POLITECNICO
MILANO 1863

SCUOLA DI INGEGNERIA INDUSTRIALE
E DELL'INFORMAZIONE

DREAM - Data-dRiven PrEdictive FArMing in Telengana

RASD
Software Engineering 2

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Contents

1 | INTRODUCTION

1.1. Purpose

The Indian's population counts 1,8 bilions people and their main source of incomes come from the agriculture sector. More precisely 80% of farmers own less than 2 hectares of cultivable land. Nowadays, as a consequence, an important part of the population is already below the poverty threshold, and if nothing will be changed during the next decades this condition will become even worst.

In addiction to this, the productivity will decrease due to many factors: for example the increasing demand of food caused by the growth of the population and the aggravation of climate conditions as a consequence of irresponsible behaviour towards the environment.

An improvement in the communication and data management system could potentially avoid and prevent production problems and lack of food for the poorer part of the population.

Our main goal is to help both farmer and Talengana's policy makers to improve their communication with the focus in quality and quantity of information. The farmer need to receive more technical and environmental advice in order to develop their working skills and consequently their productions. On the other hand policy makers should have available enough data and feedback about farmer's performances in order to improve their economical policies and the country general welfare.

1.2. Scope

In order to manage more efficiently the communications between farmers and policy makers our DREAM application will provide an easy way to access the system which will make available to all different users a dedicate set of tools and information.

Farmers will be able to monitor weather conditions, crops and fertilized suggestions. They will have the possibility to send direct requests to expert or other farmers in order

to receive advice. The ease of communicating their production data and problems will be a key point.

Telengana's policy makers will be able to monitor farmers performances and decide if current policies are providing good results. They will also be supported in the visualization of critical situations in order to intervene in advance.

1.2.1. World phenomena

World phenomena	Description
WP01	Weather changes
WP02	A rare climatic event occours
WP03	Farmer cultivates his land
WP04	Farmer harvests
WP05	A new law concerning agriculture is published

Table 1.1: Table of World phenomena

1.2.2. Shared phenomena

Shared Phenomena	Description	Control
SP1	The farmer check the weather map of the area where he belongs.	world controlled
SP2	The farmer receives a notification about an important climatic event.	machine controlled
SP3	The farmer sends an help request.	world controlled
SP5	The farmer gets an answer to a ticket he sent.	machine controlled
SP6	The farmer reads information in the archive of the software.	world controlled
SP7	The farmer writes in the forum.	world controlled.
SP8	The farmer is notified of new replies of a forum's thread.	machine controlled
SP9	The farmer reads comments in a forum's thread.	world controlled
SP10	The farmer is able to send a report about his production.	world controlled
SP11	The farmer is notified of the policy maker answer about his production.	machine controlled
SP12	The farmer is able to read the policy maker report about his production.	world controlled
SP13	The policy maker is able to analyze the weather map of his working area.	world controlled
SP14	The policy maker gets notifications about the main climatic events.	machine controlled.
SP15	The policy maker is able to read the news about the main climatic events.	world controlled
SP16	The policy maker is able to watch and analyze the statistics.	world controlled

SP17	The policy maker is able to access to the contact list.	world controlled
SP18	The policy maker receives notifications concerning new tickets addressed to him.	machine controlled
SP19	The policy maker is able to answer to the tickets.	world controlled
SP20	The policy maker gets a notification about a farmer's report.	machine controlled

Table 1.2: Table of Shared Phenomena

1.2.3. Goals

Goals	Description
G01	Allow farmers to easily check weather condition.
G02	Allow farmers to have technical and personalized advices from other farmers or experts of the field.
G03	Allow farmer to ask for help to the government.
G04	Improve the communication between farmers through a forum.
G05	Improve data communication between farmers and government.
G06	Allow the government to improve the analysis and the sharing of important data concerning agriculture.
G07	Allow the government to have specific data about farmers.
G08	Allow the policy makers to easily recognise critical and virtuous situations.

Table 1.3: Table of Goals

1.3. Definitions, Abbreviations

1.3.1. Definitions

Definition	Description
Farmer	A farmer registered in the system.
Policy Maker	An authorized user who works for the government.
Farmer Report	Document containing information about production , expenses and incomes of farmers.
Policy Maker Report	Document containing an economical/production analysis towards a specific farmer. It includes also managment suggestions about what they could do to improve or to maintain the situation.
Archive	A collection of technical information about plants fertilizers and practical tools.
Forum	An application's section where users can hold conversations in the form of posted messages.
Ticket	A special message which farmers can use in order to directly contact policy makers.

