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## Requirements Analysis and Specification Document



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# Contents

<b>List of Tables</b>	<b>3</b>
<b>1 Introduction</b>	<b>4</b>
1.1 Purpose . . . . .	4
1.1.1 Goals of the Application . . . . .	5
1.1.2 Users and Interfaces of the Application . . . . .	5
1.1.3 Dataset Description . . . . .	6
1.2 Scope . . . . .	9
1.3 Definitions, Acronyms, Abbreviations . . . . .	11
1.4 Reference Documents . . . . .	12
1.5 Document Structure . . . . .	12
<b>2 Overall Description</b>	<b>13</b>
2.1 Product Perspective . . . . .	13
2.2 Functions for the Users . . . . .	13
2.3 Users Characteristics . . . . .	14
<b>3 Specific Requirements</b>	<b>15</b>
3.1 Use Cases . . . . .	15
3.1.1 UC.1 PA registers into the system . . . . .	15
3.1.2 UC.2 PA logs into the application . . . . .	16
3.1.3 UC.3 PA enters data about new bin . . . . .	17
3.1.4 UC.4 PA visualizes data on an interactive map . . . . .	17
3.1.5 UC.5 PA visualizes info about points/area on the map . . . . .	18
3.1.6 UC.6 PA updates infographic . . . . .	19
3.1.7 UC.7 Citizen entering data . . . . .	20
3.1.8 UC.8 PA makes query on data . . . . .	21
3.1.9 UC.9 GC registers into the application . . . . .	21
3.1.10 UC.10 GC logs into the application . . . . .	22
3.1.11 UC.11 Garbage Collector visualizes data . . . . .	23
3.1.12 UC.12 Garbage Collector reports if a bin is overfull . . . . .	23
3.2 Requirements . . . . .	24
3.2.1 Functional Requirements . . . . .	24

3.2.2 Non Functional Requirements . . . . .	25
3.3 Domain Assumptions . . . . .	25
<b>4 Effort Spent</b>	<b>26</b>
<b>Bibliography</b>	<b>27</b>

# List of Tables

1.1	Epicollect5 table . . . . .	7
1.2	Litter table . . . . .	8
1.3	Bin table: distribution of bins in a municipality . . . . .	8
1.4	Bin status table: status of the bin when cleaned by GC . . .	9
1.5	Phenomena Classification . . . . .	10
1.6	Definitions, Acronyms, Abbreviations . . . . .	11

# Chapter 1

## Introduction

### 1.1 Purpose

The purpose of our project is to inform, to involve and to help communities potentially affected by environmental rubbish pollution by means of a web application for desktop and a mobile application.

Rubbish pollution is a public health issue according to the World Health Organization (WHO) and other leading research bodies:

*“Management of waste is a demanding and challenging undertaking in all European countries, with important implications for human health and well-being, environmental preservation, sustainability and economy.”* - WHO, Regional Office for Europe, 2007

*“Improper waste management and illegal waste shipments can have negative impacts on both environment and public health.”* - WHO Regional Office for Europe, Waste and human health, 2015

Litter is any kind of trash thrown in small amounts, especially in places where it doesn't belong. With time, it heaps up. The practice is unlawful because it costs municipalities millions of dollars annually in cleanup costs. It also portrays a bad picture of an area. The most frequent littered stuff includes fast food packaging, cigarette butts, used drink bottles, chewing gum wrappers, broken electrical equipment parts, toys, broken glass, food scraps or green wastes. Even practices such as leaving items overflowing beside a dustbin, deliberate throwing of items from vehicles, and abandoning items or wrappers by the roadside qualifies as littering. Littering is a dangerous activity and should not be taken lightly because it impacts the environment in multiple ways.

### 1.1.1 Goals of the Application

The client is the Public Administration.

PA wants to create a modern and efficient information system by the help of the citizens, in order to enter, access, retrieve, analyze, visualize and modify, by means of an interactive mapping tool, the available ERP data of a certain local area.

