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**Computer Science and Engineering**

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Software Engeneering 2 Project:

**“Power&Joy”**

**R**equirements **A**nalysis and **S**pecification **D**ocument

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**1.Introduction**  
  
  
**1.1 Purpose**

This is the first of a series of documents aimed to project a digital management system for a car sharing service. Identifying stakeholders, modelling scenarios and formalizing requirements and constrains of the system are the main topics of this document.

**1.2 Description of the given problem**

We are going to design a digital management system for a car sharing service that only employs electric cars (i.e. cars powered by rechargeable batteries), which are environment-friendly and noise-free.  
Precisely, we want to offer the possibility to users to choose a car among an amount of cars dislocated into Milan's urban area, to travel across the city.  
Electric cars gather their fuel when they are plugged into proper power grids; these grids are placed all around the city: they can be found into specific charging stations, beyond near a decent number of parking lots around Milan.  
Cars can be parked everywhere inside Milan urban area (i.e. any kind of appropriate car park, accordingly to Italian laws, included pay and display parking lots).   
Operators are available to make sure that cars are never left with less than 20% battery charge by charging them into near charging stations.  
The final aim of the system is to provide a service within anyone's reach, that stands for a solid alternative to public transport.

**1.3 Stakeholders**The only stakeholders that we have is Power&Joy society that require the management system of car sharing.

**1.4 Glossary**

* **System**: is the system we will create which is going to manage the car sharing service. The

system has a dedicated database where it can store and access all needed information.

* **User** : every person register in the system that want to use a car.
* **Not Register User (NRU)** : all people not registered in the system.
* **Operators:**  employees working on charging stations whose job is recharge every car that has less 20% battery level and to provide assistance to the users.
* **Passenger :** a person who is travelling in a car without driving it.
* **Registration:** consist in the act of insert all the needed information into the system as
  1. First name and Last name
  2. E-mail
  3. Password
  4. Phone number
  5. Birth date
  6. ID card code
  7. Drive licence code
  8. Credit card number
  9. Fiscal code
* **Safe Area:** Milan’s urban centre.
* **Power grid station:** a stopping place for electric cars equipped with electric socket and where operators work.
* **Available car:** is a car that is not currently used by other users and has the battery charge level over 30%.
* **Parking lot:** everyavailable car park inside the Safe Area that respect to the Italian traffic laws.
* **Special Parking lot:** every parking lot equipped with electric socket.
* **Safe Zone**: is a circular zone with 3 km of diameter which centre is a power grid station.
* **Reservation:**  is the ability of reserve a car for at maximum 1 hour, then the reservation expires.
* **Contactless card:** card acquired by users at the moment of the registration used to unlock the reserved cars.
* **Special contactless card:** Magnetic card acquired by operators at the moment of the registration that can be used to unlock any car.
* **Unlock Car:** to undo the lock of car’s doors by placing the contactless cards or special contactless cards near specific sensors placed over the car doors.
* **Password:** is the key to log in to the system.
* **Status (of a car):** any of the possible conditions of the cars (out of charge/assistance needed/out of safe area/no issues). A car can have more than one status at once. Each status is identified by a colour.
* **Reserved area:** special section of the system where operators can register and log in, and   
  from which they can access information about the position and the status of all the cars.
* **Ride:** it starts one minute after the unlock car and ends when the user shut down the car and push on the display “end the ride”.
* **Pit Stop:** it happen when the user stops the car for a short period of time (maximum 60 minutes) and keep the car reserved in order to continue the ride.
* **End the ride:** user stops the car, leaving it in a safe parking lot so that the car is made available for other reservations by other users.
* **Scalability:** is the capability of a system, network, or process to handle a growing amount of work, or its potential to be enlarged in order to accommodate that growth.
* **Quality of Service:**  is the overall performance of a computer network, particularly the performance seen by the users of the network. His attributes are: Performance, Reliability, Scalability, Capacity, Accuracy, Availability, Robustness, Integrity and Confidentiality.

**1.5 Reference Documents**

These are the documents we used as guideline:

* Specification Document: Assignment AA 2016-2017 (RASD)
* IEEE Std 830-1998 IEEE Recommended Practice for Software Requirements Specifications.
* Examples Documents: RASD sample from Oct. 20 lecture.

**1.6 Overview**

After a short description of the system’s properties, we define goals (e.g. the functions the system has to be able to perform) and constrains, and make assumptions that we suppose hold in the analyzed world. Then we analyze and formalize the goals with the help of UML diagrams (use case, sequence diagrams, class diagram) and the formal language Alloy.

