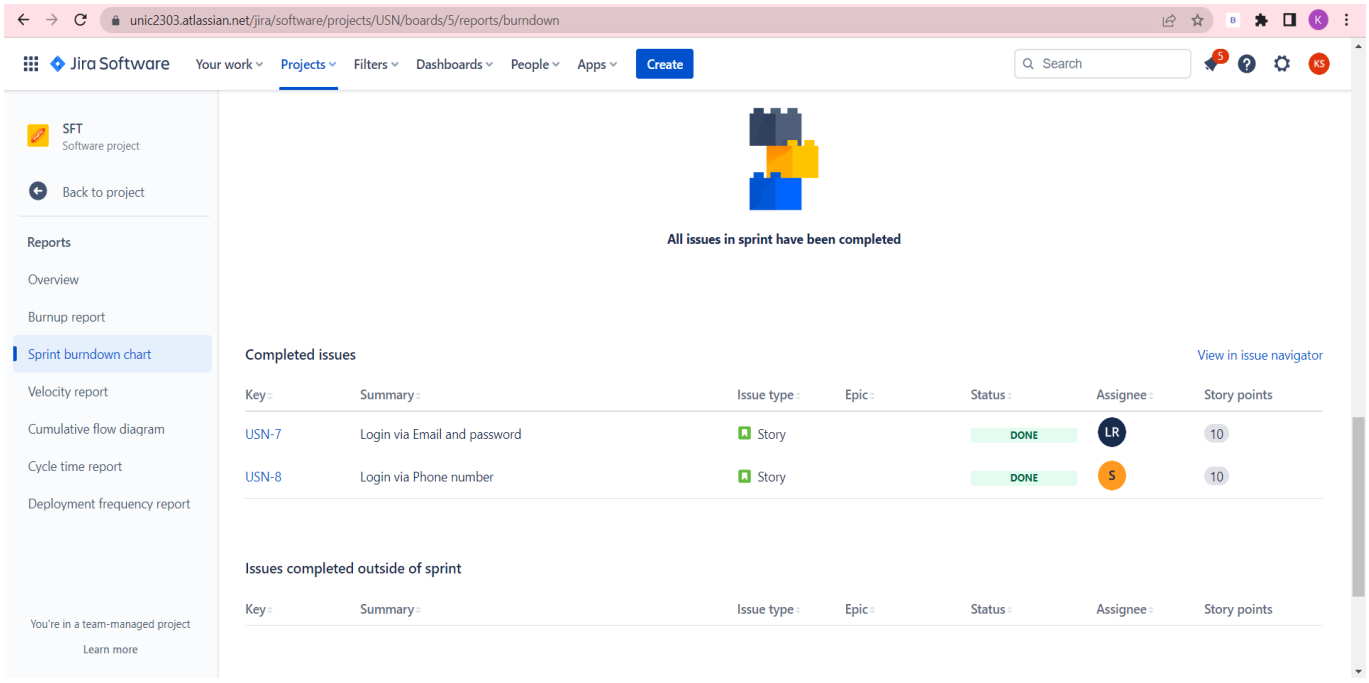
Sprint Burn Down Chart of Sprint – 1



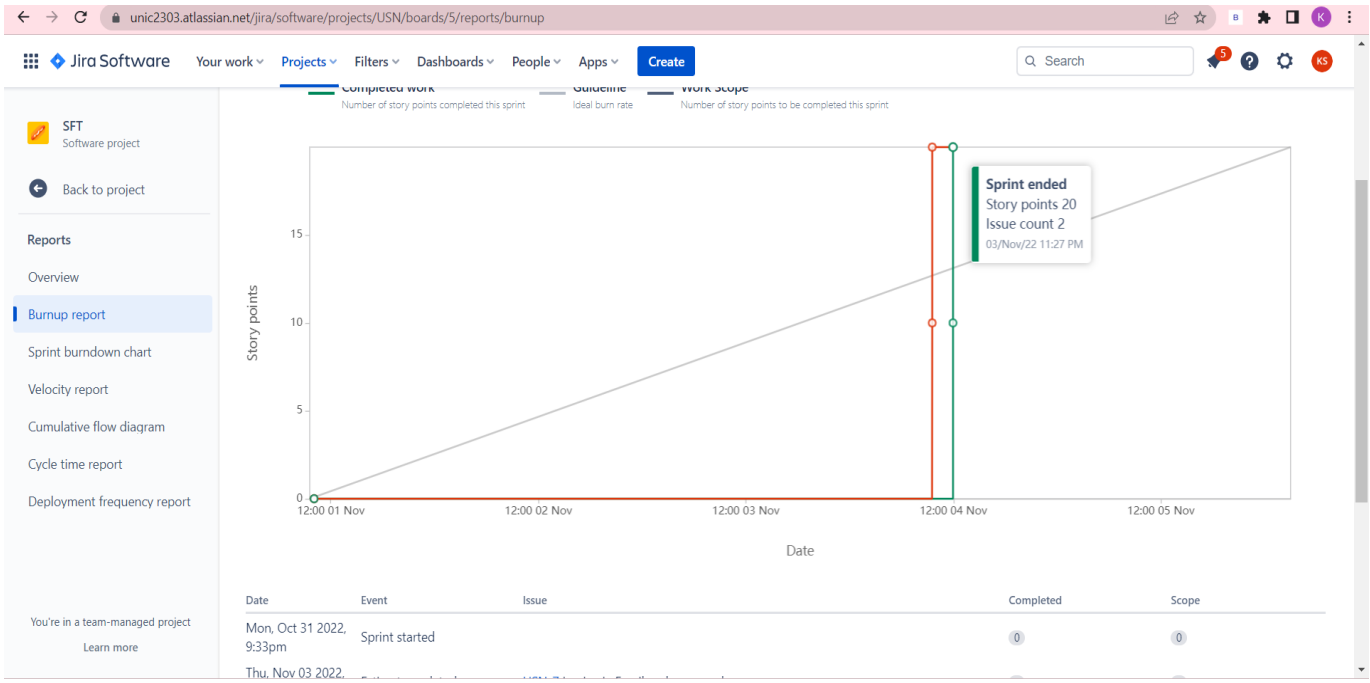