Given data about litter for a certain Public Administration, the main goal is to improve the management of garbage collection in the municipality, for example by putting a bin or an infographic in a critical area (critical areas are found by statistical analysis implemented in the application).

A low level goal is to improve the behaviour of people according to the environment and rubbish pollution.

Therefore, we received the request to design and implement the application



which has basically two great objectives:

- create the database
- help in the decision making process

### 1.1.2 Users and Interfaces of the Application

The system is designed to interact with three kind of users:

- The Citizen<sup>1</sup>
- The Public Administration
- The Garbage Collector

For each category of user we must provide an appropriate interface and the client requests for the interfaces are:

- A mobile application for the citizens and the Garbage Collector
- A web application for Public Administration

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<sup>1</sup>We consider a Citizen every person who wants to contribute in collecting garbage data. They can be citizens of the city, tourists or simply visitors of the city/park.

**Citizen:** this user should provide data about garbage distribution on the territory. It should feel free to use the application at any moment and without any constraint, such as a registration to the application, and he should perceive it to be helpful for his own surroundings not only for the entire community. For this reason the registration would not be required and we would refer to the application as something that someone could use for the preservation of his own neighbourhood. To convey this idea to the user we would use a sentence once the mobile app is opened such as:

*The whole world is one neighbourhood. Franklin D. Roosevelt*  
*Let's start from **yours**!*

**Garbage collector:** this user is a public administration employee and he is in charge of cleaning the bins. Once he has cleaned a bin he can visualize the bins distribution on a map and his position and select the bin he has just cleaned and reports if it was overfull.

**Public Administration:** it receives data from the Citizens and the garbage collectors. It can visualize data distribution and use the application to improve the management of garbage, distribution of bins and to improve Citizen behaviour by putting (if necessary) infographic about the impact that littering has on the environment. The app, by making statistical analysis of data entered by the Citizens, reports the critical areas where a bin or an infographic is needed; in this way the application helps Public Administration in the decision making process. If the application reports an area as a critical one, Public Administration will allocate there a bin or an infographic and then it will enter new data about this in the database about distribution of bins on the territory. This user should be able to visualize the data and decide to put another bin in a location where there is already one if it is reported to be overfull with a certain frequency by Garbage Collector.

### 1.1.3 Dataset Description

The dataset of environmental rubbish pollution measurements that will be used in this project comes from Epicollect5 and contains data collected in Australia. The dataset consists of georeferenced measurement points of ERP.

Dataset:

<https://five.epicollect.net/project/ev2502-5505-datacollection/data>

The main features of the epicollect dataset are summarized in Table 1.1:

Table 1.1: Epicollect5 table

Attribute	Description
Point position	expressed in WGS84
Date of creation	expressed in m/dd/yy h:min
Litter type	general information about material of garbage like metal, plastic, etc.
Count	number of piece of garbage
Description (e.g. string)	indication of the type of object
Brand (e.g. MCDonalds)	information about the brand of the litter
Litter preservation	general information about the status of preservation of the litter (degraded, slightly worn, pristine)
Size	three categories based on length of garbage (small, medium, large)
Type Of Infrastructure	the type of place where it was found (e.g. picnic table). It helps to reduce the buffer that using GPS implies (GPS provides geographical coordinates that are not necessarily so precise))
Comment description	general additional description about the garbage
Photo	a photo of the piece of garbage

The table of Epicollect 5 is modified in order to make it easier for citizens to enter data. The new main features are summarized in Table 1.2.:



Table 1.2: Litter table

Attribute	Description
Point position	expressed in WGS84
Date of creation	expressed in m/dd/yy h:min
Litter type	general information about material of garbage like metal, plastic, etc.
Quantity	quantity of garbage (low-medium-high)
Comment	general additional description about the garbage
Type of infrastructure	the type of place where it was found (e.g. picnic table). It helps to reduce the buffer that using GPS implies (GPS provides geographical coordinates that are not necessarily so precise))
Photo	a photo of the garbage

