

# **POLITECNICO**

## **MILANO 1863**

### **Software Engineering 2 project**

Academic Year 2021-2022

DREAM - Data-dRiven PrEdictive FArMing in Telengana

## **Requirement Analysis and Specification Document**

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## Content

1. INTRODUCTION .....	4
1.1 Purpose .....	4
1.1.1 Purpose .....	4
1.1.2 Goals .....	4
1.2 Scope .....	5
1.2.1 World phenomena .....	5
1.2.2 Shared phenomena.....	5
1.3 Definitions, Acronyms, Abbreviations .....	6
1.3.1 Definition .....	6
1.3.2 Abbreviations.....	7
1.4 Revision history .....	7
1.5 Reference Documents.....	7
1.6 Document Structure .....	7
2. OVERALL DESCRIPTION .....	9
2.1 Product perspective:.....	9
2.2 Product functions: .....	14
2.3 User characteristics: .....	19
2.4 Assumptions, dependencies and constraints:.....	20
3. SPECIFIC REQUIREMENTS: Here we include more details on all aspects in Section 2 if they can be useful for the development team.....	21
3.1 External Interface Requirements.....	21
3.1.1 User Interfaces.....	21
3.1.2 Hardware Interfaces.....	21
3.1.3 Software Interfaces.....	21
3.1.4 Communication Interfaces .....	21
3.2 Functional Requirements: Definition of use case diagrams, use cases and associated sequence/activity diagrams, and mapping on requirements .....	21
3.3 Performance Requirements.....	21
3.4 Design Constraints .....	21
3.4.1 Standards compliance .....	21
3.4.2 Hardware limitations.....	21

3.4.3 Any other constraint .....	21
3.5 Software System Attributes .....	22
3.5.1 Reliability.....	22
3.5.2 Availability .....	22
3.5.3 Security.....	22
3.5.4 Maintainability .....	22
3.5.5 Portability.....	22
4. FORMAL ANALYSIS USING ALLOY:.....	23
5. EFFORT SPENT:.....	24
6. REFERENCES .....	24

# 1. INTRODUCTION

## 1.1 Purpose

### 1.1.1 Purpose

Agriculture plays a vital role in India's economy. However, with food demand increasing, climate change and COVID-19 pandemic, agriculture in Telengana India is facing severe challenges, like unstable food supply chains, vulnerabilities of marginalized communities and smallholders.

Telengana's government wants to build anticipatory governance models for food systems using digital public goods and community-centric approaches to strengthen data-driven policy making in Telengana.

This document is addressed to the developers who have to implement the requirements and could be used as an agreement among policy makers, farmers and agronomists.

### 1.1.2 Goals

- G1: Allow policy makers to identify those farmers who are performing well or badly.
- G2: Allow policy makers to understand whether the steering initiatives carried out by agronomists produce significant results. <sup>1</sup>
- G3: Allow farmers to visualize data relevant to them.
- G4: Allow farmers to provide information about their production and the problem they face.
- G5: Allow farmers to ask for help and suggestion from agronomists.
- G6: Allow farmers to create discussion forums with the other farmers.
- G7: Allow agronomists to specify the areas they are responsible of.
- G8: Allow agronomists receive information about requests for help and answer to these requests.
- G9: Allow agronomists to visualize data concerning weather forecasts in the area and the best performing farmers in the area.
- G10: Allow agronomists to visualize and manage a daily plan to visit farms in the area.
- G11: Allow agronomists to confirm the execution of the daily plan at the end of each day or specify the deviations from the plan.

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<sup>1</sup> Because "with the help of good farmers" is not explicitly mentioned in the work of agronomists, this part is deleted for consistency.

## 1.2 Scope

DREAM is an effective application which aims to settle for various queuing problems faced by farmers, policy makers and agronomists.

Between farmers and policy makers, it allows policy makers identify farmers who are good at dealing with challenges or who need to help. Between farmers and agronomists, it allows they can learn each other's requests and solutions quickly, accurately and visually. Between policy makers and agronomists, it allows policy makers evaluate ability of agronomists.

The system also contains functions creates discussion forums with the other farmers, and allows users access information of weather, crop, water irrigation system and soil.