Sprint – 1 Completed Issues



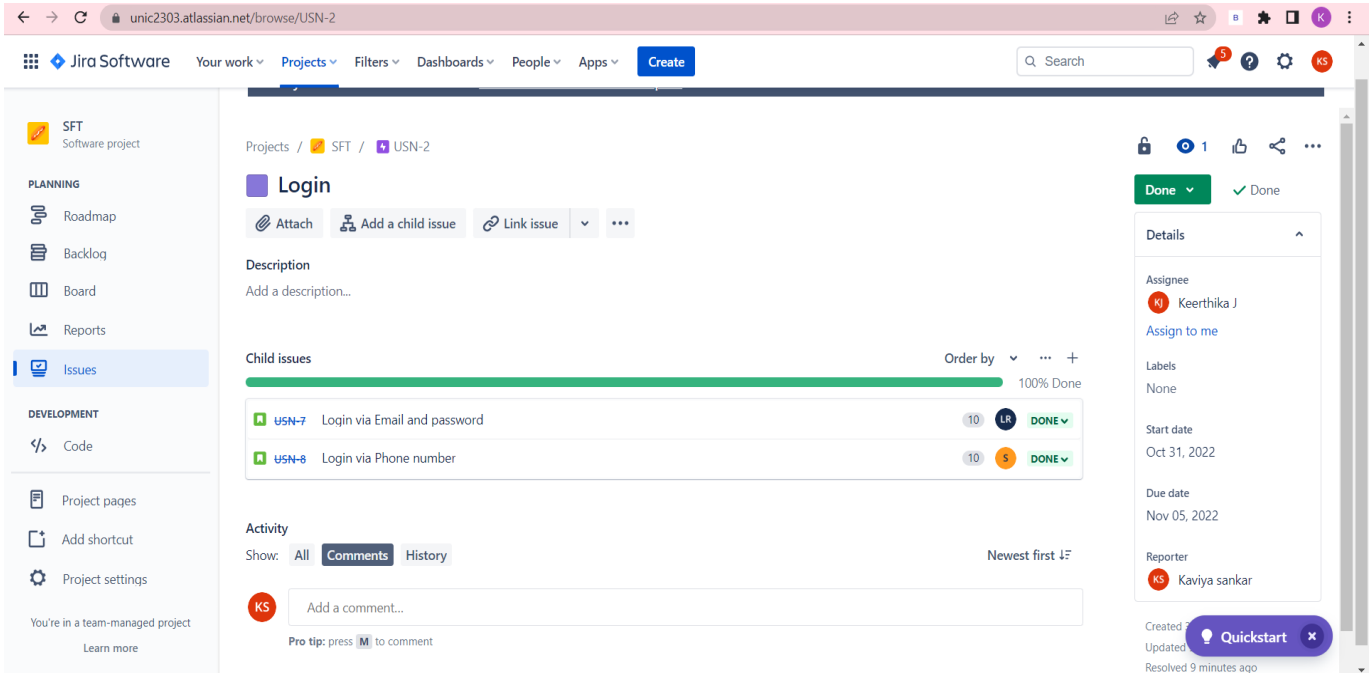
Sprint – 2 Story points and Issues Created



