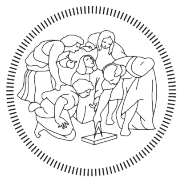

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Requirements Analysis and Specification Document

DREAM

Data-dRiven PrEdictive FArMing in Telangana

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- -, 2021

Version -.0

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Chapter 1

Introduction

The Requirement Analysis and Specification Document (RASD) has the purpose of describing, to a wide range of potential readers, the system to be developed for the problem under consideration.
It contains the description of the scenarios, the corresponding use cases and the models describing requirements and specifications.
It focuses also on interactions between the system and the users, including the implied constraints and functionalities that are going to be implemented.

1.1 Purpose

Telangana is the 11th largest and the twelfth-most populated state in India with a geographical area of 112,077 km2 and 35,193,978 residents (data from2011). The economy of Telangana is mainly driven by agriculture, a sector which plays a pivotal role in all India's economy: over 58% of rural households depend on it as the principal means of livelihood, 80% of whom are smallholder farmers with less than 2 hectares of farmland. More than a fifth of the small-holder farm households are below poverty.

Worldwide there are many threats to the agriculture sector.
World population is estimated to reach 9.7 billion by 2050, therefore food demand is expected to increase anywhere between 59% to 98% by 2050.Climate change is predicted to result in a 4%-26% loss in net farm income towards the end of the century. The COVID-19 pandemic has greatly exposed the vulnerabilities of marginalized communities, small holder farmers and the importance of building resilient food systems.

This calls for a revamp of the entire food supply chain to help bolster countries against shocks and challenges. For this reason, Telangana's government aims to design, develop and demonstrate anticipatory governance models for food systems using digital public goods and community-centric

approaches to strengthen data-driven policy making in the state. To achieve this goal, Telangana wants to partner with IT providers with the aim of acquiring and combining data concerning: weather forecasts, agriculture production (types and produced amount per product, amount of water used by each farmer), humidity of soil and information provided by the governmental agronomists. Acquiring and combining such data, the software system DREAM supports the work of three types of actors: policy makers, farmers, and agronomists.

DREAM allows Telangana's policy makers to identify farmers who are performing well and those who are performing particularly badly. The first ones, especially the more resilient to meteorological adverse events, will receive special incentives and will be asked to provide useful best practices to the others. Moreover, the system will help policy makers to understand whether the steering initiatives carried out by agronomists with the help of good farmers produce significant results. Thanks to the application the policy makers will be able to make decisions in the real world by analyzing and visualising data regarding farmers.

On the other hand, farmers are allowed to visualize data relevant to them based on their location and type of production, such as weather forecasts and personalized suggestions (i.e. specific crops to plant or specific fertilizers to use). Farmers can exploit a sort of personal diary provided by the system (aggiungere nome), in fact they can archive data daily regarding their production and any problem they face. They can also request for help and suggestion by agronomists and other farmers with whom they can also create discussion forums.

Eventually, agronomists are in charge of a certain mandal, which is a local government area and administrative division of Telangana. They can receive information about requests for help and answer them and they can visualize data concerning weather forecasts and the best performing farmers in the area. Furthermore, agronomists can visualize, up-date and confirm a daily plan to visit farms, assuming that all farms must be visited at least twice a year, but those that are under-performing should be visited more often, depending on the type of problem they are facing.

1.1.1 Goals of the Application

- *G.1*: Allows policy makers to visualize and analyze data of farmers
- *G.2*: Allows policy makers to identify those farmers who are performing well