### 1.2.1 World phenomena

- WP.1: Farmers know their farms' location.
- WP.2: Weather forecasts are available by Telengana.
- WP.3: Farmers grow specific crops.
- WP.4: Farmers face a problem.
- WP.5: Farmers carry out suggestions.
- WP.6: Farmers know the produced amount per product they plant.
- WP.7: Water irrigation system monitors the amount of water used by each farmer.
- WP.8: Sensors deployed on the territory measure humidity of soil.
- WP.9: the policy makers know how to rate performance of farmers.
- WP.10: the policy makers understand the initiatives from Agronomists.
- WP.11 the policy makers make policies.
- WP.12: Agronomists know their responsible areas.
- WP.13: Agronomists research and develop solutions.
- WP.14: Agronomists visit each farm at least twice per year.
- WP.15: Each farmer's farms are in a same area in charge of one agronomist.

### 1.2.2 Shared phenomena

- SP.1: the policy makers visualize the information about farmers. (world)
- SP.2: the policy makers visualize the information about geospatial information. (world)
- SP.4: the policy makers rate performance of farmer in the system. (world)
- SP.5: the policy makers visualize daily plan from Agronomists. (world)
- SP.6: Agronomists insert the area they are responsible of. (world)
- SP.7: Agronomists receive information about farmers' requests for help. (machine)
- SP.8: Agronomists answer to farmers' requests. (world)
- SP.9: Agronomists check data concerning weather forecasts. (world)
- SP.10: Agronomists check the best performing and under-performing farmers in the area.

(world)

SP.11: Agronomists visualize and update a daily plan to visit farms in the area. (world)

SP.12: Agronomists confirm the execution of the daily plan at the end of each day or specify the deviations from the plan. (world)

SP.13: The farmers check local weather forecasts. (world)

SP.14: The farmers search for personalized suggestions concerning specific crops to plant or specific fertilizers to use based on the type of product. (world)

SP.15: The farmers insert the data about the production (types of products, produced amount per product) into the system. (world)

SP.16: The farmers insert the problems they face into the system. (world)

SP.17: The system shows the answer to the farmer's request. (machine)

SP.18: The farmers create a discussion forum in the system. (world)

SP.19: The system shows the discussion forum to all farmers. (machine)

SP.20: The farmers comment a discussion in the system. (world)

## 1.3 Definitions, Acronyms, Abbreviations

### 1.3.1 Definition

- Marginalized communities: Socially excluded groups of people for different reasons, such as age, physical or mental disabilities, economic status, access to education, or live in isolated places or depressed areas.
- Smallholders: Smallholders are usually farms supporting a single family with a mixture of cash crops and subsistence farming.
- Challenge: It may cause exceptionable influence from human or natural factors.
- Telengana: Telengana is the 11th largest state in India with a geographical area of 112,077 km<sup>2</sup> and 35,193,978 residents (data from 2011)
- DREAM System (or "The System"): refers to the whole system to be developed.
- DREAM Services (or "Services"): refers to the functionalities offered by the DREAM System, such as daily plan management mechanism and the visualization service.
- DREAM Application (or "The Application"): refers to the application that makes DREAM Services available everywhere. In this document, this term is intentionally used in a generic way. How the application will actually be delivered (e.g., as a web app or as a mobile app) will be defined later in the Design Document of DREAM.
- Geospatial information: geospatial information is data about the water irrigation system concerning the amount of water used by each farmer, sensors deployed on the territory and measuring the humidity of soil, and weather forecasts
- Agricultural Product Reference System: A system helps governments and development agencies coordinate their activities to improve and develop agriculture. It also conducts research, provides technical assistance to projects, operates educational and training programs, and collects data on agricultural output, production, and development.

### 1.3.2 Acronyms

- WP: World phenomena
- SP: Shared phenomena
- G: Goal
- RASD: Requirement Analysis and Specification Document.
- UML: Unified Modelling Language.
- GPS: Global Positioning System.

### 1.3.3 Abbreviations

- [G.i]: i-th goal.
- [WP.i]: i-th world phenomena.
- [SP.i]: i-th shared phenomena.
- [R.i]: i-th requirement.
- [D.i]: i-th domain assumption.
- [UC.i]: i-th use case.

## 1.4 Revision history

Vision	Date	Content
0.1	30/11/21	Finish Section1
0.2	18/12/21	Finish Section2 and modify Section1 because of the decision we make about some ambiguous parts.

