RASD

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Contents

1 Introduction

1.1 Purpose of the system and brief description of the problem

PowerEnJoy is an electrical car sharing service, based on a mobile application. The targets of the service, intended as users, are people that needs to move from a place to another within a city and requires a conveyance to move (because they don't have their own or simply can't use it).
A user can make a reservation for a car, using the mobile app and his/her account, and check for the availability and status of all the cars within his/her position, identified using GPS localisation, or a specific one, inserted manually by the user. As stated before, to access the service, the user must possess a private account, so a registration is needed.
The system provides the users a safe way (identification code) to access the cars, and the riding service and keeps trace of the status of all the cars.
Moreover, the system prizes or punishes a respectively good or bad behavior from the users, applying a discount or an overcharge on the cost of a ride. As esxample, if the user leaves the car without much battery, he/she will have to pay more than the standard cost of the ride, because the car will need to be charged and this operation has a cost. On the other hand, if a user plugs the car before ending the service, it receives a discount.
The system includes other functionalities, such as GPS based maps available in every car, an emergency procedure in case an accident occur during a ride and the notification of a car status if the user requested it.

The purpose of the system, referring to both the main and each car systems, is to offer a reliable, efficient and safe service, allowing the user to benefit of the offered electric cars when needed.

1.2 Actors and stakeholders

We can clearly make a distinction between who asks for the service and who will actually use it.

- As in the Car2Go service, the stakeholder may be a corporation realted to the automotive world. However we don't exclude the possibility that a city government could ask for this software, to improve the transport condition of the city or simply to lessen the environmental impact of transport.
- The clients of the service are the so called users. User is whoever needs the car sharing service benefits of it.

We can also increase the scope to include more actors, implicitely present in the service: the cars, that plays a fundamental role of interaction between the user and the system (other than being a brainless transport), and the operators of companies that provides services like technical and emergency support.

1.3 Goals

- [G1] Ensures that only the account owner can access his/her own account, if he/she is already registered.
- [G2] Allows the user to reserve an available car for up to one hour before the service starts and to take back such reservation before the picking up time expires.

- [G3] Allows the user to look for the available cars within an area that he/she specified, or in the nearby areas, for a possible reservation. If the car has a low battery charge, less than 20%, it does not appear on the user interface.
- [G4] Ensures that the user is able to trace/check the status of a car, available or already reserved, and receive push notifications about it.
- [G5] Ensures that the user is able to access, and open, the car he/she reserved, if he/she is in time.
- [G6] Ensures that the service, and the charge on the user, starts only when the engine of a car is ignited.
- [G7] Ensures that the user is informed real-time on the current cost of the service, when using it, and the possible discounts and overcharges.
- [G8] Ensures that the user knows the safe area around him/her, during the ride.
- [G9] Allows the user to press a button on the car to contact an operator in case of emergency, such as a car accident, a mechanical problem or sudden ilness.
- [G10] Allows the user to leave the car but continue to use the service.
- [G11] Ensures that the user can end the service at any time.
- [G12] Ensures that the user receives a discount or overcharge when specific conditions are met.
- [G13] Ensures that the user is notified of the applied discount and overcharges once the service ends and payment is applied.
- [G14] Ensures that when the user picks up a car, it has no mechanical or electrical problem.

1.4 Goals further description

- [G1] leaves out a particular scenario. The system won't actually be able to know if the person accessing the account is the real owner. A user can just give the credential to a friend, and this friend can access and use the service as if it was the real user. Such case, is a decision, or problem, of the user and the system can't do anything to avoid or simply recognise it.
- [G3] denies the possibility to use a car when the battery is very low, less than 20% of charge. This represents the behavior of a person in the real world. Nobody would chose a car if it would not be able to reach the destination. A user would prefer a charged car, to drive for longer distances.
- [G4] derives from the idea that multiple users may want to use tha same available car. Only one is able to make a reservation, but the others may be interested to check if the car is effectively taken by the reserving user. It could happen that he/she takes back the reservation or simply doesn't pick up the car within the reservation time. In such case, the car would be available once again and all the interested users will receive a notification about it.
- [G9] is one of the functional goals that provides the user a reliable way to "help" the service to work correctely. Being notified of the nearby zones to park, it will be unlikely for him/her to abandon the car midway.

- [G10] considers the real world, where a user may take the car to do shopping. The service provided shoul allow the user to stop and do his/her business.
- [G12] refers to the particular condition expressed in the project description. If the user takes on two ore more passengers, he/she receives a discount of 10% on the cost of the ride. If the user leaves the car with more than 50% of the battery available, a discount of 20% is applied. If the user plugs in the car before ending the service, the applied discount is 30% over the total. However, if the user leaves the car 3 km far from a safe area or with less than 20% of the battery available, he/she is overcharged of 30% of the cost of the ride.