Other tables that should be added to implement the application:

Table 1.3: Bin table: distribution of bins in a municipality

Attribute	Description
ID	bin code
Bin position	expressed in WGS84
Date of creation	expressed in m/dd/yy h:min
Infographic	boolean which describe the presence of an infographic beside a bin

Table 1.4: Bin status table: status of the bin when cleaned by GC

Attribute	Description
ID bin	bin code
ID Garbage Collector	personal and unique code of Garbage Collector
Date of creation	expressed in m/dd/yy h:min
Status	boolean value which describes if the bin was overfull or not

## 1.2 Scope

In this section we briefly discuss the phenomena that take place in the *real world*, in the *machine* and those that are *shared* among the two.

The purpose of describing these phenomena is to guide our analysis of Use Cases and Requirements in the following sections.

Table 1.5: Phenomena Classification

Name	World , Shared , Machine	Controlled By
Presence of litter on the ground	World	
PA cleaning planning	World	
Presence of bin/infographic	World	
Bin/infographic allocation (the app helps PA in the decision making process)	Shared	World
Bin/infographic update	Shared	World
Bin status update (software has to be informed if it is overfull by GC)	Shared	World
Data Collection	Shared	World
Data Query	Shared	World
PA registers into the system	Shared	World
GC registers into the system	Shared	World
GC logs into the app	Shared	World
PA logs into the app	Shared	World
The app acknowledge the registration of PA and GC	Shared	Machine
The app acknowledge the login of PA and GC	Shared	Machine
Computation of some statistics	Machine	
Visualization of data	Machine	
Automatic attributes acquirement (e.g. geographical coordinates and date and time of uploading data and ID code for GC)	Machine	
Data are stored in database	Machine	

### 1.3 Definitions, Acronyms, Abbreviations

Table 1.6: Definitions, Acronyms, Abbreviations

Name	Definitions, Acronyms, Abbreviations
App	abbreviation for application
Web App	Web application, or web app, is a client-server computer program that the client (including the user interface and client-side logic) runs in a web browser
WGS84 (World Geodetic System 1984)	geodetic coordinate reference system (latitude and longitude in decimal degrees)
Epicollect5	a mobile and web application for free and easy data collection. It provides both the web and mobile application for the generation of forms and freely hosted project websites for data collection
Environmental Rubbish Pollution (ERP)	any unwanted or harmful outdoor refuse created by human activity, such as garbage
Garbage/Litter	the object to be added in our data collection
Citizen	everyone who wants to collaborate in collecting garbage data in a city or in a park
Garbage Collector (GC)	person in charge of garbage collection in the city
Public Administration (PA)	PA of a city which wants to use the app in its municipality to monitor and improve garbage pollution
Bin/Dustbin	the receptacle in which to deposit rubbish placed in a certain location in municipality
Infographic	a panel explaining the impact that littering has on the environment

## 1.4 Reference Documents

- IEEE Std 830-1998: IEEE Recommended Practice for Software Requirements Specifications

## 1.5 Document Structure

In the next sessions of this document we will discuss about:

1. (Chapter 2) *Overall Description*
2. (Chapter 3) *Specific Requirements*

## Chapter 2

# Overall Description

### 2.1 Product Perspective

Citizens will be able to access the system without registration from a mobile application (available for free for the three major mobile operating systems, Android, IOS, Windows Phone from their markets).

Public Administration will use a different version of the application (a Web App) that will not be available on the markets but will be provided to the PA upon a request. They will access the system after an identification.<sup>1</sup> The web application must be supported by all the most famous web browsers: in particular Google Chrome, Safari, Mozilla Firefox and Internet Explorer.

Garbage Collectors will use a mobile version of the application that will not be available on the markets, but will be provided directly by the PA. They will access the system after an identification.<sup>2</sup>

### 2.2 Functions for the Users

The system offers the following functions with respect to the different users:

- A Public Administration can:
  - register into the application
  - login into the application
  - visualize data
  - query data

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<sup>1</sup>The access would be granted only by registering to the system as PA by using its unique code

<sup>2</sup>Username, password and ID code will be given by PA to GC.