## 1.5 Reference Documents

- Project assignment specification document.
- ISO/IEC/IEEE 29148 - Systems and software engineering.
- Course slides on WeBeeP

## 1.6 Document Structure

This document is presented as it follows:

1. **Introduction:** contains a brief description of problems to be solved, purpose of system, and goals which the application must reach. Meanwhile, it describes scope, which gives more details about goals and shows world or shared phenomena.
2. **Overall Description:** gives a general description of the system, focusing on its functions

and constraints. Moreover, it provides the domain assumptions of the analyzed world.

3. **Specific Requirements:** explains in detail the functional and non-functional requirements. It lists the possible interactions with the system in the form of scenarios, use cases and sequence diagrams.

4. **Formal Analysis Using Alloy:** contains the Alloy model of some critical aspects of the system and an example of the generated world.

5. **Effort Spent:** keeps track of the time spent to complete this document.

6. **References:** lists the references used in this document.



## 2. OVERALL DESCRIPTION

### 2.1 Product perspective

#### 2.1.1 Scenarios

- **Scenario 1: Farmer Registration**

Nita is very worried about the recent weather, because there had not been any rain in the past month, which has seriously affected the crops she planted. To make matters worse, the lockdown caused by the COVID-19 pandemic caused prices on local farms to plummet. Therefore, when Nita knows about DREAM, she feels very happy. In fact, she immediately signs up as a farmer by filling out a simple form with her personal data including name, password, address, and phone number. After she accepts the Terms and Conditions of the service and the Privacy Statement, Nita completes the registration.

- **Scenario 2: Information Retrieval**

Kumar plants potato in Telengana and wants to know if tomorrow is a good time to fertilize his fields. Because of the government's publicity, he knows he could find some suggestions on DREAM. He opens DREAM and enters the information search interface.

The System displays a list of production types and the location of Kumar.

Kumar selects potato in the list, confirms that the location is the place where his potatoes are grown, and submits.

The System gives him the weather forecast for next few days which includes the information about temperature and rainfall. The System also shows that it is advised for application of fertilizer as well as earthing up based on the weather. In addition, the System suggests to do constant monitoring in potato because the infection of blight may occur due to high relative humidity.

Kumar takes the suggestions and decide to do the fertilization tomorrow.

- **Scenario 3: Problem Raising and Solving**

Balaiah is a farmer in Telengana. Recently, the cotton he plants is affected by bacterial leaf spot and the fungicide he used in the past is not very effective. Therefore, Balaiah decides to ask for help from others. He logs into DREAM

System and creates a new message in which he describes the symptoms and signs of his crops. He confirms his input and waits for a reply.

Sanjay, an agronomist, is responsible of Balaiah's area. One day, he receives a message submitted by Balaiah in DREAM System. Based on his previous research, combined with historical weather, irrigation system and soil moisture data, he enters details of suggestion about this question, including types, quantities and methods of use of pesticides. Then Sanjay confirms all contents and press down 'reply' button.

Balaiah receives the suggestions and applies them to his cotton. After then, his cotton is recovered from the disease and Balaiah is very happy about the result. He opens DREAM again, navigates to the problem he opened before and gives Sanjay's answer a 9/10 score.

- **Scenario 4: Production report**

Reddy has a bumper paddy harvest recently. After selling out all his paddy, Reddy decides to report his production. He logs in DEARM, chooses production report interface, selects "paddy" in the list of production types, enters the production amount, the paddy plantation area and the plantation period, then submits his input.

- **Scenario 5: Discussion with other farmers**

Surinder grows red chilies on her 2.5-acre farm in Telangana and uses DREAM almost every day. Recently, the government published some policies to help the farmers. Surinder wants to know what others think about the government's compensation measures for red chilies. So, she opens DREAM and creates a discussion in the forum. She enters the name and a brief description of the discussion. In the description part, she attaches the news about these measures. She confirms her input and waits for other farmers' comments.

Anil sees Surinder's post when he browses the forum in DREAM. He reviews the information posted by Surinder and thinks the measures are good for them. He writes a comment in which he explains his opinion.

Surinder receives Anil's comment and agrees with him.

- **Scenario 6: Agronomist's registration.**

Raj is a doctor of agronomist. After graduation, he devoted himself to solving the problems of agroecology encountered in the development of India. Due to his

many influential articles in top publications, he was invited by Telengana to become a distinguished expert to help establish and improve agriculture of Telengana through DREAM System. Then, he was assigned to the region with the worst environment in Telengana Province where extreme weather often occurred, which was a big challenge for him.