- *G.3*: Allows policy makers to identify those farmers who are performing badly
- *G.4*: Allows policy makers to verify the improvement of farmers who have been already helped by agronomist or good farmers
- *G.5*: Allows farmers to visualize data and suggestions relevant to them based on their location and type of production
- *G.6*: Allows farmers to insert in the system data about their production and any problem they face
- *G.7*: Allows farmers to request for help and suggestions by agronomists and other farmers
- *G.8*: Allows farmers to create discussion forums with the other farmers
- *G.9*: Allows agronomists to receive information about requests for help
- *G.10*: Allows agronomists to answer to requests for help from farmers
- *G.11*: Allows agronomists to visualize data concerning best performing farmers in the mandal
- *G.12*: Allows agronomists to visualize weather forecasts in the mandal
- *G.14*: Allows agronomists to visualize a daily plan to visit farms in the mandal
- *G.15*: Allows agronomists to update a daily plan to visit farms in the mandal
- *G.16*: Allows agronomists to confirm the execution of the daily plan at the end of each day
- *G.17*: Allows agronomists to specify the deviations from the daily plan at the end of the day

1.2 Scope

The aim of the DREAM software product is to develop and adopt anticipatory governance models for food systems to strengthen data-driven state policy.
It takes care of the acquisition and management of all data collected in order to support the work of farmers, agronomists and policy makers.
The system aims to collect data not only from sensors located throughout the territory, but also from farmers. The analysis of the acquired data aims to improve the production of farmers.

Low-performing farmers are identified by policy makers and helped by the best-performing ones.
Everything is supervised by agronomists who take care of their own geographical areas of competence.

To better understand all the phenomena involved, we distinguish them into two types according to the World and Machine paradigm [M. Jackson and P. Zane]. The World is the environment surrounding the system, while the Machine is the system itself.

1.2.1 World and Shared phenomena

Table 1.1: World and Shared phenomena

Phenomenon	**Who controls it?**	**Is it shared?**
A farmer signs up to the application or logs in if already registered	W	Y
Telangana government assigns to each agronomist his ID code	W	N
An agronomist registers into the application by using his ID code or logs in if already registered	W	Y
Telangana government assigns to each policy maker his ID code	W	N
A policy maker registers into the application by using his ID code or logs in if already registered	W	Y

The system processes the performance of a farmer (or more than one)	M	N
A policy maker visualizes the performance trend of a farmer (or more than one) over time	W	Y
A policy maker visualizes the performance score of a farmer (or more than one)	W	Y
The system notifies a farmer who is not performing well that it would be a good idea to request for help to an agronomist or a well performing farmer	M	Y
The system notifies a farmer that he improved his performance and he is entitled to receive an incentive	M	Y
The system sends personalized suggestions to a farmer based on computed data	M	Y
A farmer visualizes relevant information which are: weather forecasts, soil moisture and personalized suggestions and visits	W	Y
A farmer visualizes his history concerning relevant data regarding his production	W	Y

A farmer insert in the system the production of a certain period and the corresponding relevant data	W	Y
A farmer makes a request for help to an agronomist and/or a well performing farmer	W	Y
A farmer opens a thread about a topic on the dedicated forum	W	Y
The system associates each farmer to the corresponding mandal	M	N
An agronomist inserts in the system the mandal he is responsible of	W	Y
An agronomist receives a help request from a farmer	M	N
An agronomist replies to the help requests sent to him by farmers	W	Y
An agronomist visualizes data about best performing farmers of his mandal	W	Y
An agronomist visits a farm belonging to his mandal	W	N
An agronomist visualizes weather forecasts on the app	W	Y

The system creates the agronomist's daily plan, guaranteeing at least two visits per year for each farmer	M	N
An agronomist visualizes his daily plan	W	Y
An agronomist updates his daily plan	W	Y
An agronomist carries out his daily plan	W	N
An agronomist confirms his daily plan execution	W	Y
An agronomist specifies deviations from his daily plan at the end of the day	W	Y

1.3 Definitions, Acronyms, Abbreviations

In the following section is clarified the meaning of some definitions, acronyms and abbreviations which will be use in the RASD, in order to help the general understanding of the document.