1.5 Glossary

- User: is the person that benefits of the car-sharing service. The user is able to make reservations, check cars and ask for notification using his/her own account. To register and be able to use the service, the user must provide name, surname, phone number, e-mail, payment information, such as a credit card number, and his/her Driver License. The user is, in fact, the person who drives a car.
- Car: is one of the electric car provided by the service. The car contains various sensors which are able to detect the number of passengers, the status of the mechanical and electrical components of the car. It also possess its own system, connected to the main system of the service. This system is costantly updated on the status of the car. The car has also a screen that makes possible an interaction between the user and the car system, and a button that the user can press in case of emergency.
- Mobile application: it is the app that the user has to install on his/her mobile device in order to use the service.
- Reservation: it's the process by which the user can make a request for a car. First, the user must access his/her own account. From there, he can insert an address or chose his location, via GPS, to search for available cars from the suggested zone. Lastly, he can request a specific car to use.
- Monitoring: it it the process by which the user can chose one or more cars to be notified about its availability. The monitoring only involves cars that are not already picked up and
- GPS: global navigation satellite system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
- Picking up time / Reservation time: it is the period of time between the time when the user reserves a car from his/her account and the unlocking of the car by the same user. The maximum reservation time, allowed by the system, is one hour.
- Reservation countdown: it is the countdown after which the user is charged of a fee if it has not picked up the car.
- Status: referred to a car, it is the set of the information that describes it. They include:
  - Location

  - Battery charge
  - Money counter
  - Components state

- Passenger: is a person who can benefit of the service without driving the car. The passenger can use a car only when an user is driving it, and it doesn't need to be registered to use the service.
- Technician: is the person dedicated to repair and fix the car. It is provided by an external company.
- Operator: is the person that communicates with the user whenever an accident happens during the service and emergency button on the used car is pressed. The operator contacts other services depending on which type of accident occured, such as ambulance, police, firetrucks, technicians. As the latter ones, the operator is provided by an external company.
- Safe area: it is a specific area where the electric cars of PowerEnJoy service can park. The set of safe areas is pre-defined and owned by the company/society that requested the management system for the service.
- Special safe area: it is a safe area where power grid stations are installed.
- Power grid station: it is an installation that allows the recgharge of an electric car.
- System: it is the new system to create. It refers to the software and hardware needed in order to make the service work. The system is composed of a database (or more than one) to store the users and cars information, and the software needed to manage users actions and the single cars.
- Car system: is the system, mostly hardware, contained in every car. It checks and elaborates the status of the car and interfaces the transport, the user and the system. The user can interact with the car thanks to an installed screen, that shows informations about the service cost, a GPS based map, discounts and so on. Every car system sends information to the system via 3G connection, and viceversa.
- Discount: is an amount of money that has to be subtracted from the ride cost of a user, at the end of the service, if certain conditions (described in section 1.1, goals specification 3) are met.
- Overcharge: is an amount of money that has to be added to the ride cost of a user, at the end of the service, if certain conditions (described in section 1.1, goals specification 3) are met.
- Ride: it is the journey in the electric car. It starts when the user turns on the car and ends when the user leaves the car and closes the open doors. In the way a ride is defined, its duration coincides with the period of time where the user is charged for the service.
- Service: it refers to the whole process of reservation, ride and payment of a car, done by the user.
- Push notification/ push message: it is a notification sent to a smartphone using the mobile application.
- SMS: short message service; it is a notification sent to a mobile phone, we need a GSM gateway to use it.

- GMS gateway: device that allows SMS text messages to be sent and/or received by email, from Web pages or from other software applications by acquiring a unique identifier from the mobile phone's Subscriber Identity Module, or SIM card.

1.6 Text assumptions

- We do not consider the case where someone can use the credentials of someone else, maybe a friend: such possibility is purely user-related and the system has no way to control it.
- We should develop a mobile application able to use the position of a device through a GPS or asking it to the user.
- Users are asked to make a reservation before using an electric car. Other car-sharing service like Car2Go allow also a use without reservation, but such case is not contemplated.
- There must be some components that allow an interaction between the user and the car, to make the first able to access the second. We assume the existance of a numeric keypad connected to the internal car system. Such keypad is also used by technicians to unlock the car during repairs and controls.
- Users must first register to gain access to the main functionalities offered by the system.
- The car possesses a screen to make possible an interaction with the user and the car system.
- The ride fee calculated per minute depends on the situation. An higher fee is applied when using the car, while a lower fee is applied if the car is not parked in a safe zone and the service is still active. If the car is parked in a safe area, the service is free.
- We assume that the parking areas are provided by the PowerEnJoy owners.
- The system is able to control some functionalities of the cars, such as the door lock.
- The car possesses multiple sensors that allows, every moment, to know its status, such as battery charge, decay of the mechanical components or number of passengers.
- We assume that there are other societies that collaborate with the system of PowerEnJoy. Technicians, operators, and other actors belong to such companies.

2 Overall description

2.1 Interfaces description

- Interface with GSM provider to send SMS notifications to the users.
- Interface with the external staff. Technicians and operators are provided by a different company and the system needs to interact with them.
- Interface between the user and the car system. There are two levels of interaction:
  - The user can check for general informations of a car via his/her account, on the app.
  - The user has more detailed informations on the car, the service cost and the location during the ride, interacting with the car screen.