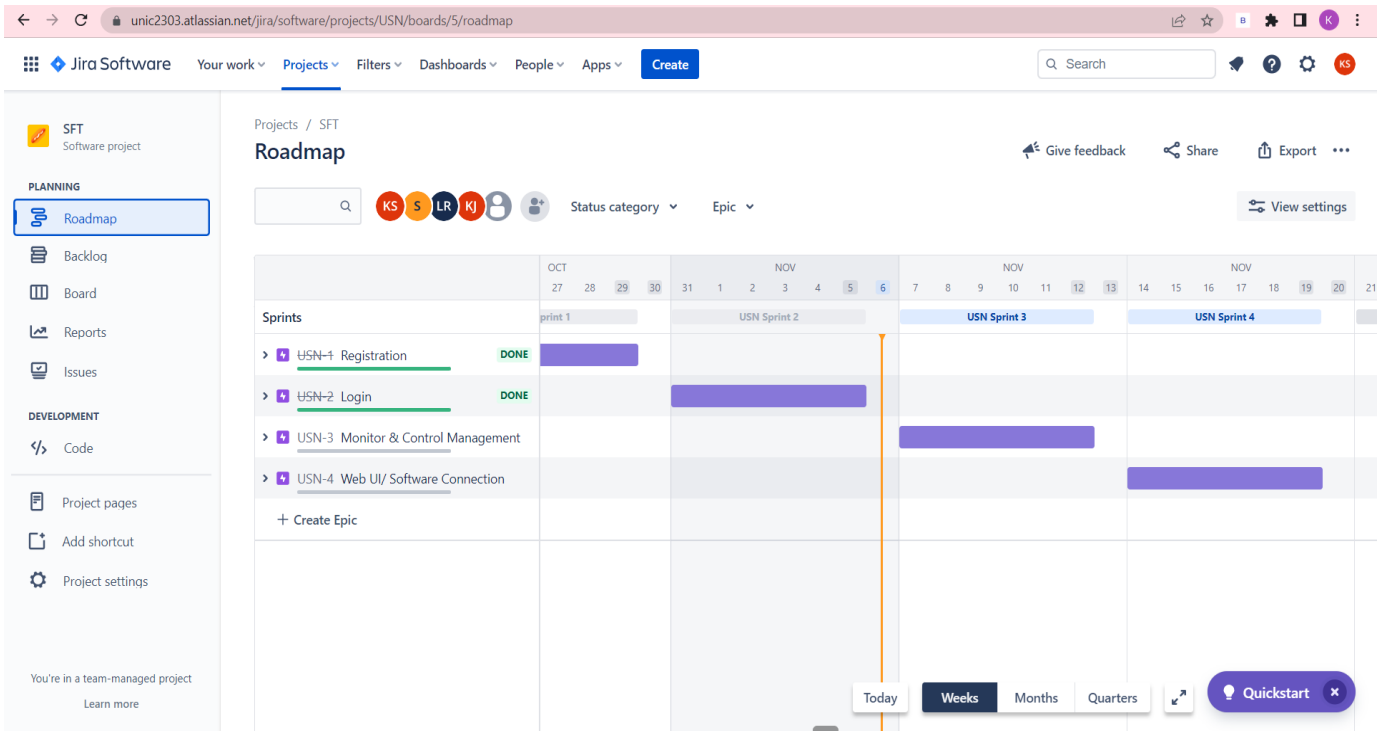
Sprint – 2 Burndown Chart



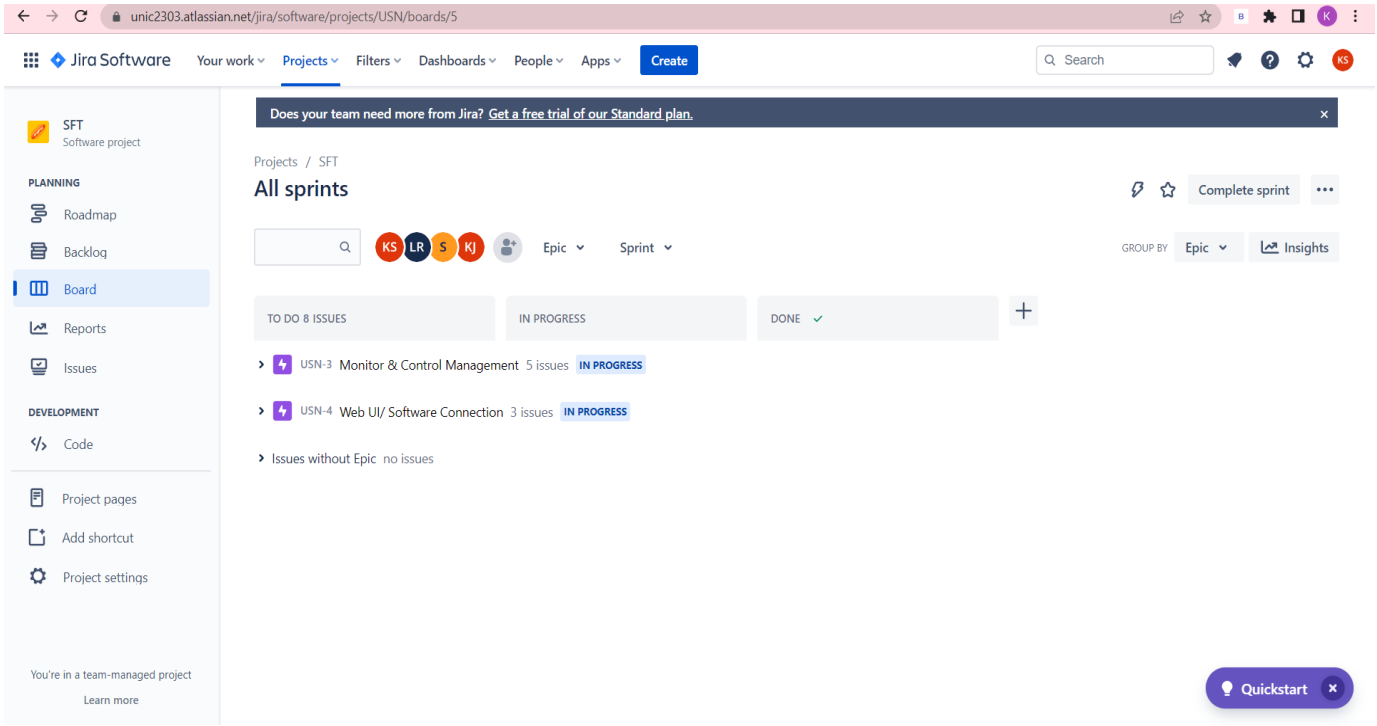
Burn Up Report Of Accumulated Sprint 1 & 2