**2. Overall Description**

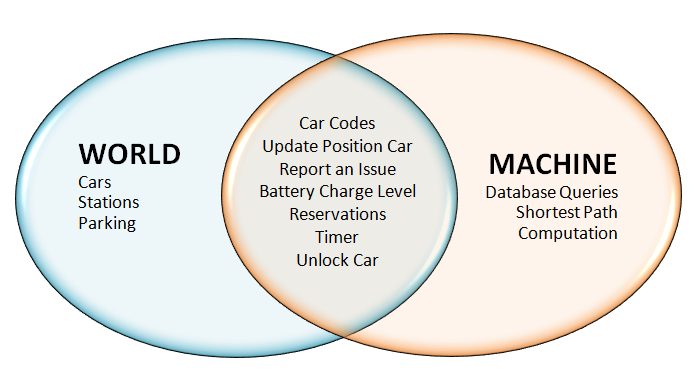
**2.1 Product Perspective**

We want this service to be accessible via mobile or web app. Every user (i.e. person who wants to reserve and ride a car) must register to the system via the mobile or web app providing general information (full name, age, sex, e-mail etc.) and specific ID's (fiscal code, drive license code). Once registered, the system allows user to view on a map the current geographical position of every available car, thanks to GPS sensors on each car. Cars already in use by other users do not display, but the system can access the information about the positions and the batteries of every single car, weather they are being used or not, any time it needs to (in case of assistance requests et al.).  
  
Users can choose a car at the time, and make a reservation for it. They shall reach the car within 30 minutes from the moment the reservation is made, to be able to use the car.  
When near, users can unlock the car by simply placing their contactless card (provided at the moment of the registration) near the sensor placed on the car door.  
The system unlocks the car soon after and the user is able to get in. In order to start the ride, the user simply needs to push a button placed inside the car.

Every car is equipped with an on-board computer, that can be used to communicate the existence of damages over the car and as GPS navigator device.  
  
Before starting the ride, the system encourage the user to make sure the car is not damaged or compromised, and to communicate it, in case issues are found, via the mobile app or the onboard computer.

Once the car is started, the user starts to be charged per minute of ride.  
Once they end the ride, users can park cars in every available car park inside the urban area (which includes any kind of parking lot, accordingly to Italian laws, pay and display car parks included, private parking lots excluded).   
  
Some special parking lots are equipped with power grids to recharge the car, and discounts are available in case users take care to plug the car in.  
Discounts are also available in case the user leaves the car with more than 50% battery charge or if he takes on the ride 2 more passengers , while the user is going to pay 30% more of the price of his ride in case he leaves the car with 20% battery charge or more than 3 km away from the nearest charging station.  
Payments are always carried out through the credit card that the user has to insert at the moment of the registration and a receipt is available to view with the mobile app or via e-mail.

A group of operators is available to give assistance to users and to make sure cars are never left under 20% battery charge. Operators work at charging stations and can access all the information about cars positions and batteries.



**2.2 Actors Identifying**

There are two main kind of people the System needs to interact with:

* Users
* Operators

Both of them need to be registered into the system.  
Operators work at the charging stations and need to pick up and recharge every car below 20% battery charge and provide assistance to users, if needed.  
The goals concerning the interaction between these two groups of people and the system are described below.

**2.3 Goals (Product Functions)  
  
Users:**

1. The system shall allow users to register via the web or mobile app by inserting all the required information
2. The system shall allow users to see the positions of all the available cars on a map
3. The system shall allow users to make a reservation for an available car
4. The system shall allow users who reserved a car to cancel the reservation
5. The system shall allow users to unlock the car they reserved
6. The system shall allow users to start the ride
7. The System shall allow users to make a pit stop of maximum 60 minute
8. The system shall allow users to end the ride only if the car is parked inside the safe area
9. The system shall allow users to communicate if the car they reserved is damaged or issues are found (e.g. dirt, damages, etc.).
10. The system shall compute the price of every ride taking into account discounts and penalties and send it to the system which take care of the payment.

**Operators:**

1. The system shall inform operators about the changes of the status of every car by changing the colors associated to each one and sending notifications only to those operators that work on the nearest charging station.
2. Operators shall select a car from the list and be able to take care of it.