- Interface between the user and the system, via app. The user is able to access the offered services thanks to the application.
- Interface between the car system and the system, to enable the communication of data.
- Interface between the system and the GPS map provider.
- Interface between the cars and the recharge stations, that enables the recharge of the vehicle. It is composed by a plug and sensors connected to the car system that are able to recognise if the car is plugged (and recharging).
- Interface between the cars and the people, both users and technicians. This interface refers to a device connected to the car system that is able to recognise codes and unlock the car.

2.2 Product functions

2.3 Constraints

2.3.1 Regulatory policies

When registering, the system shows the user the license he/she has to accept in order to benefit from the offered services.
Treatment of personal data follows the rules described by the law (Law D. Lgs. 196/2003 in Italy).
The system also asks the permission to use and manage sensible data such as position, mail and phone number, in order to achieve its purposes, respecting in every conditions and cases the privacy law.
The system mustn't use push notifications and SMSs to send SPAM and third party advertising, but can only use such means according to the offered services.

2.3.2 Possible software limitations

Problem regarding APIs management and integration can arise, leading to major complexities of the system and delays in the development of the system software.
The software that manages the system may not implement all the needed functionalities. Such problem is mostly due to a bad development.

2.3.3 Hardware limitations

The mobile device owned by the user is subject to many problems, mostly regarding the connectivity of network and localisation services:

- 3G connection, to use the app
- GPS, to use particular services of the app, such as providing the user position to find available cars
- Space for app package on the device memory
- Battery consumption

2.4 Proposed system

We will implement a client-server architecture, based on the common REST APIs, to manage the web application. A MySQL based database is needed to store the data of users and cars. A possible framework for the server is Mono, derived on the .NET Framework offered by Microsoft, but working on a large number of OS, such as iOS, Android, OSX and Microsoft. Lastly, the car interfaces with the user using some of its artifacts, such as the emergency button (User -> Car System -> System -> Operators), the car screen or the numeric keypad to access the car or to end the service.

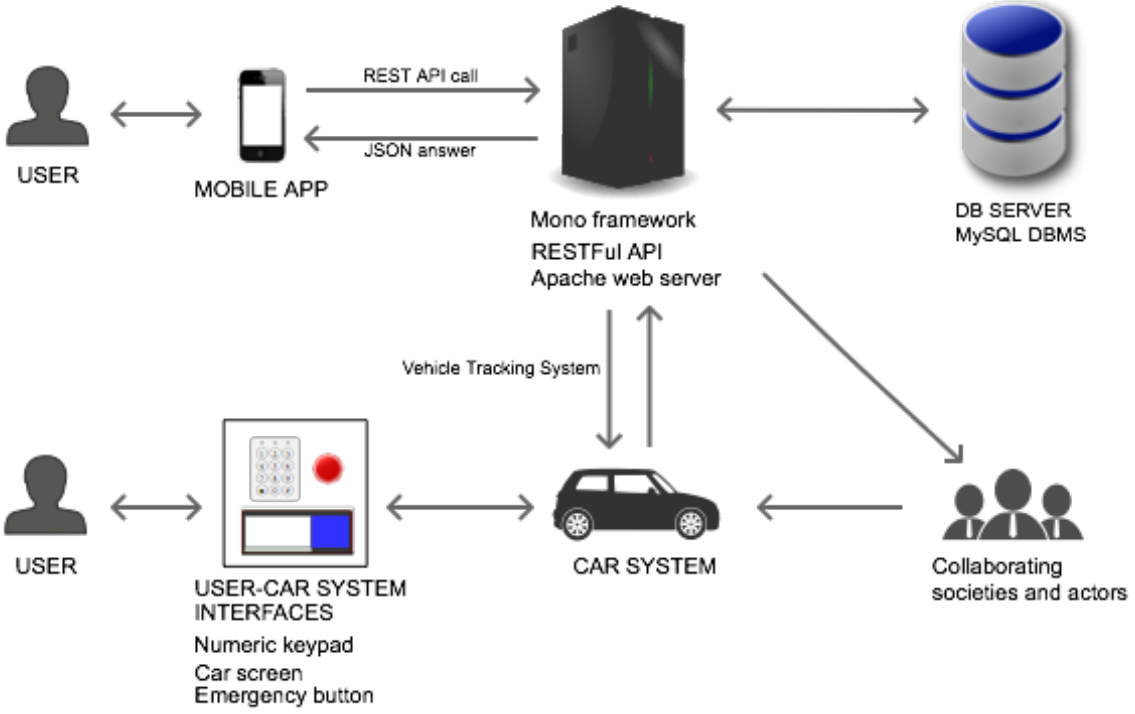

Figure 1: Architecture

2.5 Domain assumptions

- All the GPS localisation services have no fault and always returns the correct position of a device (car, phone, tablet...).
- If a car is locked, nobody can access it. However, technicians are able to use a code to operate on it.
- The databases on which the system relies on works without problems (no data loss, no incoherence).
- Once a user is registered, the system won't accept any other registration with his/her data. In other words, a user can register only once.
- Once a user is registered, his/her information will be saved and present in the system database.