- analyze data
  - modify data
- A Citizen can:
  - collect data
- A Garbage Collector can:
  - register into the application
  - login in the application
  - visualize data
  - report if a bin is overfull

## 2.3 Users Characteristics

A Citizen is a user with these characteristics:

- He owns a smartphone with GPS system
- He is able to install a mobile application on his smartphone
- He has access to the Internet

A Public Administration is a user with these characteristics:

- He manages the waste collection system of a city
- He is able to use a web application
- He has access to the Internet

A Garbage Collector is a user with these characteristics:

- His job is to clean a certain area (by collecting garbage)
- He owns a smartphone with GPS system
- He is able to install a mobile application on his smartphone
- He has access to the Internet

## Chapter 3

# Specific Requirements

### 3.1 Use Cases

Here the principal use cases are described starting from the illustration of the corresponding scenarios.

#### 3.1.1 UC.1 PA registers into the system

*SCENARIO: PA REGISTERS INTO THE SYSTEM* Carl is an employee of PA and he is in charge of registering to BinEco to use it in the municipality management system. He accesses the Web application and starts the registration phase. He enters the name of the municipality, the postal code as username and a password and eventually submits the request. PA is correctly registered to BinEco.

*UC.1 : PA REGISTERS INTO THE SYSTEM*

Participating actors: PA (Carl)

Entry Condition: registration can be done only the first time PA opens the app

Flow of events:

- PA opens the web application
- PA signs on the sign up button
- the app responds showing a form to fill
- PA fills the form with name of municipality, username (postal code) and password
- PA clicks on submit button



Exit condition: Web App returns a message

Exceptions:

- PA inserts a postal code (username) which is not correct (it contains alphabetic characters or it is longer than it should be). In this case the app notifies the error and allows PA to insert the username again.
- PA inserts a name of municipality which doesn't correspond to the postal code (username). In this case the app notifies the error and allows PA to insert data again.
- the user wants to abort the procedure
- PA is notified immediately if connection is lost, receiving a warning message

### 3.1.2 UC.2 PA logs into the application

*SCENARIO: PA LOGS INTO THE APPLICATION* Carl is an employee of the PA and has to log in BinEco. He accesses the Web application. He enters the postal code of the municipality as username and the password and submit the request. Carl correctly logs into BinEco.

*UC.2 : PA LOGS INTO THE APPLICATION*

Participating actors: PA (Carl)

Entry Condition: PA must be already registered

Flow of events:

- PA accesses the web application
- PA signs on the login button
- the app responds showing a form to fill
- PA fills the form with username (postal code) and password
- PA clicks on submit button

Exit condition: Web App returns a message

Exceptions:

- PA inserts a postal code (username) which is not correct (it contains alphabetic characters or it is longer than it should be). In this case the app notifies the error and allows PA to insert the username again.

- PA inserts a password which doesn't correspond to the postal code (username). In this case the app notifies the error and allows PA to insert data again.
- the user wants to abort the procedure
- PA is notified immediately if connection is lost, receiving a warning message

### 3.1.3 UC.3 PA enters data about new bin

*SCENARIO: PA ENTERS DATA ABOUT NEW BIN* PA has already allocated a bin in a certain location and now wants to enter data about the new bin. Carl, an employee of the PA, selects the Entering Data function, a pop-up appears with a form. Carl adds new data about the new bin to the database referring to bins distribution. Eventually, it confirms its input.

*UC.3 : PA ENTERS DATA ABOUT NEW BIN*

Participating actors: PA (Carl)

Entry Condition: PA has to be already registered and it has to be already logged into the application.