At the beginning, Raj has to register in DREAM System. He opens it, then presses down 'register' button, and follows entering all parts, like e-mail, password etc. Moreover, as an agronomist, he must enter the managed area, which environment gives to him. Finally, he successfully registers as an agronomist in DREAM System.

- **Scenario 7: Manage daily plan**

Kamla is another agronomist aimed more at environment and is also invited by Telengana government as an expert.

Today she logins DREAM system and it displays her responsible farms, the time of last visit and farmers' performance.

She finds it has been a long time since last time she visited Kumar. Moreover, she has to pays more attention to Kumar who are under-performing. She presses down Kumar's farm to check more details. The system shows, weather forecast, irrigation system and sensor data of soil humidity in this area. So according to this information Kamla builds a daily plan, then enters title, time, farmers and other details about Kumar's area.

After Kamla visited Kumar's farm, Kamla confirms execution of daily plan. Meanwhile, she also analysis the deviations from the plan and write feedback about this daily plan in system. Then she finally finishes the daily plan and presses 'close' button.

- **Scenario 8: Aamir participants in DREAM**

Aamir, a government office worker, was given the task by his supervisor, that was the first time he heard of "Dream". In fact, he immediately signs up as a policymaker by filling out a simple form with his name, email and password. The young man, finally, completes the registration by accepting the Terms and Conditions of the service and the Privacy Statement and finishes the step of sign up.

- **Scenario 9: Identify the performance of farmers**

Kumar is a new government employee. He feels full of enthusiasm about all new things. His superior sent him a task about identifying the performance of farmers.

First, he logs in the System as the role of policymaker, and he can see the whole map of the Telangana. Then he clicks the interested area, and he can see a detail interface, the System will show farm's detail to him, including short-term and long-term forecasts, water irrigation information, territory and soil humidity information. After the farmers upload their production information on the harvest season, the System will display the relative information to Kumar on the details interface, then he gives each farmer a score according to the policy standard. After calculation, Kumar enters the System, then he inputs the score results into the detail interface and confirms.

- **Scenario 10: Understand the incentive**

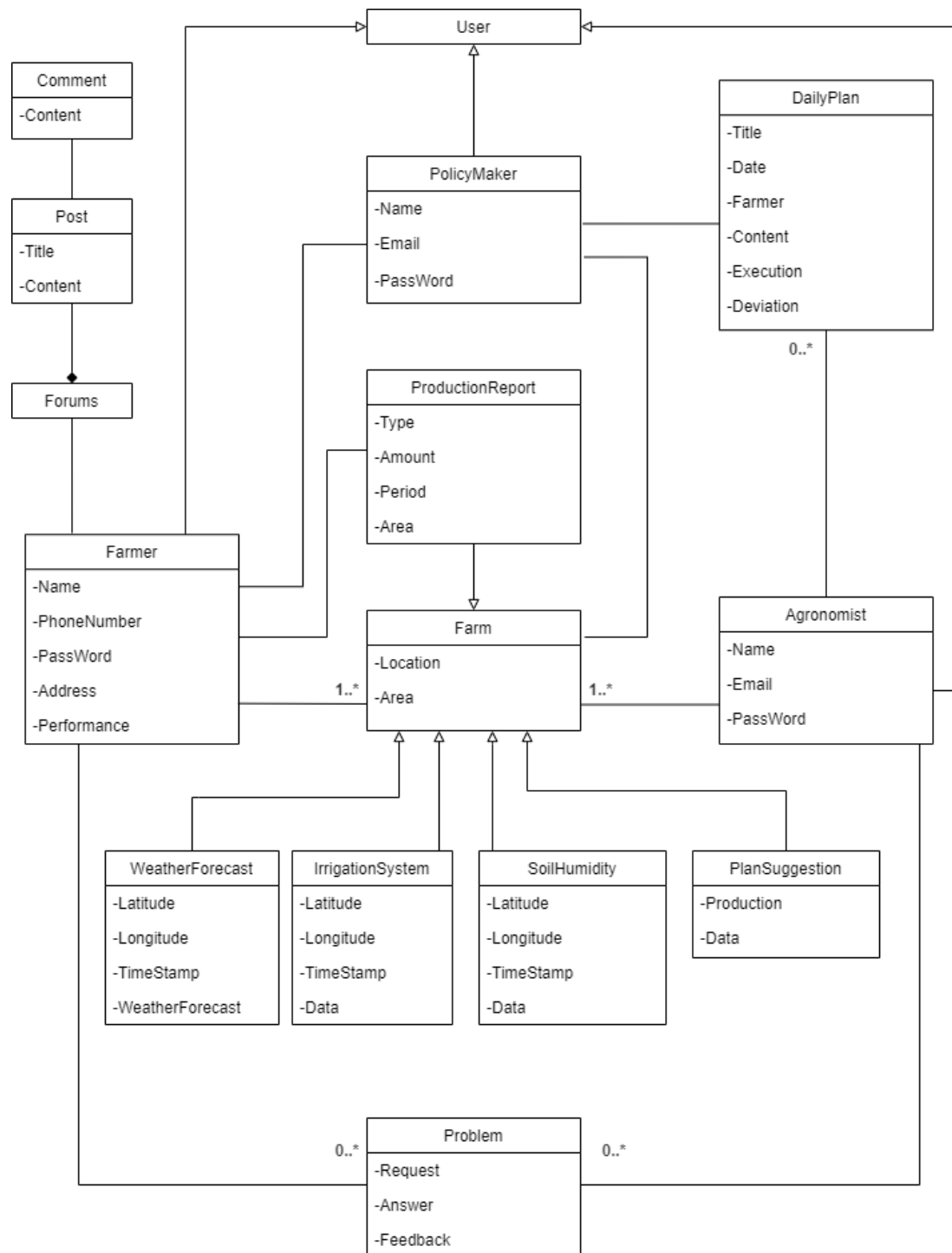
Kiran is a well-experience worker in the Telangana government, under the influence of COVID-19, the farm situation of Telangana got worse and worse, she worried about the farmers and wanted to help them. Then Kiran is assigned to the management part of agronomists. She needs to pay attention to the daily plans of agronomists.