**2.4 Domain Properties**

* The contact-less card is received by users not later than 3 days after the registration is performed.
* Parking a car where is not allowed by the traffic laws is subject to penalties for the user that parked it, according to Italian laws.
* Damages found on the cars are paid by the last user before the one who signals the found damages

**2.5 Text Assumptions**

* There are no identical fiscal codes or license numbers related to different users
* The credit card inserted at the moment of the registration by the user is a valid (existing and working) one.
* Users only register into the system once.
* The user who unlocks the car is the owner of the contact-less card he uses and is the same who is actually going to drive it.
* Cars are equipped with GPS sensors in order to be localized from the system.
* Cars are equipped with pressure sensors on every seat, in order to let the system know exactly how many passengers are onto the car anytime.
* Users start the ride after at maximum 1 minute after they unlock the cars
* Every car is always equipped with the relative key to start the engine
* The user will not try to start the engine of the car before making sure the car has no issues and communicating it to the system via the on-board computer
* In case of issues on a car, users always notice them and notify it to the system
* Users will never try end the ride without turning off the engine first.
* Users will not leave the car in a zone where is not possible to detect the GPS sensor, even if it is inside the safe area.
* Users do not leave cars into private parking lots.
* User will not perform any kind of maintenance or reparation operations to the car
* User will not leave the car in any kind of condition which could cause damage or any issue on the surrounding area.
* ~~“Users will not try to leave cars outside the safe area”.~~
* Users will always leave the car with the windows closed, handbrake activated, lights and radio off and all the documents stored in their right place at the end of every ride.
* Users will always instantly receive, after they end a ride, the information about the ride itself via e-mail and the mobile app. These information include time and money spent, distance traveled , etc.
* All the payments are correctly performed at the end of every ride
* If an operator taps the button “OPERATE" associated to an issued car, he actually performs all the needed actions in order to fix that car within 4 hours , and always remember to tap the button “ISSUE RESOLVED” once they finished.
* Operators are registered into the system and all their data is stored onto the database; The information inserted by operators at the moment of the registration is always consistent.
* Operators have a special section of the system where they can log and access all the information they need to perform their job. They can log using a password chosen during the registration.
* Operators are always available to pick up calls from users who need assistance
* Operators have a special contact-less card they can use to unlock the cars, acquired at the moment of the registration into the system.
* In case users leave any kind of items into the cars after ending the ride, they can inform operators about that via a phone call, and operators will pick their stuff; users will collect it in one of the charging station.

**2.6 Constrains**

* The implementation language must be Java .
* The credit card payment system must be able to be dynamically invoked by other systems relying on it.

**Network connections**

“Power&Joy” webApp needs internet connection for working. In particular if a user needs to make a reservations or cancel it , he has to switch on 3G or LAN wireless connection.

**Concurrent operations**

The system has to guarantee multiple processes from different connect users.

**Hardware limitations**

All the mobile phone must have GPS to localize them and compute the shortest path to the reserved car. They required a space for App package too.

**Interfaces to other applications**

The system will interface with a new MySQL database. All the information about users are saved here and the system through queries can use them.

**3. Specific Requirements**

* 1. **Functional Requirements**

1. **The system shall allow users to register via the web or mobile app by inserting all the required information**
   1. The system require to insert all personal information that consist on :First name and Last name  
      E-mail  
      Password  
      Phone number  
      Birth date   
      ID card code   
      Drive licence code   
      Credit card number   
      Fiscal code
   2. The system check that all information inserted are valid (e.g. all text boxes must be not empty, the name cannot contain numbers etc).
   3. The system includes the information of the new user onto the database
   4. The system sends a confirmation e-mail to the new user.
2. **The system shall allow users to log in**
   1. In order to log in, the system shall require users to insert their credentials (consisting of an e-mail/username and a password) into an input form accessible from the web or mobile app.
   2. The system shall verify that the credentials are valid , and only in that case give access to the area where cars positions are displayed.
   3. In case the credentials are not valid, the system shall negate the access .
3. **The system shall allow users to see the positions of all the available cars on a map**
   1. The car are equipped with a GPS sensors that allow the system to localize them anytime.
   2. The system put all the cars positions on a map that can be visualized by users via web or mobile application.
   3. The user shall be able to insert a specific address or geographical position, in order for the system to show the available cars around the wanted location.
   4. The system shall allow users to view all the positions of the cars which are strictly placed around users current position by simply tapping a button on the app. This is only possible if GPS sensor are working on the device the user is utilizing to view the map.
4. **The system shall allow users to make a reservation for an available car**
   1. When the user find a suitable car he can reserve it by clicking on the “RESERVE” button on the application.
   2. After doing the reservation the system starts a timer of 60 minutes. If the user is not able to unlock the reserved car before the time expires, the system cancels the reservation making the car available again for other users.
5. **The system shall allow users who reserved a car to cancel the reservation**
   1. Once a user reserved a car, the system shall allow him to cancel the reservation for it before the timer of 60 minutes expires by clicking on a button “CANCEL RESERVATION” on the mobile or web app.
   2. If the user cancels a reservation, the system shall make the car available again for other users.
6. **The system shall allow users to unlock the car.**
   1. Any reserved car can only be unlocked using the contactless card owned by the user that reserved that specific car, and before the timer of 60 minutes expires.
   2. When the user places the contactless card near the sensor of the car, the system shall acquire information about the card, verify that it corresponds to the user that actually reserved that car, in that case, the system shall unlock the car in order for the user to get in
   3. In case the contactless card is not recognized as valid by the system, the system denies access to the car, until a valid card is recognized by the time the timer expires.
7. **The system shall allow users to communicate if the car they reserved is damaged or issues are found (e.g. dirt, damages, etc.).**
   1. Before starting the engine the system shall remind the user through the on-board computer to check for damages on the car and to communicate it in case issues are found via the mobile app or the same onboard computer
   2. In case of issues, the system shall cancel the reservation , make the car unavailable for users, marking it as “RED" and inform the nearest operators.
8. **The system shall allow users to start the ride.**
   1. In order to start the engine the user shall turn the car key inside the lock (just like a normal car works)
   2. The system shall start to charge the user by minute of ride as soon as he ignites the car engine.
   3. The system shall display on the onboard computer the updated amount of money spent for the ride.
   4. ~~If the users wants to, the system shall compute the shortest path from the user’s current position to the final destination of the ride and display it on the onboard computer.~~