- All the notifications that a user can receive from his/her account are immediate and always working.
- All the updates of the status of a car are immediate and correct.
- A user will never leave the car in a zone unreachable by GPS localisation or too far from the nearest safe area.
- A user will never leave the car with a door open, and neither the passengers will.
- A user will never leave a door open for more than ten minutes.
- Users will encounter no problems when accessing the car using a code.
- When registering, users will insert only Credit Card info or Debit Card info as methods of payment.
- Technicians and operators are always available and provided by a third party agent.
- Passwords and codes are unique.
- Discounts and overcharges are always calculated and applied in the correct way.
- Technicians and other services (police, ambulances, firetrucks) will reach the location addressed by the user/operator in the shortest possible time.
- Every car is able to detect it a mechanical/electrical problem occurs, and modify its internal status.
- The set of safe areas for parking cars is pre-defined by the management system.

3 Requirements

3.1 Functional requirements

- [G1] Ensures that only the account owner can access his/her own account, if he/she is already registered:
  - [R1.1] When the user registers, the system shall send him/her a mail or an SMS containing an unique code, that she/he can use to access his/her account.
  - [R1.2] When the user inserts is credential to log into his/her account, the system shall verify the correctness of the inserted data, the unique code expressed in requirement [R1.1].
- [G2] Allows the user to reserve an available car for up to one hour before the service starts and to take back such reservation before the picking up time expires:
  - [R2.1] When the user selects the option to reserve a car, the system shall verify if it is already reserved.
  - [R2.2] When the user selects the option to reserve a car, the system shall check if the reservation time is less than one hour.
  - [R2.3] If the check described in requirement [R2.2] is negative, meaning that the user expressed a reservation time longer than one hour, the system shall reject the user's request.

  - [R2.4] When the user selects the option to reserve a car, the system shall verify if it the user has already made a reservation. If he/she has, the system shall notify him/her with a message on the mobile screen.
  - [R2.5] If the reservation time expires, meaning that the user didn't reach the car in time, the system shall cancel the user reservation and charge him/her of 1 EUR. The system shall also send a push notification the user to inform him/her of the fee.
  - [R2.6] When the user makes a reservation for an available car, the system shall provide him/her an option to take back the reservation, from his/her account.
  - [R2.7] When the user picks up the car or the reservation time expires, the system shall disable the option to take back the reservation.
  - [R2.8] When the user picks up the car, the car system shall notify the system and disable the reservation countdown.

- [G3] Allows the user to look for the available cars within an area that he/she specified, or in the nearby areas, for a possible reservation. If the car has a low battery charge, such as less than 20%, it does not appear on the user interface:
  - [R3.1] The system shall be able to detect the user position, using GPS localisation of the device he/she is using (automatic localisation).
  - [R3.2] The system shall be able to recognise and locate the address given by the user (manual localisation).
  - [R3.3] The system shall display a list, interfaced to the user as a map, of the available cars with more than 20% of the battery charge, within 5km from the given location.
  - [R3.4] For every car in the list described in requirement [R3.3], the system shall provide essential information, as battery charge, estimated working distance, location, distance from the given address/current user location, maximum number of passengers.

- [G4] Ensures that the user is able to trace/check the status of a car, available or already reserved, and receive push notification about it:
  - [R4.1] Along with requirement [R3.3], the system shall also display a list of already reserved car, but not already picked up.
  - [R4.2] When the user touches a car on the map of his/her app, the system shall provide him/her two options regarding that car: reservation or monitoring, depending on the car availability. Moreover, the status of the car shall be displayed.
  - [R4.3] When the status of a car is updated - from reserved to available, from reserved to picked up and from available to reserved - the system shall notify all the users that made a monitoring request, grouped in a list, on that car.
  - [R4.4] When the user decides to not be notified on a car for which he/she previously requested a monitoring, the system shall delete the user from the list of users that wants to check the status of that car.
  - [R4.5] When a car is picked up, the system shall notify the users that made the monitoring request, as described in [R4.3] and after that, delete the list.

- [G5] Ensures that the user is able to access, and open, the car he/she reserved, if he/she is in time:

  - [R5.1] When the user communicate via his/her account that he/she's nearby the car he/she reserved, the system shall send an SMS or a mail to the user, containing a unique code to unlock the car.
  - [R5.2] When the user communicate via his/her account that he/she's nearby the car he/she reserved, the system shall make the car unlockable only by the code descripted in requirement [R5.1].
  - [R5.3] If the user doesn't reach the car within the reservation time and he/she already received the code to open it, the system shall reset the sequence needed to open the car, making the user unable to access it.