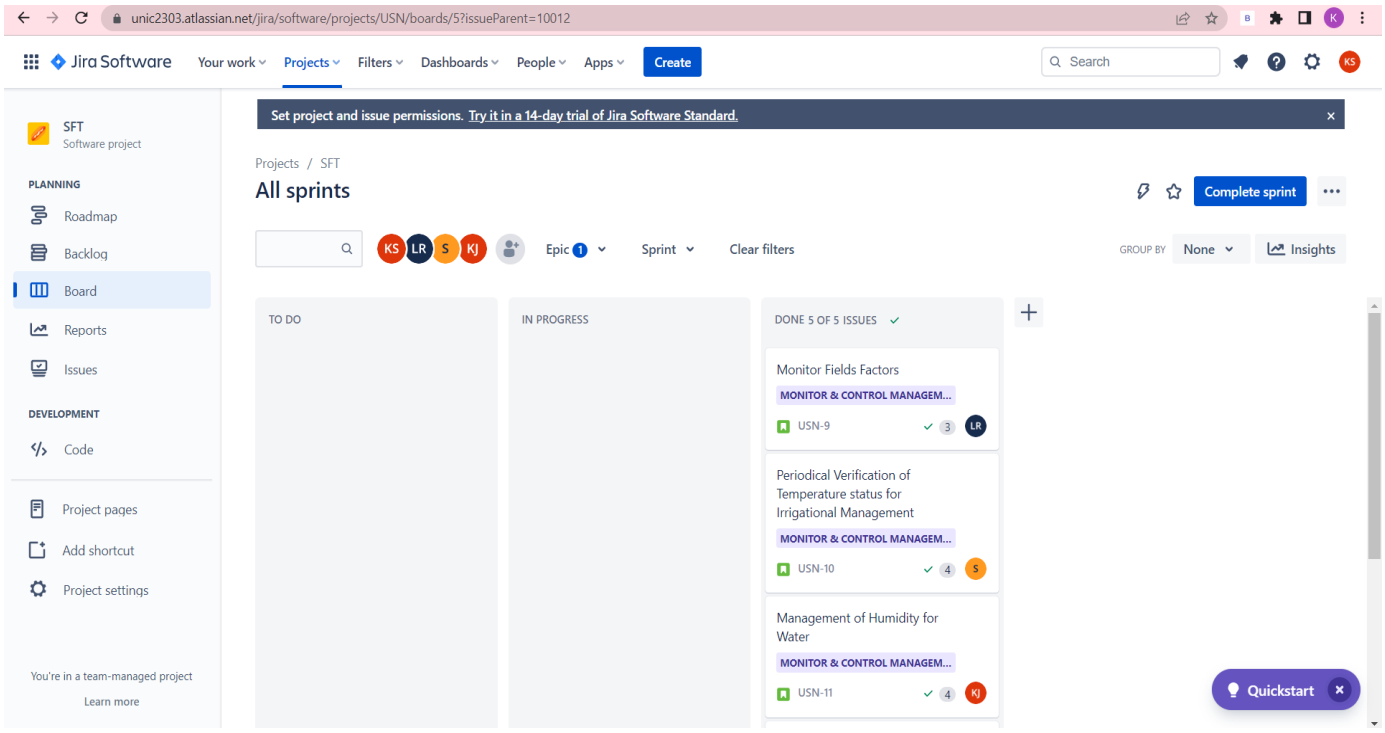
Completed Issues Of Sprint – 2



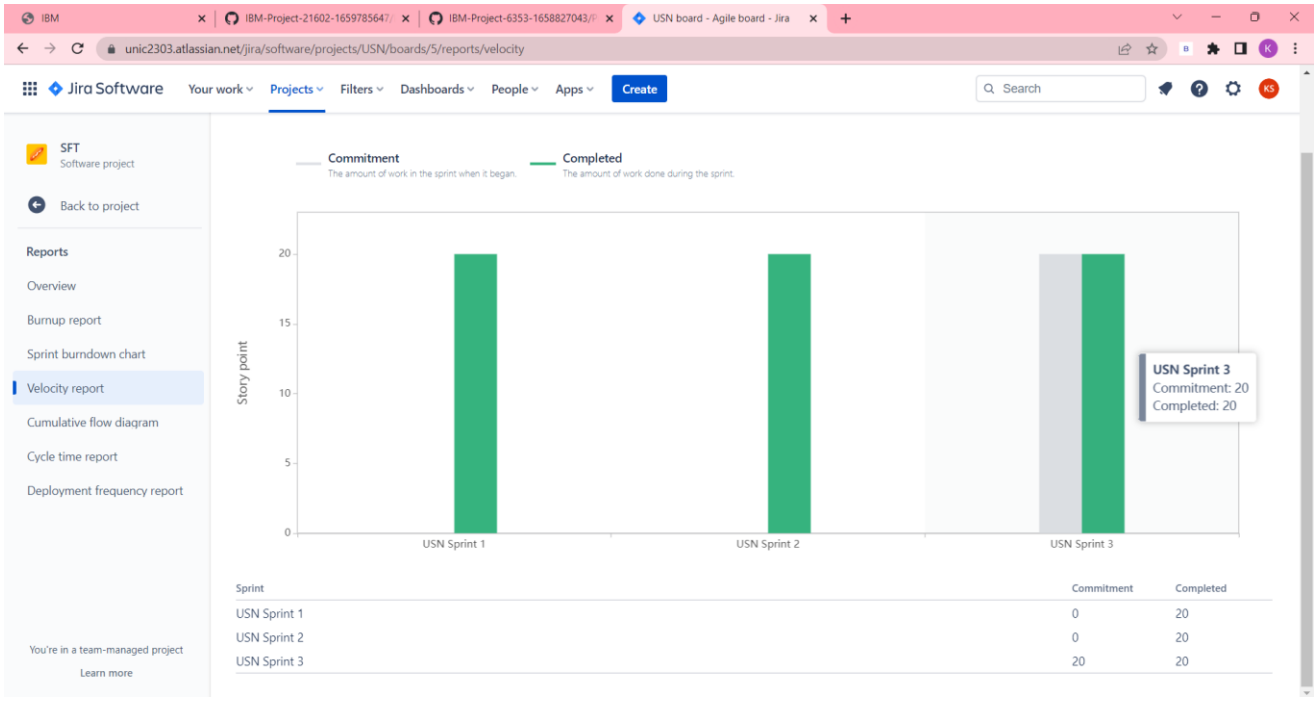
Sprint – 3 Created in RoadMap



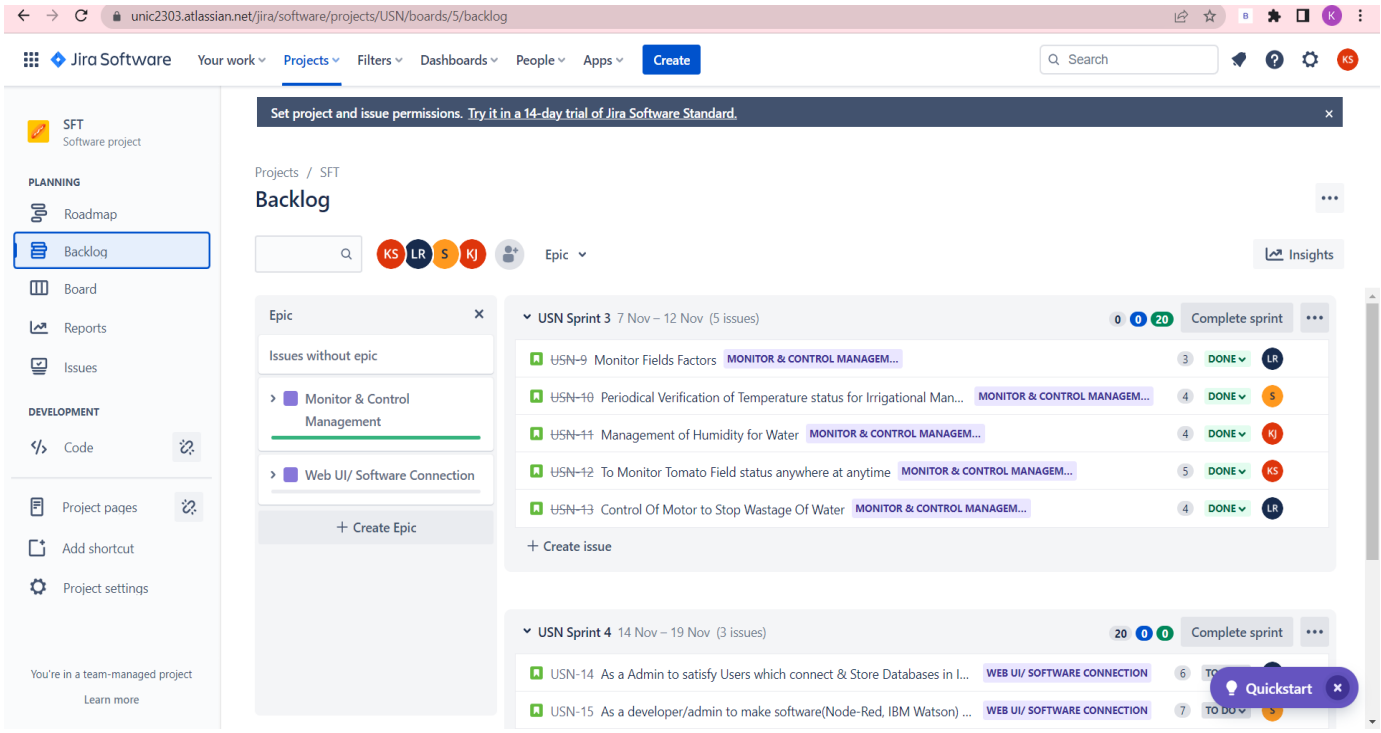
Sprint – 3 Progress in Board



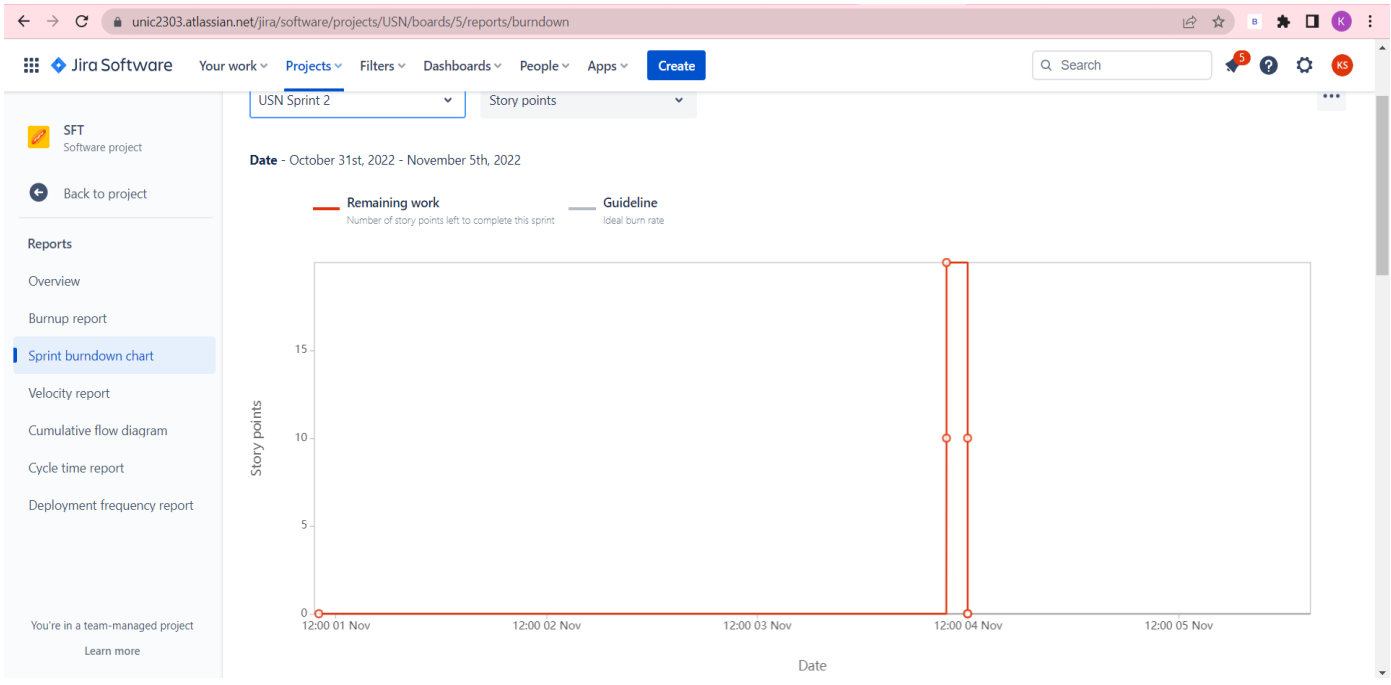
Sprint – 3 Done issues in Board



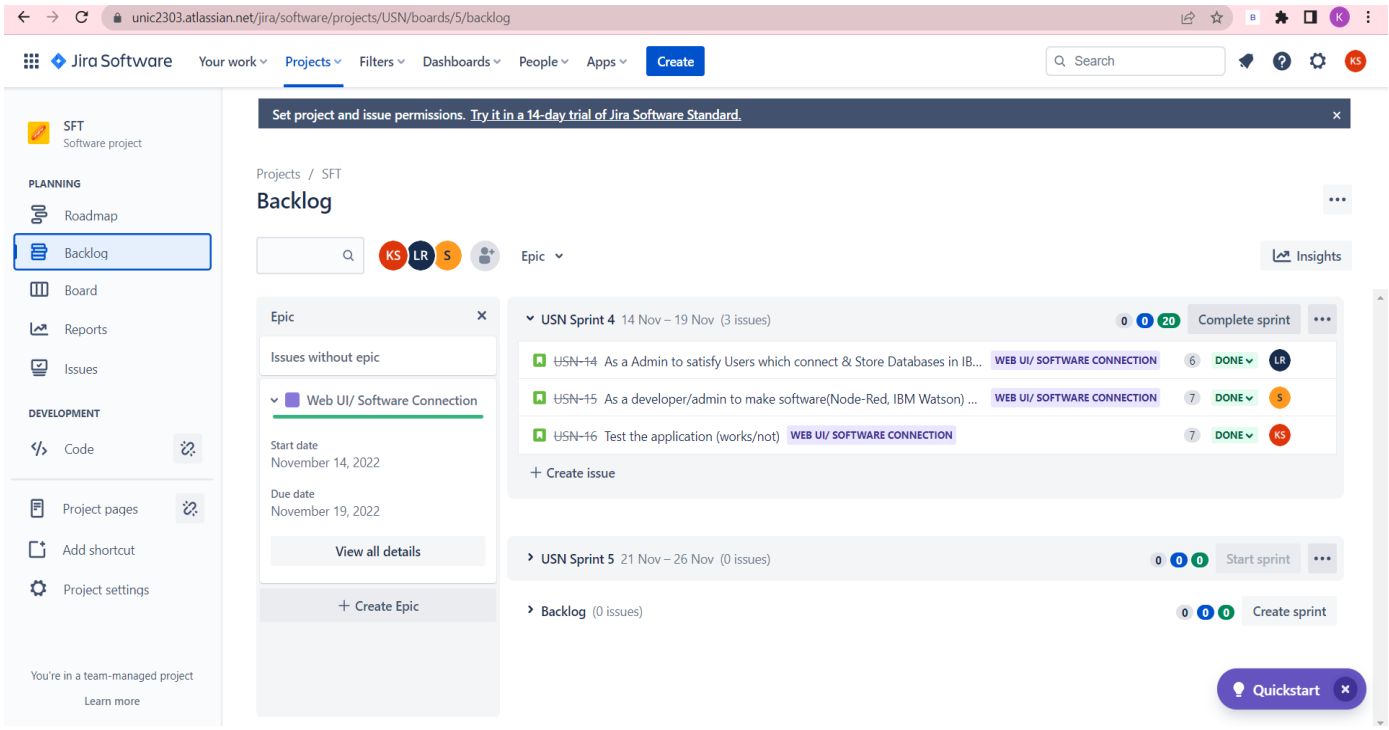
Velocity Report Of Sprint 3



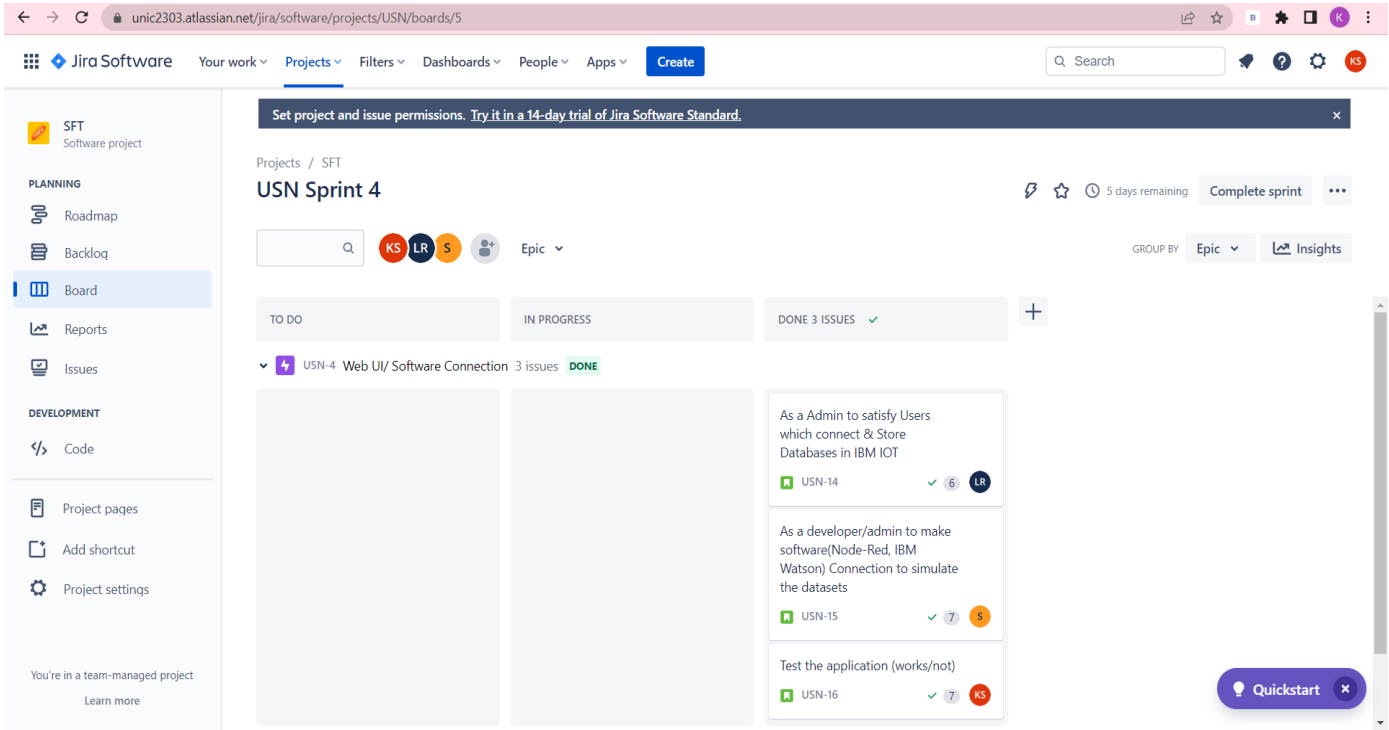