1.3.1 Definitions

Table 1.2: Definitions

The System	The whole system to be developed
Application Service	Functionality offered by the System for certain users
Policy Maker	The user of the application who decides about new policies for Telangana

Farmer	The user of the application who owns or manages a farm
Performance	Indicator of the progress of a farmer's activity up to a certain date. Its value is the score
Score	Is the performance rating computed by a function that depends on: type and quantity of harvested product, weather conditions, quantity of water consumed, soil moisture.
Well Performing Farmer	A farmer who has a score higher than a certain threshold
Bad Performing Farmer	A farmer who has a score below a certain threshold
Best Performing Farmer	A farmer who has ...
Agronomist	The user of the application dealing with the management of a certain mandal
Mandal	A local government area and administrative division. Telangana is subdivided into districts which are themselves subdivided into mandals
History	Application service for the farmer, corresponding to a sort of personal diary. It collects information provided by the user daily: type and quantity of harvested product and notes regarding any problems encountered during the day
Daily Plan	Application service that allows the agronomist to manage his daily work schedule. Specifically, it allows him to track and organize visits to farmers

Discussion Forum	Application service which a farmer can use to exchange ideas and opinions about a topic
Help Request	Application service which a farmer can use to request for help and suggestions to the agronomist or/and other well performing farmers

1.3.2 Acronyms

Table 1.3: Acronyms

DREAM	Data-dRiven PrEdictive FArMing in Telangana
RASD	Requirement Analysis and Specification Document
UML	Unified Modelling Language

1.3.3 Abbreviations

Table 1.4: Abbreviations

G.i	i-th goal
R.i	i-th requirement
D.i	i-th domain assumption
UC.i	i-th use case

1.4 Revision History

Table 1.5: Revision History

Version	Date	Authors	Summary
1.0	–/–/2021	Arslan Ali Elisa Servidio Federica Suriano	First release

1.5 Reference Documents

- Specification document: "R&DD Assignment A.Y. 2021/2022"
- Software Engineering 2 course slides
- EEE Std 830-1998: IEEE Recommended Practice for Software Requirements Specifications

1.6 Document Structure

The RASD is structured in the following five chapters:

- **Chapter 1:** It contains a general introduction to the problem of interest and a more detailed list of the goals of this project. The scope of the application is described thanks to the analysis of the phenomena involved. A part relating to the definitions used in the document is also included.
- **Chapter 2:** It contains an overall description of the project including some possible scenarios of interest, the system class diagram and state diagrams. The most important product functions necessary for the correct functioning of the application and all the assumptions on the domain are also described.
- **Chapter 3:** In this part the software product requirements are described in detail. The description of the interfaces is included and the functional requirements are defined thanks to the use of UML diagrams. This section also includes performance requirements, design constraints and software system attributes.
- **Chapter 4:** It contains formal modeling of the software product using the Alloy tool and dedicated comments to better clarify each part of the modeling.

- **Chapter 5:** It contains all the information regarding the hours of work required to create the document and the tasks assigned to each person in the team.

At the end of the document the bibliography is also included.

Chapter 2

Overall Description

This chapter contains a general description of the system from a high level point of view.
It describes the general factors that affect the product and its requirements. It does not state specific requirements. Instead, it provides them a background, which is useful to define them in detail in *Chapter 3*.
Starting from scenarios and domain models, it proceeds with an analysis of product functions and users' most relevant needs in order to define assumptions, dependencies and constraints of the entire application system.

2.1 Product Perspective

In subsection *2.1.1* are listed the most relevant scenarios which are a narrative description of what users do and experience as they try to make use of the application.
They provide a general depiction of how major components of the system and users interact.
Moreover, in subsections *2.1.2* and *2.1.3* the domain of the system is defined through different models using UML.

2.1.1 Scenarios

1. Scenario: **Sunil discovers DREAM**

   Sunil is a farmer from Telangana. Unfortunately, due to the adverse and unpredictable effects of climate change, his production of black carrots is gradually decreasing. Sunil learns from a colleague of his that there is an application called DREAM that could help him. Sunil registers and logs in, hoping to profit from it and improve his production.