- [G6] Ensures that the service, and the charge on the user, starts only when the engine of a car is ignited:
  - [R6.1] When the user is in the turned off car and uses its ignition key, the system shall start the car, initializing its screen and the car internal system.
  - [R6.2] When the user is in the turned off car and uses its ignition key, the system shall begin to charge the user per minute, after having initialized the internal system of the car, as stated in requirement [R6.1].

- [G7] Ensures that the user is informed real-time on the current cost of the service, when using it, and the possible discounts and overcharges:
  - [R7.1] Every minute, the car system shall increase the money counter and display its value on the screen of the car, depending on its status. Different rates are applied if the car is turne on or off while the service is active.
  - [R7.2] When the car system detects that more than two passengers are on the car, it shall display on the car screen a message about a possible 10% discount on the ride cost if the condition persists.
  - [R7.3] When the car system detects that the battery charge of the car is above 50%, it shall display on the car screen a message about a possible 20% discount on the ride cost if the condition persists.
  - [R7.4] When the car system detects that the battery charge of the car is below 20%, it shall display on the car screen a message about a possible 30% overcharge on the ride cost if the condition persists.
  - [R7.5] When a condition described in requirements [R7.2], [R7.3] and [R7.4] is not met, the car system shall display no message on the car screen about discounts/overcharges.

- [G8] Ensures that the user knows the safe areas around him/her during the ride:
  - [R8.1] When the service starts, the car system shall elaborate a detailed map of a 10km radius zone from the car location, using GPS. The map status in continuosly elaborated during the ride.
  - [R8.2] Referring to requirement [R8.1] the car system shall show the map on the car screen, along with the car status, as stated in requirement [R7.X].
  - [R8.3] When the service starts, in addition to requirement [R8.1], the system shall inform the car system of the location of the safe areas, distinguishing between normal safe areas and the ones with power grids. Only the safe areas with available parking places are shown.

- [G9] Allows the user to press a button on the car to contact an operator in case of emergency, such as a car accident, a mechanical problem or sudden ilness:
  - [R9.1] When the user presses the button, the system shall notify an operator on the location of the car and its status. The operator belongs to an outer service provider agency.
  - [R9.2] When the user presses the button, the system shall arrange a call between the user inside the car and the operator of requirement [R9.1].
  - [R9.3] If the user presses the button multiple times in a short period, less than 2 minutes, the system shall recognise only the first and start the procedure described in the requirements [R9.1] and [R9.2].
  - [R9.4] When the user presses the button, the car system shall end the service (following the ending procedure) and turn off the car.
- [G10] Allows the user to leave the car but continue to use the service.
  - [R10.1] When the user leaves and turns off the car, the system shall apply a new rate over the ride cost. When the user turns on the car once again, the old rate is applied once again and the riding service continues.
- [G11] Ensures that the user can end the service at any time:
  - [R11.1] When the user leaves and turns off the car, the car system shall check if the car is located in a safe area or not, communicating with the system.
  - [R11.2] If the user has left the car in a safe area, the car system shall stop the charging counter and save the car status.
  - [R11.3] If the user has left the car in a non safe area, the car system shall continue charging the user with a different rate.
  - [R11.4] When the user has left the car, closed all the doors, and inserted into the numeric keypad the code he/she used to access the car, the car system shall communicate the car status to the system. The system shall execute the payment process, communicate the car system to lock the car.
  - [R11.5] When the car system has locked the car and informed the system, the latter shall update the car status in the main database, and tag the car available once again.
- [G12] Ensures that the user receives a discount or overcharge when specific conditions are met:
  - [R12.1] When the user uses the access code to end the service and the car system provided the car status to the system, the system shall check the battery of the used car. If more than 50% remains the system shall apply a discount of 20% on the cost of the ride with that car. If less than 20% remains, the system shall apply an overcharge of 30% on the cost of the ride with that car.
  - [R12.2] When the user uses the access code to end the service and the car system provided the car status to the system, the system shall check the number of passengers. If it is more than two the system shall apply a discount of 10% on the cost of the ride with that car.
  - [R12.3] When the user uses the access code to end the service and the car system provided the car status to the system, the system shall check if the car is plugged into a power grid. If such condition is met and the car is located in a safe-area, the system shall apply a discount of 30% on the cost of the ride with that car.

  - [R12.4] When the user uses the access code to end the service and the car system provided the car status to the system, if the car it is located at more than 3km from the nearest safe area, the system shall apply an overcharge of 30% on the cost of the ride with that car.

- [G13] Ensures that the user is notified of the applied discount and overcharges once the service ends and payment is applied:
  - [R13.1] When the system applies the payment process on the user, it shall inform the user with a push notification of the applied discount and overcharges, based on the requirements [R12.X].

- [G14] Ensures that when the user picks up a car, it has no mechanical or electrical problem:
  - [R14.1] When a car detects a problem, the car system shall inform the main system of the new status. The system shall then contact third party technicians, giving them the location of the car and a unique code to access it. Moreover, the system shall tag the car as unavailable.
  - [R14.2] When the car system notifies the main system that all the problems are solved, the system shall update the car status, reset the access code of the car and tag it as available.