Completed Backlog Of Sprint-3



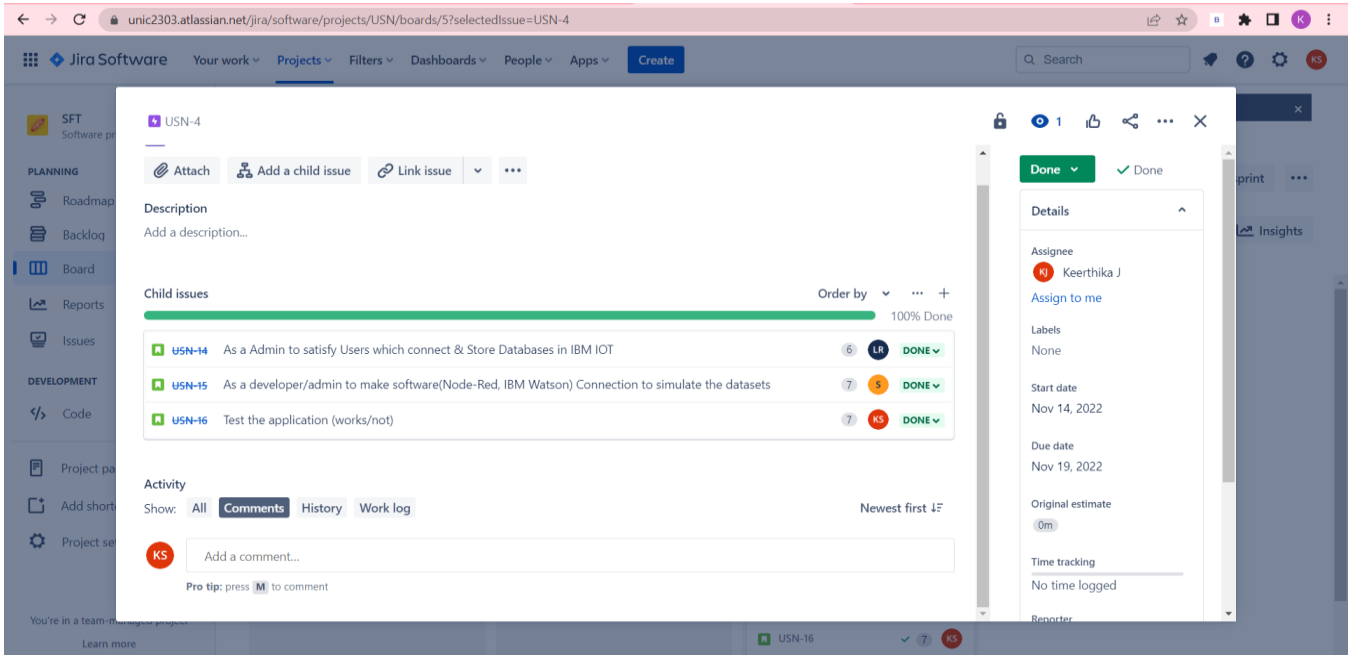
Sprint – 3 Burndown Chart



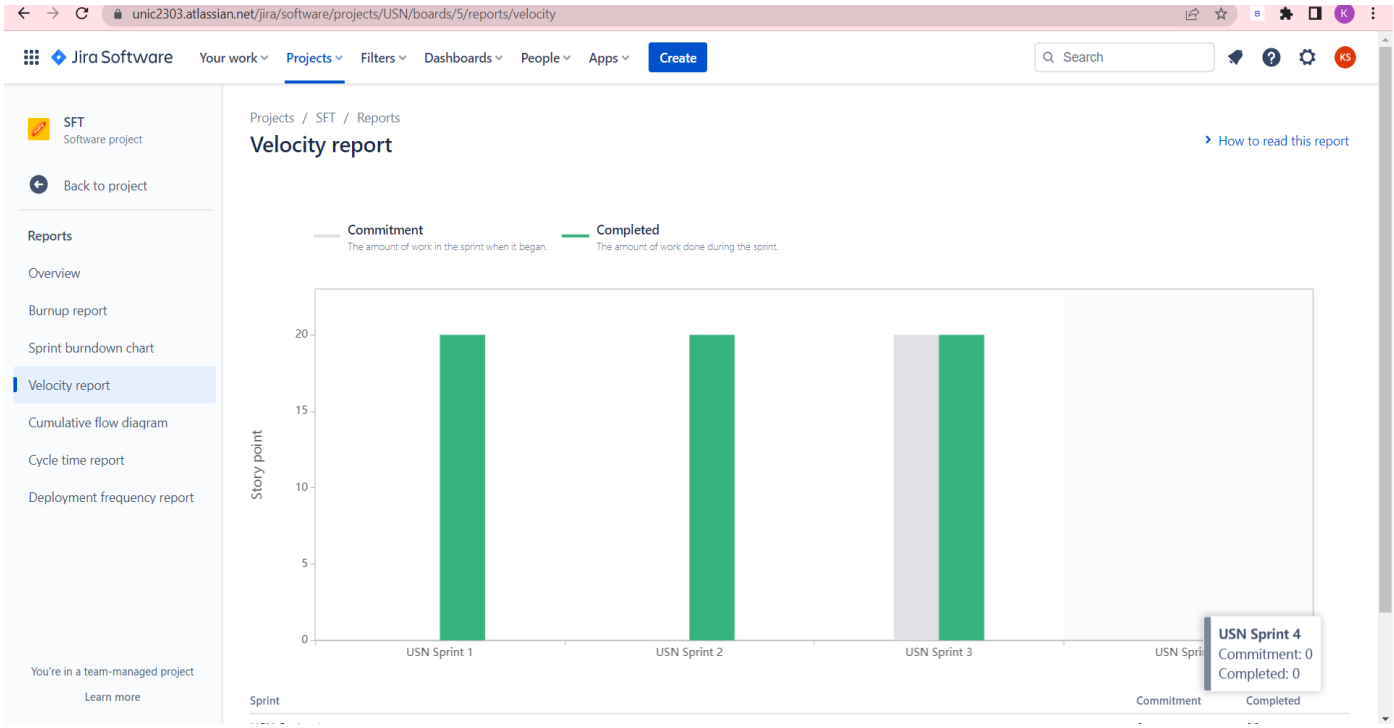
Sprint – 4 Backlog created and completed



Sprint – 4 Issues Completed in Board



Sprint – 4 completed



Velocity Report of Sprint 3 & 4

7. CODING & SOLUTIONING

7.1 Feature 1

```
import time

import sys

import ibmiotf.application

import ibmiotf.device

import random

#Provide your IBM Watson Device Credentials

organization = "rsu1tr"

deviceType = "sf"

deviceId = "smartfarm"

authMethod = "token"

authToken = "Q-******-**********Y"
```

7.2 Feature 2

Publish Data to IBM Watson IOT Platform

```
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 data
deviceCli.connect()
 def myOnPublishCallback():
       print ("Published Temperature = %s C" % Temperature, "Humidity = %s %%" % Humidity,"SoilMoisture = %s %%" % SoilMoisture,"Ph = %s %%" % ph, "to IBM Watson")

   success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback)
```

```
if not success:
        print("Not connected to IoTF")
deviceCli.commandCallback = myCommandCallback


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

7.3 Feature 3

Now Create Twilio SMS Api for send Alert Message to the End User / Authority