Table 1.4: Table of Definitions

1.3.2. Abbreviations

Abbreviation	Description
A1	

Table 1.5: Table of Abbreviations

1.4. Revision history

1.5. Reference Documents

- Specification document: Assignment RDD A.Y. 2021-2022
- Course slides

1.6. Document Structure

1.6.1. Section 1

Introduction about the purpose and scope of the system. Discussion of the main world and shared phenomena concerning our application's domain and goals are pointed out. Furthermore we sum up all the definitions and references in order to have a better comprehension of the following chapters.

1.6.2. Section 2

Descriptions of different scenarios which describe multiple interactions that the application could face, then there is a structural description of the system represented by the presence of various graphs such as class diagrams , statecharts , use case diagrams , sequence diagrams and activity diagrams with all of their main characteristics. After this there is the product functions section where there are multiple descriptions of all the possible functionalities which are present inside the application. In the last part there is a list of the domain assumptions and the characteristics of the users who will exploit the application.

1.6.3. Section 3

This is the main part of the document, at the beginning there is a description of the software and communication interfaces. After this there is the list of the requirements along with their description and a table which maps the goals with the respective requirements and domain assumptions. In addiction to this there is a part with all the use case diagrams followed by their respective descriptions, then there are the corresponding sequence and activity diagrams and a table which has the aim to map all the requirements with the respective diagram. At the end there is a list of the performance requirements and design constraints of the system.

1.6.4. Section 4

This section is filled with description of the system using the Alloy language.

1.6.5. Section 5

This section is created to show how much time every student spent in the multiple parts of the documents.

1.6.6. Section 6

This sections is made in order to point out all the references used during the creation of this document.

2 | OVERALL DESCRIPTION

2.1. Product perspective

2.1.1. Scenarios

Registration Yamir is a farmer in the province of Hyderabad and he saw in the newspaper the new project DREAM proposed by the government to help the agriculture's economy of the country. So he decided to register at the program. After he opens the app the system asks him to insert various information about his personal and fiscal status, his farmlands and how many collaborators he has. Yamir fills all the text boxes and clicks confirm. Then he is asked for the final confirmation through the mail. He sees an email from DREAM and after opening it he can click the link to conclude the registration. The system shows to Yamir that the registration has been completed.

Checking the weather Anirudh is a farmer who lives in the outskirt of Warangal, he has bought a new piece of land where he would plant a new sort of vegetable. In order to check if this is the right time to plant the seeds he needs to know as soon as possible if there will be a week full of rain or there will be a sunny period in the next weeks. For this purpose Anirudh uses the application DREAM to check the weather conditions in the next period, it allows the farmer to check lot of data suck as the humidity in the air , the amount of water that will fall down and the most important one which is the probability of rain in a certain day in order understand if this is the right time plant a new type of plant or not , because the rain water is vital for the beginning of the lifecycle of a plant.

Looking for plants information Shyla have planned a visit to the city market for tomorrow in order to buy some new plants and seed for her land. She has already some ideas about the plant he wanna cultivate, but she would like know something more. Since she is already registered to the DREAM platform he log in and navigates to the archive area. She search for "Apple Gourd" in the archive and open its technical sheet. Shyla sees that "Apple Gourd" is a really nice plant for the humidity and type of soils of his

land. Shyla is now more informed and sure of her choice.

Sending a ticket Ravi has a problem inside a piece of his lands because during the monsoons season the river has overflowed and flooded a good amount of fields . This particular part of his territory is very fruitful , he's always able to obtain a really good amount of products from it but this year he doesn't know how to get out from this terrible situation. In addiction to this , he is not sure if he will be able to pay the providers without the incomes produced by this piece of land. Ravi try to resolve this situation by sending a ticket thanks to the dedicated part in the DREAM application. In this help request he writes about his problem and in few days an expert in this answered to him by explaining a possible solution to balance the income by using the other fields he owns and to recover the piece of land which is under the water.

Checking for news Ranjeet usually wakes up at 6:00 A.M., the first thing he checks is the news part on the DREAM application in order to understand how to organize his daily work. He discovers that in the afternoon of that day with an high probability there will be a strong storm . Thanks to the notification he is able to close all the greenhouses and to ask for help to his colleagues to make his cultivation environment safety and to prevent huge damages.