3.2 Non functional requirements

3.2.1 Usability

- [R15] The system shall provide different languages that the users can chose.
- [R16] Both the mobile app and the car screen shall use different way to represent safe area and special areas with power grid stations on the maps.
- [R17] The mobile application shall be installable on different OS.
- [R18] Along with the push notifications, the mobile application shall emit a brief sound.
- [R19] The system shall provide trivial information about the service, such as discounts and overcharges conditions, rate table and contacts.

3.2.2 Performance

All the possible issues regarding the performance of the whole system (system, mobile app and car systems) are already covered in the domain assumptions and as such not considered as requirements.

- Operations are elaborated and completed without delays and in a short amount of time. With short we mean a time comparable with the times of the current systems. The discount calculation won't take hours, as example.
- The menus and screens of all the devices will be smooth and without graphical problems.

3.2.3 Interfaces mockup

Figure 2: Car research mockup

Figure 3: Registration mockup

4 Modeling

4.1 Scenario identifying

In this sub-section we present some of the possible situations that can happen.

4.1.1 Scenario 1

Lilith just finished her work and can not wait to go home. However her car had some problems in the past few days and this morning Lilith decided to have it fixed. She opens her PowerEnJoy app on her phone and logs in her personal account. From there, she searches for the available cars around her. Fortunately, Lilith finds a car 500 meters from her position. The car is available and with a high battery charge, 75%. Lilith makes the reservation, specifying that in about half of an hour she will pick up the car. It just takes 20 minutes to reach the car and Lilith uses a special option on her page to receive via SMS a special code to unlock the car. The girl picks up the car and drives, enjoying the ride. She parks the car in the nearest safe area from her home, ends the service using the previous code and walks away.

4.1.2 Scenario 2

Mitch needs to go pick up his son at the elementary school and wants to use the PowerEnJoy service. He opens the app, logs in and reserves a car. Lilith just got out of her office and needs to go shopping for some food. She lend her car to her younger brother and because she is already accustomed to the PowerEnJoy service, she immediately logs in her account and searches for an available car. However, there is only one car in the neighborhood and it is already reserved (by Mitch). Lilith is faithful that the one that reserved it will have some problems and take back the reservation, so she requests to monitor the car and receives notifications about it. Meanwhile Mitch receives a phone call from her wife, telling him that she already picked up their son. The reservation time still hasn't expired yet and Mitch is able to take back his reservation. Lilith receives then a notification on her cellphone that the car she was monitoring became available. Happy about how things turned out, she reserves the car, goes pick it up and drives to a shopping centre.

4.1.3 Scenario 3

Mitch and his wife are going on a date and they are using a car offered by the PowerEnJoy service. Only Mitch needed to log in his account and make the reservation, before picking up the car, because he is the one who drives, while his wife is only a passenger. Mitch's wife is enjoying the ride but suddenly shouts to her husband to stop the car immediately: they just passed in front of a flower shop, and she loves flowers. Mitch satisfies the request of his wife, parks the car, after they have exited, he locks it with the ignition key. They pass about an hour in that shop, having fun. After that, Mitch opens the car and starts driving again, continuing the rest of the date with his wife.

4.1.4 Scenario 4

Lilith and her two sisters just got out of the jym and wants to go eat something. Hilda, one of the sisters, suggests a nice restaurant but it's pretty far from them, and they don't want to catch a bus to go there. Lilith tells then her sisters about PowerEnJoy and shows them how to make a reservation. Fortunately they find an available car just 100 meters from them. They go pick up the car and Lilith, the one who made the reservation, drives to the restaurant. Realizing that they will spend a lot of time there, Lilith decides to end the service when exiting the car, inserting once again the code she used to access the car. During the meal, Lilith realizes that after having picked up the car she turned off her phone. Once she turns it on, she sees that not long ago, just after the end of the service, she received a notification about the cost of the ride and its discounts. However, what she sees is unexpected: she received a discount because she took two passengers, her sisters, in the car, but she also had an overcharge of 30% because she parked the car 5 km away from the nearest safe area. Hilda laughing says: "I told you it was pretty far!". Poor Lilith, looks like she won't enjoy her meal after all.

4.1.5 Scenario 5

Lilith has been working for 10 straight hours and feels very tired. She opens her PowerEnJoy application, searches for the available cars near her and reserves one. After having picked up the car using a special code received via SMS, she starts driving. Unfortunately, when waiting at a semaphore, someone collides with the car that Lilith is driving. No one is hurt, but boh the cars are in a bad shape. Lilith knows what to do and quicly presses the emergency button on the car and after a few seconds she is able to speak with an operator to explain the situation. The person that picks up the emergency call is Marie, that asks Lilith information about the accident, such as location, type of problem and

general information. After that, Marie contacts a society that allocates some technicians and send them to the accident point. If needed, Marie contacts also police, ambulances and firefighters. Lilith doesn't have to worry: when she pressed the button, the service ended and she doesn't have to pay more than needed. Unlucky Lilith, looks like she won't be able to relax after her hard day.