First, she logs in the System as a policymaker, then she can see the whole map of Telangana, and she notices that one agronomist list. Now she wants to check the daily plan of every agronomist so that she clicks the name of them, and then the details of daily plan show out, including the name of agronomist, the visit date, the farmers' name and the deviation. If the deviation changes a lot because of the incentives of agronomist, Kiran needs to collect relevant details information from daily plans and feed it back to her superiors, and finally comprehensively evaluate the agronomists' daily plans, check if the productivity has been effectively improved due to the suggestions of agronomist.

### 2.1.2 Class Diagram

This section details the class diagram of the System. It provides a high-level view of the main concepts on which the system is focused.

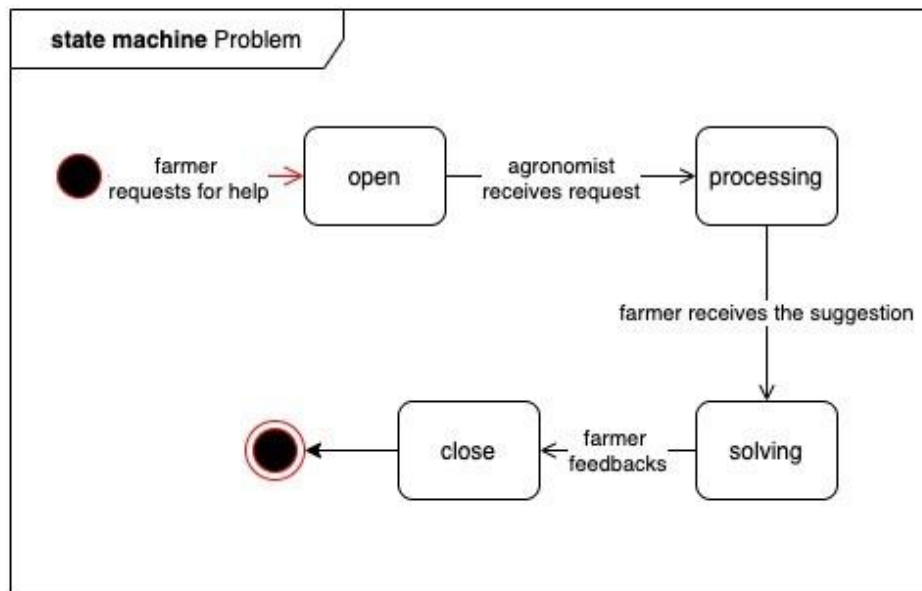
The main elements in the class diagram are:



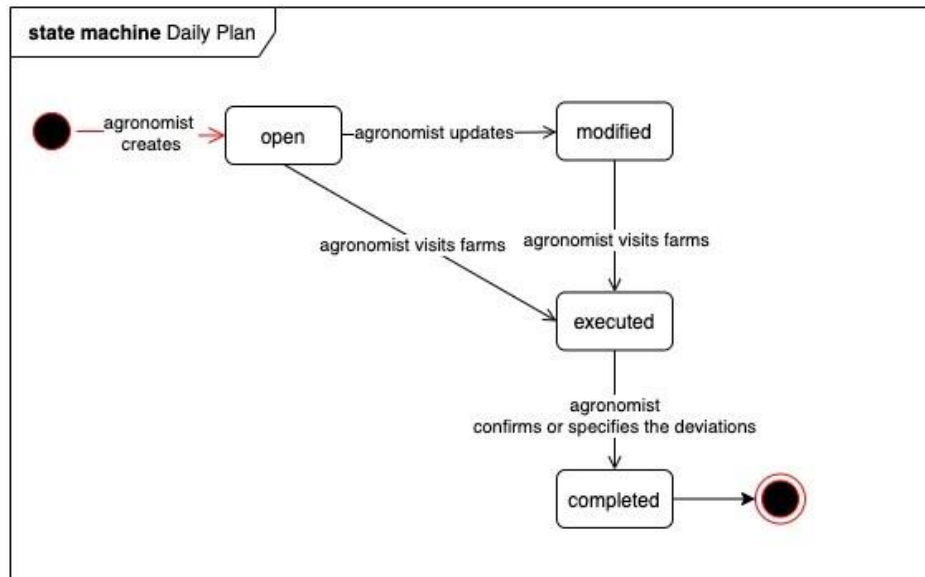
### 2.1.3 State Charts

State charts describe the behavior of the system while considering all possible states the objects can have when an event occurs. This analysis helps to clarify the most critical aspects of the system.

In the following, two simple state diagrams related to some concepts introduced in the previous section are shown. In particular, the first shows the state transitions of a problem, while the second one focuses on the states of a daily plan.



State Chart 1: Problem



State Chart 2: Daily Plan

## 2.2 Product functions

- **Farmer Register:** DREAM Application will allow Farmer to register by entering all the

required information listed in Table 1. When registering to the application, firstly, he/she will declare to have read the Privacy Statement and secondly, he/she will have to accept the Terms and Conditions, which specially include his/her consent to the acquisition and processing of his/her data.

Information	Description	Mandatory
Full name	The Farmer's full name	Yes
Password	A password that meets the minimum-security requirements, i.e., it is at least 8 characters long and contains at least one number and one letter	Yes
Address	The Farmer's Address	Yes
PhoneNumber	The Farmer's phone number	Yes

Table 1

- **Retrieve Information:** Farmer can select the location manually or use the location provided by GPS. If Farmer want to visualize the suggestions about his/her type of production, he/she must specify the type of production from the list of production types displayed in the System. Otherwise, System will display the weather only.

Information	Description	Mandatory
Location	The location of the Farmer or the production	Yes
ProductionType	The Farmer's type of production	No

Table 2

[TBD] does it need to be split down to smaller functions?

- **Ask for Help from Agronomist:** DREAM will allow Farmer to ask for help. Farmer can create a message by inputting the description of the problems and submit. Then the message, together with information of the Farmer, will be visible to the agronomists.

Information	Description	Mandatory
Description	The detail of the problem	Yes

Table 3

- **Feedback the problem-solving result:** After Farmer applies the suggestion from Agronomist, he/she can feedback the result. Farmer can open the problem he/she created before and give a score.

Information	Description	Mandatory
Problem	Associated problem	Yes
Score	The feedback of the result after applying the suggestion.	Yes

Table 4

- **Report Production:** The Farmer can report the production when the harvest has been gathered in. After registration to the System and creating a report, he/she need to specify information listed in table 5 accordingly.

Information	Description	Mandatory
Type	Type of product	Yes
Amount	Produced amount per product	Yes
Area	Plantation area of the product	Yes
Period	Plantation period of the product	Yes

Table 5

- **Create a post:** If Farmer wants to discuss or asks for help from other farmers, he/she can create a post in the forum by inputting the parameters listed in Table 6. After being created, the post would be visible to all Farmers.