Filling a report Anish, at the end of the harvesting season , wants to shares the results of his productions with the government and the experts in order to understand if he's doing a good job with his cultivations or not. His aim is to obtain extra grants because he spent lot of time and efforts in the cultivation of his fields. The application allows him to complete a pre-compiled report Anish can insert all of the needed data which will be sent to the policy maker who asses his work. If the results of his productivity will be really good he will obtain more money from the state as a reward and in order to spur him to continue like this, on the other hands in case of negative evaluation of his work he could obtain monetary aids.

Replying to a thread in the forum Naresh is an expert and productive farmer in the province of Adilabad and he likes to share his knowledge in order to help others farmers. As every evening after dinner he logs into the DREAM application and gives a look into the forum section. He notices some new messages to a thread he was really expert about. After opening the thread he read all the messages and then he clicks in the "send comment" button in order to give his opinion. After having wrote the message he confirms to submit it and he return in the forum's home looking for some other open

topics.

Receiving response of economical help Kushagra is eating his lunch when he receives a notification from the DREAM applications. Since he was waiting an answer for and important request he lunches the app and, since he is already logged in, the ticket's page is showed. He sees the reply he was waiting for and he click to read all the answer. in the message he is asked to send other specific information in order to proceed with the request of economic refreshment. He click to the reply button and writes down all the information. Now he presses the forward button and then he logged out from the application.

Looking for statistics Kushagra have to produce a report for the government about the farmers in his monitored area. He logs into the DREAM system and navigates to the analysis page. Here he can visualize all the important data of the area through different charts, grouping and ordering them how he prefers. Once he has arranged the data in a meaningful way he exports them in order to insert them into the report he is writing as supporting arguments.

Replying to tickets Bhavin is working in his office when he receives a notification through the DREAM application. A new ticket from Ravi, regarding an hydrological problem is arrived. Ravi clicks on the notification and the app opens on the ticket's management page. Bhavin now can open the unread ticket and read the entire message. After that he click on the reply button and write down some advice and useful information for Ravi's problem.

Organize an inspection Akanksha is one of the policy makers of Siddipet and he's scheduling his next inspection week. In order to fix all the appointments he needs to call Dayanand and Kamalkant, two big farm owners. After he has logged in the DREAM application he navigate to the contacts list. Here he can insert the names and click the search buttons. Two contacts are now showed in the list and he can click on each one to see more information. After clicking on Kamalkant he see his phone number and he is ready to call. Once he has finished the call he can do the same for Dayanand.