2. Scenario: **Rajesh looking for advice**

   Rajesh is a landowner from Adilabad district in Telangana, he owns several agricultural properties in the city. After his recent business trip to Russia, where he attended the beet fair, he is convinced to plant beets on his land too. As this is a little-known plant in the area, he doesn't know who to ask for advice. Rajesh's son Ram, also in the agricultural sector for several years, advises his father to use DREAM since Rajesh already had an account registered with the application. Rajesh consults on the application the discussions already opened by other Telangana farmers to see if any of them had ever sought advice on beet cultivation. Unfortunately he cannot find any, so thanks to the suggestion of his son Ram he decides to open a thread on the dedicated forum, so that he can ask for advice about the plant from other farmers throughout Telangana.

3. Scenario: **Anita and her strategic plan**

   Anita is the administrator of her mandal Sarangapur, in Jagtial district, as an inspector of production and development of the primary sector. Sarangapur is characterized by great periods of drought, so water is a particularly precious resource for citizens. Recent analyzes have shown that over 90% of the water is used by farmers. Anita discovers DREAM and she wants to monitor the water consumption within each mandal in Telangana over the current year. Her goal is to identify the one that consumes the least water to study its strategies, so she enters the parameters of interest (quantity of water and Telangana mandals) on the application. At this point the app returns the mandals and the corresponding consumed water in this last year and Anita is pleased to discover that the primacy is Pegadapalli, a mandal from her own district.

4. Scenario: **Manoj, the Indian tycoon**

   Manoj is an Indian tycoon who would like to invest his capital in the agricultural sector. He accesses the DREAM application as policy maker and checks the map showing the performance score of each mandal. Manoj identifies the best performing ones and decides to invest in Geesugonda mandal which is located in Warangal district.

5. Scenario: **Mahima is thrilled with joy for DREAM**

Mahima is the Additional Director of Agriculture who assist the state Head quarter Commissioner&Director of Agriculture in Telangana. She belongs to the Department of Agriculture, which provides agricultural services to farmers and aims to transfer the latest technical knowledge to the farming community. She was one of those who pushed for the creation of DREAM. Mahima is thrilled with joy for its market launch and she is looking forward to use the application, therefore she gets her personal ID code to be able to registers with the role of policy maker and logs into DREAM.

6. Scenario: **A new job for Shanti**

   Shanti is a young agronimist who operated in Palakeedu, a mandal in Suryapet district. She sees the announcement published on the Telangana government website in which it is reported that the DREAM application has been launched on the market and that for each mandal is required an agronomist. She is unemployed and interested in filling this role. Therefore, she sends her CV, gets hired and receives her personal ID code which allows her to register into DREAM. Eventually, she inserts Palakeedu as mandal of her competence.

7. Scenario: **Champak tries natural farming**

   Champak is a farmer who has planted wheat. The last crop was poor because he didn't have enough money to buy suitable pesticides. He still can't afford them, however he cannot suspend his agricultural activity since his family depends on it as the principal means of livelihood. For this reason Champak creates a help request to both the agronomist and well performing farmers. The first to answer is Jayapal, a well performing farmer from his same mandal. Jayapal suggests him to plant potatoes instead of wheat because they are more resistent. However, Champak has already planted wheat therefore changing crops is out of the question. Champak waits for other answers untill Rajat, the agronomist, replies suggesting him to cover the seeds with microorganisms obtained from particular formulations of cow dung. Champak is willing to follow the advice and is satisfied with the answer. He marks the help request as solved.

8. Scenario: **The busy life of Aruna**

   Aruna is the DREAM agronomist responsible for Jaipur mandal in Mancherial district. It is early morning and the working day is about

to begin. Aruna consults the daily plan to check which are the scheduled visits for the day. An appointment with the farmer Gangesh is scheduled for the afternoon. At that moment she receives a phone call from him, who informs her that his wife is not well, he has to take her to the doctor and for this he has to cancel the scheduled visit. Aruna wishes him the best and updates the daily plan, cancelling the appointment. Further on, she completes all the appointments scheduled in the morning and she drives her car to reach Jaya, a farmer. Unfortounately, Aruna has a small accident with her car, she is unharmed but she will miss the appointment. She informs Jaya and calls a mechanic. She finally returns home in the evening and confirms the daily plan, also specifying the deviation corresponding to the missed visit due to the accident. She also has to reschedule in the first two free slots in her agenda the appointments with Jaya and Gangesh. To do so, she updates the daily plan of the next day.