Information	Description	Mandatory
Title	The title of the discussion	No
Content	The detail of the discussion	Yes

Table 6

- **Leave a comment:** If Farmer wants to comment on the post created by another Farmer, he/she can create a comment by inputting the parameters listed in Table 7. After being created, the comment would be appended to the related post and visible to all Farmers.

Information	Description	Mandatory
Post	The post which Farmer wants to comment	Yes
Content	The content of the comment	Yes

Table 7

- **Policy maker Register:** DREAM System will allow Policy maker to register. He/she can register by entering all the required information listed in Table 8. When registering to the System, He/she will first declare to have read the Privacy Statement, and secondly, they will have to accept the Terms and Conditions, which specifically include their consent to the acquisition and processing of their data.

Information	Description	Mandatory
Name	The Policy maker's full name	Yes
Email	The Policy maker's email	Yes
Password	A password that meets the minimum-security requirements, i.e., it is at least 8 characters long and contains at least one number and one letter	Yes



Table 8

- **Visualize basic farm data:** DREAM System will allow policy makers to visualize farm information in interests of whole Telangana area, including short-term and long-term forecasts, water irrigation information, territory, soil humidity information and production information, which helps policy maker to identify the performance of farmers.

Information	Description	Mandatory
Location	The interested area of policymaker	Yes

Table 9

- **Input the score of farmers:** After calculating the final score of performance, policy maker can input the score into the System.

Information	Description	Mandatory
Famer	The personal information of farmers	Yes
Performance	The final score for the performance of farmers	Yes

Table 10

- **Visualize agronomist:** When the policy maker logins into the System, he/she can select the agronomist who he/she interested, then find basic information of daily plan, like title, date, farmer, execution, deviation and so on.

Information	Description	Mandatory
Name	The interested agronomist.	Yes

Table 11

- **Visualize the details of daily plan:** If the policy maker wants to check the details of daily plan of Agronomist, then he/she can click the "Title" of the daily plan to acquire exact situation of execution.

Information	Description	Mandatory
Title	The interested title of the daily plan	Yes

Table 12

- **Register as agronomist:** DREAM Application will allow agronomists to register by entering all the required information listed in Table 13. When registering to the System firstly, he/she will declare to have read the Privacy Statement, and secondly, he/she will have to accept the Terms and Conditions, which specially include his/her consent to the acquisition and processing of his/her data.

Information	Description	Mandatory
Name	Name of agronomist	Yes
Email	Email of agronomist	Yes
Password	A password to verify that account is used correctly. It has at least 8 alphanumeric characters, 2 numeric characters.	Yes

Table 13

- **Visualize farmer's basic data:** DREAM system allows agronomist to visualize farmers' basic information in his/her responsible area. After agronomist logs into System, he/she can choose basic information table about farmer. In table about farmer, system displays farmer's name, performance and the time of last visit.
- **Visualize farm's basic data:** DREAM system allows agronomist to visualize farm's basic information in his/her responsible area. After agronomist logs into System, he/she can choose basic information table about farm. In table about farm, system displays farm's location and owner.
- **Visualize farm's detail data:** DREAM system allows agronomist to visualize farm's detail information in his/her responsible area. He/she can click an interested location to visualize weather forecast, soil humidity and irrigation system information in system.

Information	Description	Mandatory
Location	Farm which agronomist is interested in	Yes

Table 14

- **Answer to requests:** DREAM system will allow agronomist to answer farmer's request. After Agronomist receives a request from farmer who is in agronomist's responsible area, he/she searches relative information, gives answer to farmer's request.

Information	Description	Mandatory
Answer	Answer to requests	Yes

Table 15

- **Create a daily plan:** DREAM system will allow agronomist to create a new daily plan. When agronomist decides to create a new daily plan, he/she has to log in System then enter the following required information listed in Table 16.

Information	Description	Mandatory
Title	Title of daily plan	Yes

Date	Date of daily plan	Yes
Farmer	Farmer involved in this plan	Yes
Content	Details about daily plan	Yes

*Table 16*

- **Modify a daily plan:** DREAM system will allow agronomist to modify his/her daily plan. When agronomist change his/her decision about daily plan, he/she can open existing daily plan and modify one or more elements in Table 17.