Flow of events:

- PA clicks on the “add bin” function icon on its terminal
- BinEco responds by opening a pop-up with a form to be filled in
- PA fills the form, by selecting:
  - ID bin
  - position
- once finished PA submits the input

Exit condition: the app returns a message

Exceptions:

- PA is notified immediately if the connection is lost, receiving a warning message

### 3.1.4 UC.4 PA visualizes data on an interactive map

*SCENARIO: PA VISUALIZES DATA ON AN INTERACTIVE MAP* Carl is an employee of the PA who manages the software. He needs to visualize data about bins distribution on the map. He opens the app and he logs in.

*The map with all the points of litter is shown as default visualization. He presses the 'Layers' button on the map and a pop-up appears with the list of all possible layers(litter, bins and critical areas). Carl deselects the layer of the litter and activates the layer of the bins. The map shows the distribution of the bins.*

#### *UC.4 : PA VISUALIZES DATA ON AN INTERACTIVE MAP*

Participating actors: PA (Carl)

Entry Condition: PA has to be already registered and it has to be already logged into the application.

Flow of events:

- BinEco provides PA an interactive map with all the visualized points corresponding to data of litter
- PA presses layer button
- a pop-up opens up with all selectable layers
- PA selects/deselects layers according to what he wants to visualize (litter, bins, critical areas)

Exit condition: the app shows the requested layers on the map

Exceptions:

- PA is notified immediately if the connection is lost, receiving a warning message

### **3.1.5 UC.5 PA visualizes info about points/area on the map**

*SCENARIO: PA VISUALIZES INFO ABOUT POINTS/AREA ON THE MAP Carl is one of the employees of PA who manage the software. He needs to visualize information about data (attributes for bin/litter and the result of statistical analysis (provided by the software)). The map shows all the data (referring to litter/bins or critical areas). Selecting a certain point/area a pop-up appears with specifications about data.*

#### *UC.5 : PA VISUALIZES INFO ABOUT POINTS/AREA ON THE MAP*

Participating actors: PA (Carl)

Entry Condition: PA has to be already registered and it has to be already logged into the application. A layer must be visible on the map.

Flow of events:

- PA selects a certain point/area of the map

Exit condition: PA receives the selected response: the Web App returns a pop-up with specification of data.

Exceptions:

- PA is notified immediately if connection is lost, receiving a warning message

### 3.1.6 UC.6 PA updates infographic

*SCENARIO: PA UPDATES INFOGRAPHIC* PA has already allocated the infographic in a certain location. Carl, an employee of PA, accesses the Web application available on desktop. He visualizes data on the interactive map of bins, he clicks on a certain point (which is coloured in a certain way referring to the fact that, according to the statistical analysis made by the software, there is necessary an infographic) and he modifies only the attribute referring to infographic (YES or NO). Eventually, He confirms its input.

*UC.6 : PA UPDATES INFOGRAPHIC*

Participating actors: PA (Carl)

Entry Condition: PA has to be already registered and it has to be already logged into the application. The layer with bin data is selected and shown on the interactive map.

Flow of events:

- PA clicks on a bin colored in red
- a pop-up appears with the specification about data and with an update function
- PA activates the “Update” function on its terminal
- BinEco responds by presenting a form to PA
- PA updates infographic by changing the attribute 'infographic'
- once finished PA submits the input

Exit condition: the Web App returns a message

Exceptions:

- PA is notified immediately if connection is lost, receiving a warning message

### 3.1.7 UC.7 Citizen entering data

*SCENARIO: CITIZEN ENTERING DATA* Bob is walking in a park. He sees a piece of garbage on the ground. He accesses his mobile app, takes a picture of the garbage and, suddenly after, starts filling the form with data attributes. Then he confirms his input and eventually a message appears.