9. Scenario: **Durvish, the inspector**

   Durvish is the administrative head of Doma mandal, in Vikarabad district. The DREAM application was launched on the market the year before and now he wants to understand whether the steering initiatives carried out by agronomists with the help of good farmers have produced significant results. Therefore, Durvish accesses DREAM with his account and he enters the parameters of interest on the application to select only farmers of his mandal with at least an Help Request solved. At this point the app returns the selected farmers. Durvish wants to visualize their general trend of the performance score as indicator of the efficiency of the application. He selects score as attribute and mean as operation, in return a time chart is shown. He pleasantly discovers that, except for an initial fluctuating trend, the general performance score of farmers with at least a solved Help Request of his mandal is constantly growing, a sign of effective usefulness of DREAM.

10. Scenario: **Deepa fights soil salinity**

    Deepa is a farmer of Telangana who is already using the application DREAM. The cotton she planted is now ready for harvest. The amount of cotton obtained from her hectare of land results in 3 bales, which correspond approximately to 107 kg each. Deepa accesses the app, selects the date corresponding to the current day and inserts in the system type and quantity of product harvested. Two days after, while approaching to plant cotton seeds again, she has a problem regarding

the salinity of the soil which is particularly high and would not allow cotton to grow. For this reason, Deepa stores this information in the system selecting the current day, also adding that it was necessary to buy a biostimulant whose formulation neutralizes excess salts within the soil.

11. Scenario: **Haresh's first encounter with coffee**

    Haresh is a farmer of Telangana who is already using the application DREAM. It is October and within a few days he will have to harvest the sorghum he has planted. To better organize the work of the next few days, Haresh accesses the application and checks the weather forecasts. After the harvest he will also have to decide what to plant, which is why he also checks the soil moisture. Furthermore, due to the drought expected for November, the app suggests Haresh to plant coffee, a product that does not require a particularly humid soil. Haresh thinks that it could be a good idea, however he has never cultivated coffee so it could be necessary to confront with the agronomist about some technical details. Haresh doesn't remember when his next visit with the agronomist will occur, therefore he accesses the visits page on the application and pleasantly reads that one is scheduled for November 5th.

12. Scenario: **Lohit helps the most needy**

    Lohit is the DREAM agronomist responsible for Raipole mandal in Siddipet district. The performance score in his mandal for a good percentage of farmers has been around a value that has not been particularly high for more than six months. For this reason Lohit wants to visualize data regarding best performing farmers to formulate strategies to be applied to the most needy. He accesses DREAM and visualizes farmers whose performance score is between the highest. Analyzing the corresponding data he finds out that they cultivate all the same type of product: rice, which is cultivable under widely varying conditions but prefers hot and humid climate. Therefore, before advising other farmers to plant rice, he consults weather forecasts and humidity of soil trend, discovering that with a very high probability there will be in the next weeks the perfect conditions.

2.1.2 Class Diagram

In this section is reported the Class Diagram of the System, whose main concepts are presented from a high-level point of view.