2.1.2. class diagram

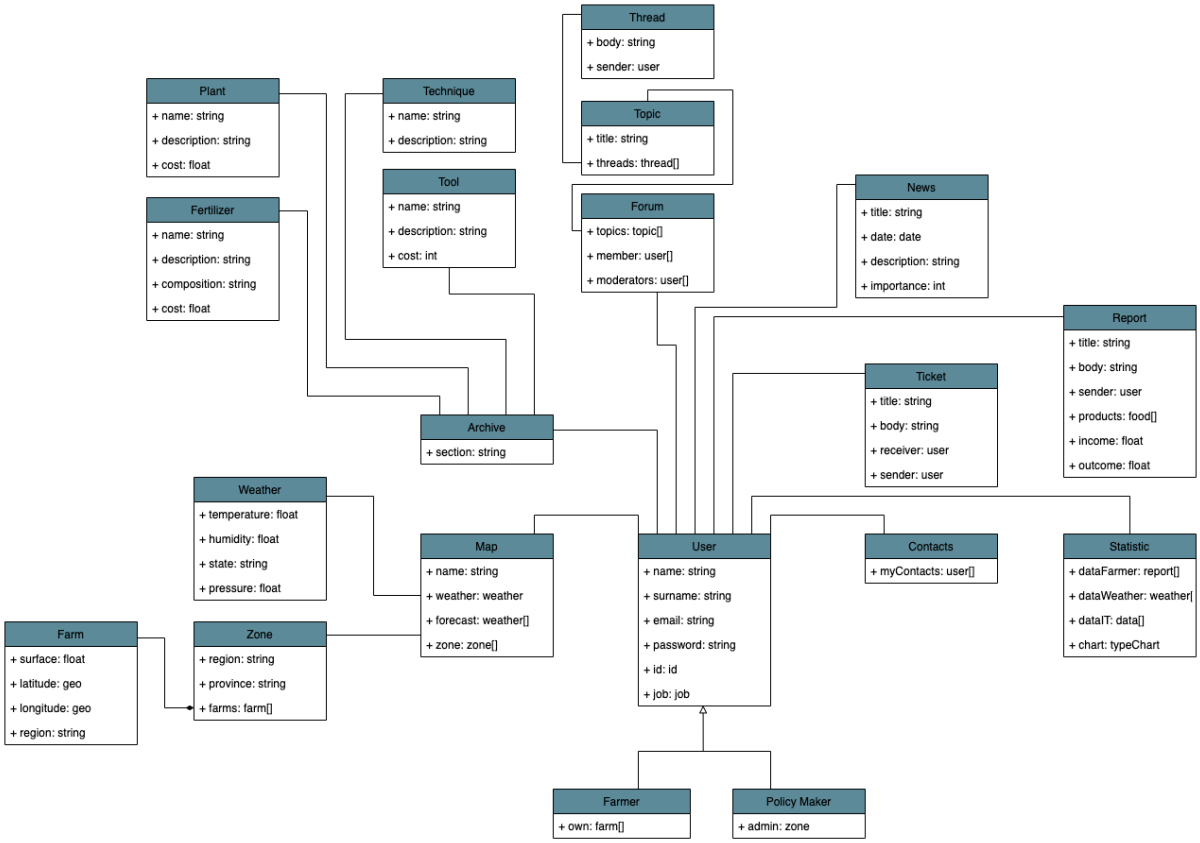

Figure 2.1

2.1.3. statechart

2.2. Product functions

The system gives the farmers and policy makers the opportunity to exploit multiple main functionalities.

Functionalities available for the farmers

- **Weather forecast:** The farmer has the possibility to see the weather forecast of the place where he/she is located. In addiction to this he/she is able to analyze other important data such as the amount of water that could fall down, the percentage of humidity in the air or the probability that there will be a thunderstorm.
- **Reading news:** The farmer is able to stay updated on the latest news thank to the dedicated part on the application. The information gathered in this sector

of the application concern all the possible facts linked to politcs, agriculture and climate changes.

- **Plants archive:** The farmer can improve his knowledge about the plant and vegetable he has in his farmland thanks to the large pool of information inside the plants archive in the application. He/She has the possibility to search the plants by their name and then obtain the important details in order to cultivate them.
- **Sending Tickets:** The farmer can send a ticket in the appropriate part inside the application where he/she can ask everything about one or more problems he/she faces during his/her job and an expert or a member of the government will analyse the request and propose a solution.
- **Using Forum:** The farmer can discuss a problem or propose his/her opinion with the other farmers and experts by writing it inside the forum that is available inside the application. Here all the comments or discussions are public and can we red by everyone .
- **Sending reports:** The farmer can share with the policy maker and the experts his/her productivity data by completing the a pre-compiled report which is available inside the appropriate part in the application.

Functionalities available for the policy makers

- **Reading news:** A policy maker can stay updated of the main events which affect the politics and the climate, this is possible thanks to the news part inside the application. When a huge news about the topics mention before happen , the system is able to collect it and let the user know the fact in detailed.
- **Read and answer to tickets:** A policy maker can read , analyze and answer to all the tickets in the compartment present inside the software. He/She is also able to know from who the tickets come from , in this way he/she can try to resolve the problem in a more direct way.
- **Analyze statistics:** The policy maker has the possibility to watch and analyze all the statics which come from the analysis of all the report sent by the farmer. Inside this area there will also be the possibility to watch information about the weather forecast , the humidity in the air and other important data linked with the climate.
- **Address book:** The policy maker has the possibility to access to all of his/her contacts in the special area inside the application. In this way he/she can communicate with all kind of people from the experts of the different sectors to the farmers.

2.3. User characteristics

The system can be exploit by the following actors:

- **Farmer:** A person which own a farm. He/she can be helped from the government, policy makers and experts and could help other colleagues if he/she wishes.
- **Policy maker:** A person who is designed to analyse and monitor a specific zone composed of different farms. He/she becomes a link between farmers and government.