4.1.6 Scenario 6

Mitch and his wife are thinking to go on a vacation, but they are undecided about the destination. The travel agency isn't far from their home so they decide to book an electric car and use it. Mitch opens the PowerEnJoy application, searches for the available cars and find one available. After having reserved it, requested the code to acces it, and picked it up, he drives, directed to the destination. Having used it a lot of times, Mitch knows the rate of the service, calculated per minute, and realizes that on his credit card there isn't enough money to pay the ride. However he also knows all the possible discounts and to spend less he parks the car in a safe zone with a power grid station and plugs it to recharge the battery. Luckily for him, he also left the car with more than 50% of the battery, so as soon as he ends the service, he receives a notification on his phone about the 30% discount due to the plugging in and 20% due to the battery level. Mitch is very happy because he only payed half of the cost, but so isn't his wife: to receive the first discount he parked 2km away from the travel agency, so they now have to go by feet.

4.1.7 Scenario 7

Lilith and her sister Hilda are talking about the services offered by PowerEnJoy. Lilith is actually a registered user and she appreciates the car sharing service, so she decided to invite her sister and make her register to benefits of PowerEnJoy. Lilith explains that in order to register, Hilda must insert in the app, under the registration section, her name, surname, number phone, mail, Driver Licence informations (number and postcode) and the optional fiscal code (of the ID Card). Hilda inserts all the information carefully and without errors, and after less then a minute, she receives an SMS and a mail containing the password to log in to her personal area of the app.

4.2 UML models

4.2.1 Use case diagram

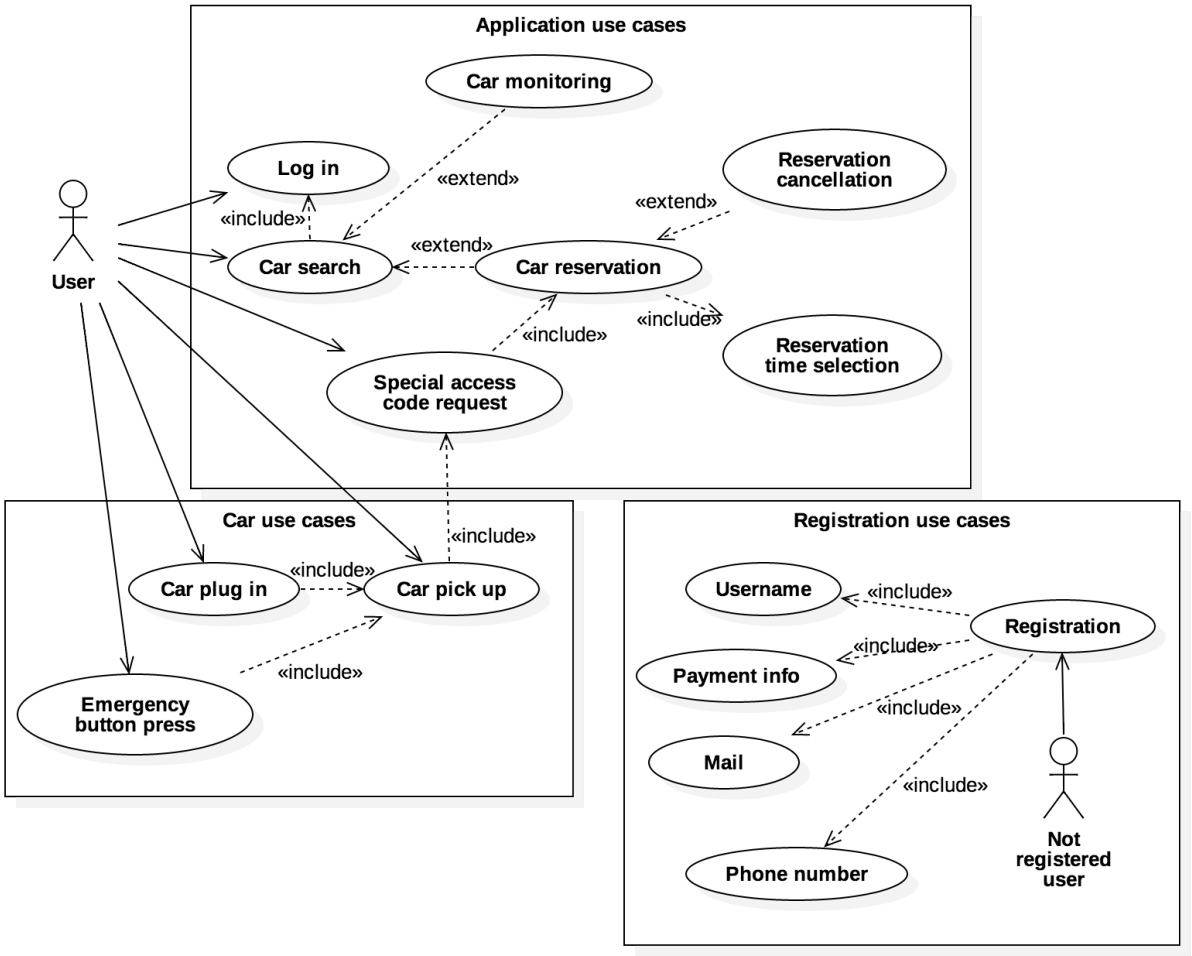

Figure 4: Use case diagram, portraying all the functionalities that the user expects from the service