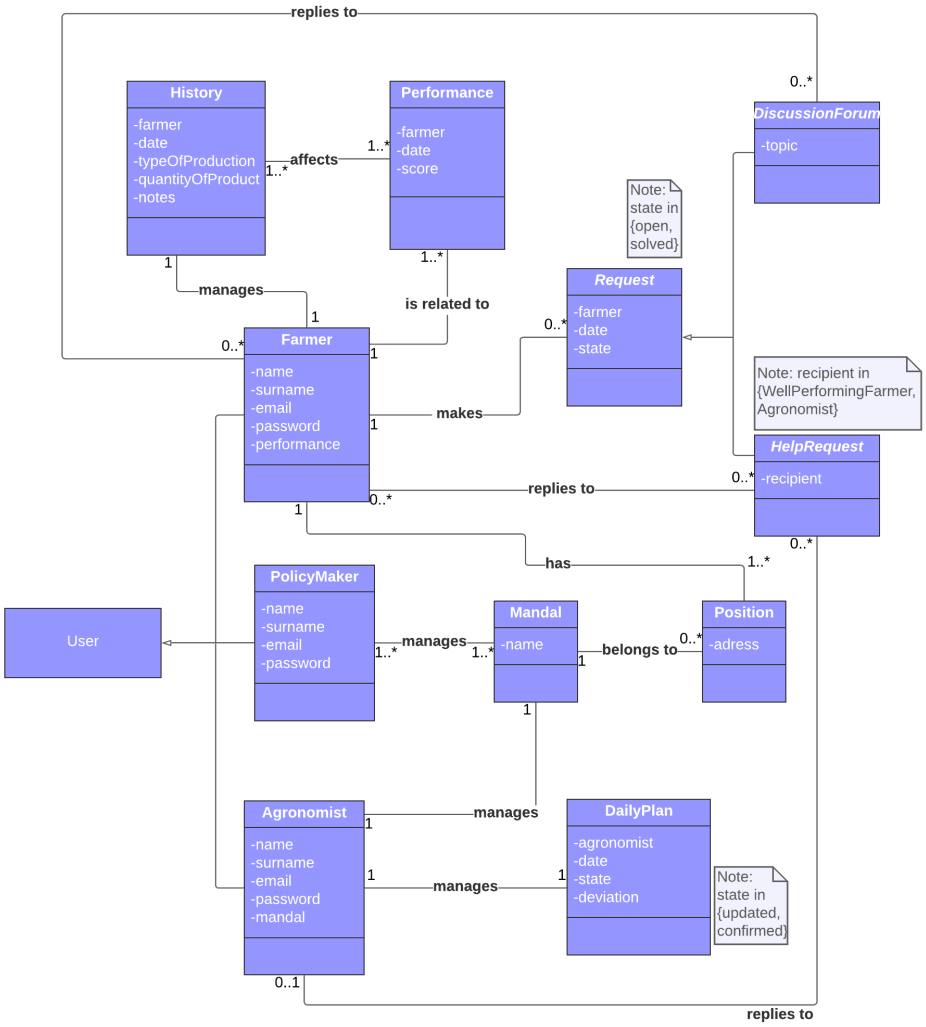

Figure 2.1: Class Diagram

2.1.3 State Charts

Daily Plan Managing State Diagram

This state diagram shows the three states of a Daily Plan.
The Daily Plan is *Created* and then *Updated* or carried out and *Confirmed*, depending on whether the agronomist needs to change the plan or not.

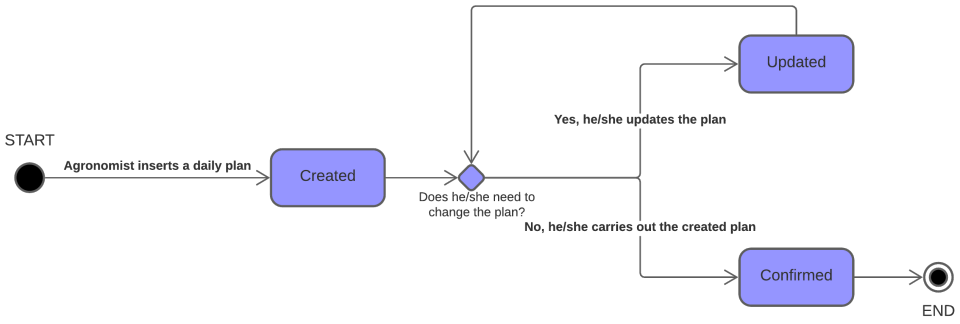

Figure 2.2: Daily Plan Managing State Diagram

Help Request State Diagram

This state diagram shows the two states of a Help Request.
The Help Request is *Created* and then *Solved*, depending on whether the farmer is satisfied with the reply received or not.