2.4. Assumptions, dependencies and constraints

Domain Assumptions	Description
D1	A farmer can exploit the application functions only if he/she is registered and the account is unique.
D2	A policy maker can exploit the application functions only if he/she is registered and the account is unique.
D3	Every farmer and policy maker give the authorization to use their geographical data for the internal system processes.
D4	Every farmer give the authorization to use their land registry data for the internal system processes.
D5	The registered farmers are the owners of the farm.
D6	Every farm is delimited, land registered from government and has a unique identifier.
D7	Before sending economical helps or bonuses to farmers there is an external check by a government financial organ.
D8	The weather data extracted from the external API are reliable.
D9	Every farmer own a generic mobile device in order to use the application, otherwise the government will provide one.
D10	A farmer own all the information to fulfill the report or he/she obtains them from an external provider.
D11	Farmers send the report with all of their data every 6 months.
D12	The farmers' forum is moderated internally by them.

Table 2.1: Table Of Domain Assumptions

3 | SPECIFIC REQUIREMENTS

3.1. External Interface Requirements

3.1.1. Software Interfaces

The system needs to interface with an external geo-localization API in order to understand the position of the farmer's land, to filter the information giving relevance based on the geographical position.In addiction to this interfaces , the application uses an API to obtain land registry data usefull for the internal system behaviour. In order to give weather information and forecasting the application exploit an external weather API, this functionality must be reliable with the aim to guarantee the correct system behaviour, it provides data concerned the temperature , the humidity in the air , the percentage of pollution , the wind speed , the probability of precipitations and its quantity. An external chart API is exploited with the purpose to offer to the policy makers multiple facets and analysis of the data. The system also requires and API to support the internal archive ,this allows to always have up to date data about plants and fertilizer. The application uses an external forum's framework in order to manage all the threads and topics. In order to keep our news section reliable and up to date the application interfaces with an external news API which extracts only the relevant information about politics , economy and agriculture.

3.1.2. Communication Interfaces

In order to maintain the correct behaviour of the application and up to date information the system requires an stable internet connection.

3.2. Functional Requirements

3.2.1. List Of Requirements

Requirements	Description
R1	The system shall allow an unregistered farmers to register.
R2	The system shall allow an unregistered policy makers to register.
R3	The system shall allow a registered farmers to unregister.
R4	The system shall allow a registered policy maker to unregister.
R5	The system shall send a confirmation email to a farmer who finishes the registration process in order to confirm the entire procedure.
R6	The system shall send a confirmation email to a policy maker who finishes the registration process in order to confirm the entire. procedure.
R7	The system shall allow the farmer to check the weather conditions of the entire week.
R8	The system shall allow the farmer to visualize the weather characteristics like the humidity , the temperature and the probability of precipitations in the current day.
R9	The system shall allow the farmer to visualize the general weather map of Telengana.
R10	The system shall allow the farmer to visualize the weather map of his farm.
R11	The system shall allow the farmer to visualize the news.
R12	The system shall allow the farmer to visualize the archive.
R13	The system shall allow the farmer to search inside the archive.
R14	The system shall allow the farmer to visualize the results of the research in the archive.
R15	The system shall allow the farmer to send a ticket request.
R16	The system shall allow the farmer to get notified by an answer of his/her ticket.
R17	The system shall allow the farmer to compile a report.
R18	The system shall allow the farmer to send a report to a policy maker.
R19	The system shall allow the farmer to get notified for a report answer.
R20	The system shall allow the farmer to visualize the forum.
R21	The system shall allow the farmer to open a topic in the forum.
R22	The system shall allow the farmer to read a topic in the forum.

R23	The system shall allow the farmer to create a new thread in the forum.
R24	The system shall allow the farmer to answer to a thread in the forum.
R25	The system shall allow the farmer to delete a thread in the forum.
R26	The system shall allow the farmer to read a thread in the forum.
R27	The system shall allow the policy maker to check the weather conditions of the entire week.
R28	The system shall allow the policy maker to visualize the weather characteristics like the humidity , the temperature and the probability of precipitations in the current day.
R29	The system shall allow the policy maker to visualize the general weather map of Telengana.
R30	The system shall allow the policy maker to visualize the weather of the area he/she checking.
R31	The system shall allow the policy maker to visualize the news.
R32	The system shall allow the policy maker to get notified when he/she gets a ticket.
R33	The system shall allow the policy maker to answer to a ticket request.
R34	The system shall allow the policy maker to get notified when he/she gets a report from a farmer.
R35	The system shall allow the policy maker to write an answer to a report.
R36	The system shall allow the policy maker to visualize the forum.
R37	The system shall allow the policy maker to read a topic in the forum.
R38	The system shall allow the policy maker to read a thread in the forum.
R39	The system shall allow the policy maker to visualize data.
R40	The system shall allow the policy maker to aggregate and disaggregate data.