Information	Description	Mandatory
Title	Title of daily plan	No
Date	Date of daily plan	No
Farmer	Farmer involved in this plan	No
Content	Details about daily plan	No

*Table 17*

- **Complete a daily plan:** After the agronomist creates a daily plan and visits the farmer, he/she has to change the state of execution and enter deviation in the System.

Information	Description	Mandatory
Execution	State of plan already done or to be done	Yes
Deviation	Differences between plan and reality	Yes

**Table 18**

## 2.3 User characteristics

The actors of the application are the following:

- Unregistered User: a single person who has not yet registered.
- Farmer: a single person who has registered to the DREAM System and can use the Services it offers to visualize data, ask for help, report production, and discuss with other farmers.
- Policy maker: a single person who has registered as a Policy maker, to visualize the basic farm data, score the performance of farmers and visualize the daily plan of Agronomist.
- Agronomist: a single person who has registered as an agronomist in DREAM system, to browse information, answer requests and manage daily plan.

## 2.4 Assumptions, dependencies and constraints

### 2.4.1 Domain Assumptions

- [D.1] The external service used by the System to retrieve the weather forecasts is assumed to work properly.
- [D.2] Farmer owns a working smartphone which supports GPS.
- [D.3] The GPS is assumed to be accurate.
- [D.4] Data given by Farmers are assumed to be correct.
- [D.5] The external service used by the System to show the information about the water usage of each farmer is assumed to be accurate.
- [D.6] The external service used by the System to show the information about the humidity of soil is assumed to be accurate.
- [D.7] Every character owns a working smartphone or computer which has access to Internet connection
- [D.8] Agronomist knows how to solve requests from farmers.
- [D.9] Agronomist has at least one responsible farm.
- [D.10] Agronomist visits each farm at least twice a year.
- [D.11] Agronomist visits under-performing farm more often.
- [D.12] Farmer's farms are in the same area.
- [D.13] A Farmer has at least one farm.
- [D.14] Policy maker knows the standard of recognizing the performance of farmers.
- [D.15] Agricultural Product Reference System provides suggestion about planting.

### 2.4.2 Dependencies

- The System will use the GPS of the Farmer's computer/smartphone.
- The System will use the Internet connectivity of the Farmer's computer/smartphone.
- The System will use an external service to retrieve meteorological short-term and long-term forecasts
- The System will use an external service to retrieve water usage per farmer.
- The System will use an external service to retrieve the data about the humidity of soil.
- The System will use an external service to retrieve personal suggestions concerning specific crops

**3. SPECIFIC REQUIREMENTS:** Here we include more details on all aspects in Section 2 if they can be useful for the development team.

### 3.1 External Interface Requirements

3.1.1 User Interfaces

3.1.2 Hardware Interfaces

3.1.3 Software Interfaces

3.1.4 Communication Interfaces

3.2 Functional Requirements: Definition of use case diagrams, use cases and associated sequence/activity diagrams, and mapping on requirements

### 3.3 Performance Requirements

### 3.4 Design Constraints

3.4.1 Standards compliance

3.4.2 Hardware limitations

3.4.3 Any other constraint

## 3.5 Software System Attributes

3.5.1 Reliability

3.5.2 Availability

3.5.3 Security

3.5.4 Maintainability

3.5.5 Portability

## 4. FORMAL ANALYSIS USING ALLOY:

This section should include a brief presentation of the main objectives driving the formal modeling activity, as well as a description of the model itself, what can be proved with it, and why what is proved is important given the problem at hand. To show the soundness and correctness of the model, this section can show some worlds obtained by running it, and/or the results of the checks performed on meaningful assertions.

## 5. EFFORT SPENT:

Timeline	Content	Xu	Zhang	Hu
15/11→19/11	Section1	3.5h	4.5h	2.5h
20/11→22/11	Review section1	0.5	0.5h	0.5h
23/11	Offline discussion section1 part1	1h	1h	1h
24/11→29/11	Section2	5h		
30/11	Offline discussion section1 part2	3h	3h	3h
TBD				
1/12→2/12	Review Section2	1h		
3/12	Offline discussion section2 in Patio	6h		
4/12→6/12	Section3			
7/12→9/12	Review section3			
10/12	Offline discussion section3 in Patio			
11/12→16/12	Section4			
18/12→19/12	Review section4			
20/12→22/12	S5&S6, Final discussion in Patio			
23/12	DDL			

## 6. REFERENCES