#### *UC.7 : CITIZEN ENTERING DATA*

Participating actors: Citizen (Bob)

Entry Condition: True (litter can be reported all times)

Flow of events:

- Citizen opens the application
  - Citizen activates the “insert Garbage” function on his terminal
  - BinEco responds by presenting a request for the access to the camera
  - Citizen gives the permission
  - Citizen takes the picture
  - BinEco responds by presenting a confirmation request about the photo
  - Citizen confirms
  - BinEco responds by presenting the form to fill
  - Citizen fills the form, by selecting:
    - litter type
    - quantity of litter (low, medium, high)
    - type of infrastructure
    - comment (not mandatory)
  - once the form is filled, Citizen submits the input
- Exit condition: the app returns a message

Exceptions:

- Citizen is notified immediately if internet connection is lost, getting a warning message
- Citizen doesn’t confirm the submit of the photo and he retakes it
- Citizen needs information about meaning of attributes while entering data:
  - while filling the form Citizen clicks on the info button regarding an attribute

- a pop-up with information on the attribute opens up
- once Citizen is done he closes the pop up and returns filling the form

### 3.1.8 UC.8 PA makes query on data

*SCENARIO: PA MAKES QUERY ON DATA* Carl is an employee of the PA who manages the software. He needs to make an analysis by querying data by one or more attributes. He opens the query section and chooses the attribute and the value then presses to the search button. The software after a few seconds returns a list of all the selected rows and their visualization on the map.

*UC.8 : PA MAKES QUERY ON DATA*

Participating actors: PA (Carl)

Entry Condition: PA has to be already registered and it has to be already logged into the application.

Flow of events:

- PA activates the query function on its terminal
- BinEco responds by presenting an Advanced Search Query Builder to PA
- PA makes query on data by attributes
- once finished PA presses search button

Exit condition: PA receives the selected response: the app highlights the selected objects on the map and returns a summary table

Exceptions:

- PA is notified immediately if connection is lost, receiving a warning message

### 3.1.9 UC.9 GC registers into the application

*SCENARIO: GC REGISTERS INTO THE APPLICATION* Kevin is an employee of the PA and he is a garbage collector. He has to register into BinEco. He accesses the Web application. He enters the username, password and ID code which he was given by PA and submits the request. Bob correctly registers into BinEco.

*UC.9 : GC REGISTERS INTO THE APPLICATION*

Participating actors: GC (Kevin)

Entry Condition: registration can be done only the first time GC opens the app

Flow of events:

- GC opens the web application
- GC signs on the sign up button
- the app responds showing a form to fill
- GC fills the form with username, password and ID code
- GC clicks on submit button

Exit condition: the application returns a message

Exceptions:

- GC inserts username which doesn't correspond to the password. In this case the app notifies the error and allows GC to insert data again.
- GC inserts username and password which don't correspond to the ID code. In this case the app notifies the error and allows GC to insert data again.
- the user wants to abort the procedure
- GC is notified immediately if the connection is lost, receiving a warning message

### **3.1.10 UC.10 GC logs into the application**

*SCENARIO: GC LOGS INTO THE APPLICATION Kevin is an employee of the PA and he is a garbage collector. He has to log into BinEco. He accesses the web application. He enters his username and password and submits the request. Bob correctly logs into BinEco.*

*UC.10 : GC LOGS INTO THE APPLICATION*

Participating actors: GC (Kevin)

Entry Condition: GC has to be already registered

Flow of events:

- GC accesses the Web application
- GC signs on the login button
- the app responds showing a form to fill
- GC fills the form with username and password
- GC clicks on submit button

Exit condition: the application returns a message

Exceptions:

- GC inserts username which doesn't correspond to the password. In this case the app notifies the error and allows GC to insert data again.
- the user wants to abort the procedure
- GC is notified immediately if connection is lost, receiving a warning message

### 3.1.11 UC.11 Garbage Collector visualizes data

*SCENARIO: GARBAGE COLLECTOR VISUALIZES DATA Kevin is an employee of the PA and he is a garbage collector. He wants to visualize data on the interactive map to know the distribution of bins around him.*

*UC.11 : GARBAGE COLLECTOR VISUALIZES DATA*

Participating actors: GC (Kevin)

Entry Condition: GC has to be already registered and has already logged into the application

Flow of events:

- BinEco acquires the position of GC through GPS

Exit condition: the app returns the visualization of data about bin distribution according to the position of GC considering a certain buffer

Exceptions:

- GC is notified immediately if connection is lost, receiving a warning message

### 3.1.12 UC.12 Garbage Collector reports if a bin is overfull

*SCENARIO: GARBAGE COLLECTOR REPORTS IF A BIN IS OVERFULL Kevin, a Garbage Collector, wants to report if a bin is overfull. Kevin opens the mobile app, finds on the map the right bin and modifies only the attribute referring to the condition of the bin (overfull: YES or NO). Eventually, it confirms its input.*

*UC.12 : GARBAGE COLLECTOR REPORTS IF A BIN IS OVERFULL*

Participating actors: GC (Kevin)

Entry Condition: GC has to be already registered and he has already logged into the application

Flow of events:

- GC visualizes data about bins on the interactive map and finds the data corresponding to his position and click on it



- BinEco responds by presenting him a pop-up
- GC activates the “Update condition of bin” function on its terminal
- BinEco responds by presenting a form to GC
- GC updates the status of bin table<sup>1</sup>:
  - overfull (boolean y/n)
- once finished GC submits the input

Exit condition: the app returns a message

Exceptions:

- there is no data corresponding to the position of GC (considering a certain buffer). GC doesn’t update anything.
- GC is notified immediately if the connection is lost, receiving a warning message

## 3.2 Requirements

We divide the functional requirements of the application by the user class (actors) which are (mainly) involved in it.

### 3.2.1 Functional Requirements

- Public Administration:
  - *R.PA.1* The system must allow user registration
  - *R.PA.2* The system must allow user authentication
  - *R.PA.3* The system must allow user to visualize data on an interactive map
  - *R.PA.4* The system must allow authenticated users to make query on data
  - *R.PA.5* The system must allow authenticated users to edit database tables (update bin/infographic)
  - *R.PA.6* the system must allow user to download data
  - *R.PA.7* The system must allow authenticated user to make query on data and visualize the results on an interactive map
  - *R.PA.8* The system must guarantee multiple users to access it concurrently
- Citizen:

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<sup>1</sup>The attribute ID code is automatically filled in by the software (for each GC, the ID code is linked directly to his password and username). PA thanks to the ID code knows which GC has updated data.

- *R.C.1* The system must allow any users to load a new data by filling a form
- *R.C.2* The system must guarantee multiple users to access it concurrently
- Garbage Collector:
  - *R.GC.1* The system must allow user registration
  - *R.GC.2* The system must allow user authentication
  - *R.GC.3* The system must allow user to visualize data on an interactive map
  - *R.GC.4* The system must allow authenticated users to edit database tables (update status of bin table)
  - *R.GC.5* The system must guarantee multiple users to access it concurrently

### 3.2.2 Non Functional Requirements

- Available 24/7
- The system has to provide a feedback in 5 sec

## 3.3 Domain Assumptions

- *D.A.1* For each data, details about litter are correctly entered
- *D.A.2* Accurate litter's locations are known by GPS
- *D.A.3* Each smartphone used by Citizen and GC has a GPS system installed and the application has the privilege to access it
- *D.A.4* PA has already an organized database of distribution of bins on territory
- *D.A.5* GC correctly reports if bin is overfull
- *D.A.6* When the software defines a critical area, bin/infographic is allocated there by PA in a certain amount of time
- *D.A.7* When bin/infographic is allocated in critical zone by PA, database of distribution of bins on territory is immediately correctly updated
- *D.A.8* GC are referred to by the corresponding PA using a personal ID code
- *D.A.9* PA provides each GC with specific username and password (and ID code)

## Chapter 4

# Effort Spent

This document was written in a total amount of around 30 hours divided so between the four group elements:

Elisa SERVIDIO : 8 hours

Dorotea RIGAMONTI : 8 hours

Mohammad MAHDI SAFARI : 7 hours

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