```
import os
from twilio.rest import Client
account_sid = 'AC5a226c4cfb911efa753ef6f8e486d27a'
auth_token = '494dd178c1bd36c06fa44301fca2b543'
message = client.messages \
        .create(
        from_ ='+18585440834',
        body='Alert!!',
        to = '+919498063191')
        print(message.sid)
```

8. Testing

Testing is the process of evaluating a system or its component with the intent to find whether it satisfies the specified requirements or not. In simple words, testing is executing a system in order to identify any gaps, errors, or missing requirements in contrary to the actual requirements.

8.1 Test cases

Count	Input	Output	Results
1	Soil Moisture: 70 Ph : 8	Motor OFF	Normal Condition
2	Soil Moisture: 40 Ph : 5	Motor ON	Critical Condition
3	Soil Moisture: 80 Ph : 7	Motor OFF	Normal Condition
4	Soil Moisture: 50 Ph : 9	Motor OFF	Normal Condition
5	Soil Moisture: 35 Ph : 4	Motor ON	Critical Condition
6	Soil Moisture: 20 Ph : 3	Motor ON	Critical Condition
7	Soil Moisture: 100 Ph : 8	Motor OFF	Normal Condition
8	Soil Moisture: 90 Ph : 6	Motor OFF	Normal Condition
9	Soil Moisture: 10 Ph : 3	Motor ON	Critical Condition
10	Soil Moisture: 45 Ph : 2	Motor ON	Critical Condition

8.2. User Acceptance Testing

User Acceptance Testing (UAT) is **a type of testing performed by the end user or the client to verify/accept the software system before moving the software application to the production environment**. UAT is done in the final phase of testing after functional, integration and system testing is done.

Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolve

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By design	12	5	3	20	40
External	5	3	12	10	30
Fixed	8	2	0	20	30
Not Reproduced	3	7	8	15	25
Skipped	3	5	2	1	11
Won't Fix	2	1	7	5	15
Totals	33	23	32	71	159

Test Case Analysis

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

Section	Total cases	Not Tested	Fail	Pass
Client Application	5	0	**0**	5
Security	3	0	**0**	3
Exception Reporting	10	0	**0**	10
Final Report Output	6	0	**0**	6

9.RESULTS

9.1. Performance Metrics

CPU usage

The Python V3.7.0 is utilize the computer processor. For each circle the program runs in O(1) time, ignoring the organization and correspondence. The program dozes for each 1 second for better correspondence with MQTT. As the program takes O(1) time and the compiler advances the program during assemblage there is less computer chip load for each cycle. The impending directions are on the stack memory, so they can be popped after execution.

Memory usage

The sensor values, organizing information are put away in sram of the ESP32 . It's a ton of information since ESP32 has just restricted measure of memory (520 KB) .For every memory cycle the specific addresses are overwritten with new qualities to save memory and ideal execution of the program.

Garbage collection

In the server-side trash assortment is finished by the Hub structure. In the IoT gadget, python has no trash assortment highlights. Yet, it isn't required in that frame of mind as the memory is utilized again for putting away the information. Any hanging pointer or inadequately dealt with address space isn't apportioned.

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).

Some examples of such agriculture IoT devices are *allMETEO*, *Smart Elements*, *and Pycno*.

Predictive analytics for smart farming

Precision agriculture and predictive data analytics go hand in hand. While IoT and smart sensor technology are a goldmine for highly relevant real-time data, the use of data analytics helps farmers make sense of it and come up with important predictions: crop harvesting time, the risks of diseases and infestations, yield volume, etc. Data analytics tools help make farming, which is inherently highly dependent on weather conditions, more manageable, and predictable.

Connectivity

The need to transmit data between many agricultural facilities still poses a challenge for the adoption of smart farming. Needless to say, the connection between these facilities should be reliable enough to withstand bad weather conditions and to ensure non-disruptive operations.Today, IoT devices still use varying connection protocols, although the efforts to develop unified standards in this area are currently underway. The advent of 5G and technologies like space-based Internet will, hopefully, help find a solution to this problem.

Acknowledgments

The authors acknowledge to the Mobile Computing Laboratory of the School of Technology and Management of the Polytechnic Institute of Leiria and to the Computer Science and Communication Research Center for the facilities granted in the implementation of part of this work, in the context of the Smart IoT Ecosystems research line.

10. ADVANTAGES & DISADVANTAGES

Advantages

- All device status can be shown in a dashboard
- Automatic alerting of developer as well as Farmer/End User using SMS
- Automatically turning on/off motor when the soil moisture and Ph reach a threshold value.
- Authentication is not required to turn on/off of motor via sending SMS alert manually
- Users can see the dashboard using a web application as well as MIT app inventor.

Disadvantages

- Need large database since many data is stored in cloud database every second.
- If the physical device is damaged the entire operation is collapsed.
- Always need to connect with the internet.

11.CONCLUSION

The suggested study gives data on a number of soil factors, such as temperature, soil moisture, and air temperature, in order to forecast the suitability of irrigation. This technology aids in the analysis of the soil's properties, ensuring a more effective irrigation system for tomato production use. To ensure a fully automated system, the sensor data is made to learn using machine learning techniques. Implementing an IoT-based smart farming system improves crop quality and lessens the need for human labour in tomato production processes.

12.FUTURE SCOPE

The existing devices can be modified to work in different specialized crop as well as mini smart farming by every individual contribution in farming. Many factors can also play a major role for future smart farming where doing the cultivation process without the involvement of human in the field. Every single minute changes occur in the field can also be detected and rectified in future scope.Following the plant breeding and genetics revolutions, this Third Green Revolution is taking over the agricultural world based upon the combined application of ICT solutions such as precision equipment, the Internet of Things (IoT), sensors and actuators, geo-positioning systems, Big Data, Unmanned Aerial Vehicles (UAVs, drones), robotics, etc.

13.APPENDIX

Source Code

```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
import os
from twilio.rest import Client
account_sid = 'AC5a226c4cfb911efa753ef6f8e486d27a'
auth_token = '494dd178c1bd36c06fa44301fca2b543'
client = Client(account_sid,auth_token)
#Provide your IBM Watson Device Credentials
organization = "rsu1tr"
deviceType = "sf"
deviceId = "smartfarm"
authMethod = "token"
authToken = "Q-1nP3j-JqTt4O7HyY"
```

```
# Initialize GPI

def myCommandCallback(cmd): # function for Callback

        print("Command received: %s" % cmd.data['command'])

        status=cmd.data['command']

        if status=='motoron':

                print("Turn Motor ON")


        elif status=='motoroff':

                print("Turn Motor OFF")

        #print(cmd)




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 data

deviceCli.connect()


while True:

        #Get Sensor Data from DHT11

        Temperature=random.randint(0,100)

        Humidity=random.randint(0,100)

        SoilMoisture=random.randint(30,65)#(Value = 50-60)

        ph=random.randint(0,10)#Ph value (6.2-6.8)


        data = { 'Temperature' : Temperature, 'Humidity': Humidity,'SoilMoisture':SoilMoisture,'Ph':ph}

        #print data


 def myOnPublishCallback():

    print ("Published Temperature = %s C" % Temperature, "Humidity = %s %%" % Humidity,"SoilMoisture =
 %s    %%" % SoilMoisture,"Ph = %s %%" % ph, "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)

        if SoilMoisture==50:

           print("Motor is ON")
```

```
            message = client.messages \
            .create(
            from_ ='+18585440834',
            body='Alert!!',
            to = '+919498063191')
            print(message.sid)
        else :
            print(" ")

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

GITHUB LINK: https://github.com/IBM-EPBL/IBM-Project-21602-1659785647