R41	The system shall allow the policy maker to change the visualization of data.
R42	The system shall allow the policy maker to visualize contacts.

Table 3.1: Table Of Requirements

3.2.2. Mapping Requirements on Goals

R/G	G1	G2	G3	G4	G5	G6	G7	G8
R1	X	X	X	X	X	X	X	X
R2			X		X	X	X	X
R3								
R4								
R5	X	X	X	X	X	X	X	X
R6			X		X	X	X	X
R7	X	X						
R8	X	X						
R9	X							
R10	X	X						
R11		X			X			
R12		X						
R13		X						
R14		X						
R15			X		X	X	X	X
R16			X		X			
R17			X		X	X	X	X
R18			X		X	X	X	X
R19			X		X			
R20		X		X				
R21		X		X				
R22		X		X				
R23		X		X				
R24		X		X				
R25		X		X				
R26		X		X				
R27						X		
R28						X		
R29						X		
R30						X		
R31					X	X		
R32			X		X	X	X	X

R33			X		X	X	X	X
R34			X		X	X	X	X
R35			X		X	X	X	X
R36					X	X		
R37					X	X		
R38					X	X		
R39			X		X	X	X	X
R40			X		X	X	X	X
R41			X		X	X	X	X
R42			X		X		X	

Table 3.2: Mapping Requirements on Goals Table

3.2.3. Mapping Domain Assumptions on Goals

D/G	G1	G2	G3	G4	G5	G6	G7	G8
D1	X	X						
D2			X		X	X	X	X
D3	X	X	X		X	X	X	X
D4	X	X	X		X	X	X	X
D5			X		X	X	X	X
D6		X	X		X	X	X	X
D7			X		X	X	X	X
D8	X	X				X	X	
D9	X	X	X	X	X	X	X	X
D10			X		X	X	X	X
D11			X		X	X	X	X
D12		X		X				

Table 3.3: Mapping Domain Assumptions on Goals Table

3.2.4. Use Case Diagrams

Name	Event
D1	

3.2.5. Sequence Diagrams

3.2.6. Activity Diagrams

3.3. Performance Requirements

- The system should be available 99.5% of the time.
- The response time of a research in the archive should last a maximum of 4 seconds.
- The response time of a research of a news should last a maximum of 4 seconds.
- The load time of the weather map should last a maximum of 3 seconds.
- The refresh time of the weather map should last a maximum of 3 seconds.

3.4. Design Constraints

3.4.1. Standards compliance

- The system must require the farmer the permission to retrieve data regarding the position.
- The system must manage the data retrieved from the users in respect with the privacy laws.

3.4.2. Hardware limitations

- Customer device
- Mobile network connection
- GPS

3.4.3. Any other constraint

3.5. Software System Attributes

3.5.1. Reliability

Due to the presence of a great amount of sensible data the system provides duplicates of the components. In addiction to this it should be safe implementing a storage system which implies the redundancy of data with the aim to avoid data losses.

3.5.2. Availability

There's should be copies of the different components of the system in order to have the possibility to keep the service up while there is the necessity to make maintenance operations.

3.5.3. Security

There are many important data give by the farmers like their landing data or they geographical position which must be protected from a potential attack directed to the database. The system must use a system of encryption and decryption of the data in order to maintain the data safe and to avoid useless concerns for the users.

3.5.4. Maintainability

The system is developed by using the best practices and modalities of software engineering in order to maintain it and have the possibility to expand its functionalities.

3.5.5. Portability

The application is developed in order to be compatible with the majority of the versions of iOS and android for smartphone, it will be possible to use it in the future versions of these two and potentially it will be compatible with new emergent operating systems which could expand their presence in the country.

4 | Formal analysis using Alloy

5 | EFFORT SPENT

Student 1: Brunello Simone

Topic	Hours
General Reasoning	
Purpose	
Scope	
Class Diagram	
External Interface Requirements	
Product Functions	
Domain Assumptions	
Functional Requirements	
Use Cases	
User charachteristics	
Sequence Diagrams	
Alloy	
Document Organisation	
System Attributes	
Design constraints	

Student 1: Nicholis Nicolas

Topic	Hours
General Reasoning	
Purpose	
Scope	
Class Diagram	
StateChart	
Activity Diagrams	
Domain Assumptions	
Functional Requirements	
Use Cases	
Use Case Diagrams	
Sequence Diagrams	
Alloy	
Document Organisation	
System Attributes	
Design Constraints	

6 | REFERENCES