4.2.2 Use case descriptions

Name: Normal usage of the service
Actors: User (Lilith, Scenario 1)
Entry conditions: The client is already registered to the application
Flow of events:

- The user logs in the app using his/her credentials.
- The user searches for an available car using a special section of the app.
- The user selects an available car and inputs the time he/she thinks will be necessary to reach the car and pick it up.
- The user uses a special option on the app that allows him/her to communicate that he/she's nearby and needs the code to access the car.

- The system sends the user an SMS or mail containing the access code.
- The user uses the received code to access the car.
- The user turns on the car and drives.

Exit conditions: The user exits the car, and uses again the code neede to open it.
Exceptions:

- The credentials furnished by the client are not correct. In this case the system doesn't redirect the user to the main page of the app but notifies him/her with an error message on the screen.
- The user doesn't pick up in time the car, so it has to pay a fee of 1 EUR. If the user already received the code to access the car, the system invalidates it.

Name: Cancellation of a reservation
Actors: User (Mitch, scenario 2)
Entry conditions: The client is already registered to the application.
Flow of events:

- The user logs in the app using his/her credentials.
- The user searches for an available car using a special section of the app.
- The user selects an available car and inputs the time he/she thinks will be necessary to reach the car and pick it up.
- Before the reservation time expires, the user can select the cancellation option from his/her app.

Exit conditions: The user cancels the reservation he/she previously made.
Exceptions:

- The credentials furnished by the client are not correct. In this case the system doesn't redirect the user to the main page of the app but notifies him/her with an error message on the screen.
- The user doesn't pick up in time the car, so it has to pay a fee of 1 EUR and cannot cancel the reservation anymore.

Name: Monitoring of cars
Actors: User (Lilith, scenario 2)
Entry conditions: The client is already registered to the application and has already logged in.
Flow of events:

- The user searches for the cars, available or not, within a certain zone, that could be his/her position or a specific address.
- Instead of making a reservation, the user can select multiple car to monitor.
- The system sends push notifications to the user when the status of the car he/she requested to monitor changes.

Exit conditions: The status of a car changes to picked up, and the system deletes all the monitoring lists on that car after having sent a notification, or the user cancels the monitoring request.

Name: Temporary pause of the service
Actors: User (Mitch, scenario 3)
Entry conditions: The registered client reserved a car and picked it up.
Flow of events:

- The client decides to stop the car for a certain amount of time, still wanting to benefit of the service.
- The client stops the car and locks it.
- The system checks if the car is parked in a safe area or not. If it is, the halt has no further cost, otherwise the system changes the service fee (lowering it, the client isn't consuming battery).

Exit conditions: The clients unlocks the car and turns it on, to continue driving or ends the service using the access code of the car.

Name: Bonuses application
Actors: User (Lilith and her sisters, scenario 4; Mitch, scenario 6)
Entry conditions: The registered client reserved a car, picked it up and is about to end the service.
Flow of events:

- The user parks the car, exits and uses the access code to end the service.
- The system checks if the conditions to gain a discount or overcharge are met:
  - For the majority of the ride there were more than two passengers, 10% discount.
  - When the service ended the car had more than 50% of the battery filled, 20% discount.
  - When the service ended the car had less than 20% of the battery filled, 30% overcharge.
  - When the service ended the car was plugged into a power grid station, 30% discount.
  - When the service ended the car was parked more than 3km from the nearest safe area, 30% overcharge.
- The system calculates the new cost of the ride, based on the applied discounts/overcharges.

Exit conditions: The system sends push notifications to the user informing him/her of the total cost of the ride and the applied discounts/overcharges.

Name: Emergency handling
Actors: User (Mitch, scenario 3)
Entry conditions: The registered client reserved a car and picked it up.
Flow of events:

- The client decides to stop the car for a certain amount of time, still wanting to benefit of the service.
- The client stops the car and locks it.
- The system checks if the car is parked in a safe area or not. If it is, the halt has no further cost, otherwise the system changes the service fee (lowering it, the client isn't consuming battery).

Exit conditions: The clients unlocks the car and turns it on, to continue driving or ends the service using the access code of the car.

Name: Registration
Actors: User (Hilda, scenario 7)
Entry conditions: None.
Flow of events:

- The user downloads the app and starts it.
- The user select the registration option from the main menu of the app.
- The user inserts data in order to complete the registration:
  - Name and surname
  - Fiscal code or ID Card information (optional)
  - Phone number
  - Mail address
  - Preference over the notification channel (SMS? Mail? Or both?)
  - Driver Licence number and postcode

Exit conditions: The user unlocks receives the password thanks which he/she can log in to the personal area of the mobile app.