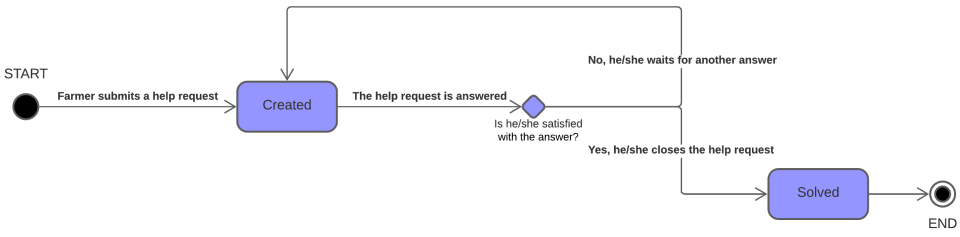

Figure 2.3: Help Request State Diagram

Discussion Forum State Diagram

This state diagram shows the two states of a Discussion Forum.
The Discussion Forum is *Created* and then *Solved*, depending on whether the farmer is satisfied with the replies received or not.

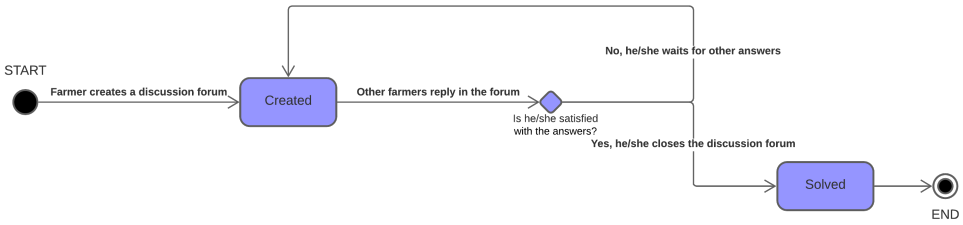

Figure 2.4: Discussion Forum State Diagram

2.2 Product functions

Policy maker registers
Farmer registers
Agronomist registers
Help Request
Discussion Forum
Agronomist Daily Plan
(Farmer's history ("diary"))
Notifications

2.3 Users Characteristics

Policy maker
Agronomist
Farmer

2.4 Assumptions, dependencies and constraints

Vuoto

2.4.1 Domain Assumptions

Vuoto

2.4.2 Dependencies

Vuoto

Chapter 3

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Vuoto

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Vuoto

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Vuoto

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3.1.3 Software Interfaces

Vuoto

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Vuoto

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Vuoto

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Vuoto

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Vuoto

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Vuoto

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Vuoto

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Vuoto

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Vuoto

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3.5.3 Security

Vuoto

3.5.4 Maintainability

Vuoto

3.5.5 Portability

Vuoto

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Formal Analysis using Alloy

Vuoto

4.1 Alloy Model

Vuoto

4.1.1 Signatures

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4.1.2 Facts

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4.1.3 Assertions

Vuoto

4.1.4 Analysis Results

Vuoto

Chapter 5

Effort Spent

5.0.1 Ali Arslan

Table 5.1: Effort spent - Ali Arslan

Task	Hours
Case study comprehension for Q&A session with stakeholders	0.45
Attendance of Q&A session with stakeholders	1.00
Document restyling	0.40
Goals section	0.30
World and Shared phenomena	1.00
Class Diagrams	1.30
State Diagrams	0.30

5.0.2 Servidio Elisa

Table 5.2: Effort spent - Servidio Elisa

Task	Hours

Case study comprehension for Q&A session with stakeholders	0.45
Attendance of Q&A session with stakeholders	1.00
Latex document template	0.15
Purpose section	0.35
Goals section	0.30
World and Shared phenomena	1.30
Class Diagrams	1.30
State Diagrams	0.50
Definitions, Acronyms, Abbreviations section	0.20

5.0.3 Suriano Federica

Table 5.3: Effort spent - Suriano Federica

Task	Hours
Case study comprehension for Q&A session with stakeholders	0.45
Attendance of Q&A session with stakeholders	1.00
Goals section	0.30
Scope section and World and Shared phenomena	2.30
Class Diagrams	1.30
State Diagrams	0.30
Document Structure section	0.20

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