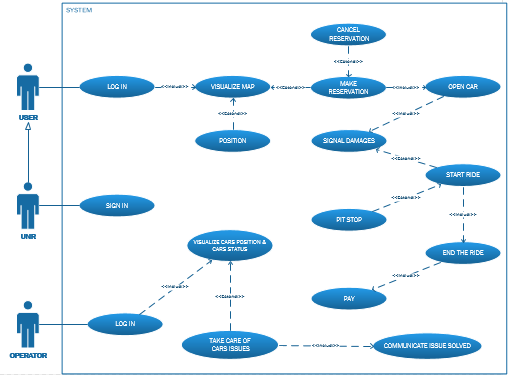
1. **The System shall allow users to make a pit stop of maximum 60 minute.**
   1. The system shall allow users to make a pit stop of maximum 60 minutes communicating it tapping a button “START PIT STOP” on the onboard computer. When they do it, the system starts a timer of 60 minutes.
   2. When the user wants to end the pit stop he needs to tap again a button “RESTART THE RIDE” on the onboard computer, or simply restarting the car.
   3. During the pit stop the system shall still go on charging users for 50% of the price during all the time the pit stop lasts or since the timer expires.
   4. During the pit stop the system shall always make the car stay reserved for the current user, and unavailable to other users.
   5. When the Timer expires the system cancels the reservation for that car, making it available for other users to use.
2. **The system shall allow users to end the ride only if the car is parked inside the safe area and the car engine is shut down.**
   1. When the user wants to end the ride, he has to communicate it to the system by tapping a button “END THE RIDE” on the onboard computer.
   2. The system shall check if the car is parked inside the safe area using the GPS sensor information, and only in that case allow user to end the ride stopping charging the user.
   3. If the car is not parked into a safe area, the system shall go on charging users until they move the car inside the safe area and tap the button “END THE RIDE” on the onboard computer.
   4. The button “END THE RIDE” shall only be available to press if the car engine is shut down.
3. **The system shall compute the price of every ride taking into account discounts and penalties and send it to the system which take care of the payment.**
   1. When a ride ends (if the users taps the “END THE RIDE “ button while the car is parked inside the safe area ,or if the pit stop timer of 60 minutes expires) the system shall compute the total cost of the ride using the price currently displayed on the on-board computer and taking into account the following rules:
      1. If the system detects the user took at least two other passengers onto the car, the system applies a discount of 10% on the last ride.
      2. If a car is left with no more than 50% of the battery empty, the system applies a discount of 20% on the ride.
      3. If a car is left plugged into on of the power grids available, the system applies a discount of 30% on the last ride.
      4. If a car is left at more than 3 KM from the nearest power grid station or with more than 80% of the battery empty, the system charges 30% more on the ride.
4. **The system shall allow operators to log into a dedicated area .**
   1. order to log in, the system shall require operators to insert their credentials (consisting of an e-mail/username and a password) into an input form accessible from the web or mobile app.
   2. The system shall verify that the credentials are valid , and in that case give access to the dedicated area.
   3. In case the credentials are not valid, the system shall negate the access
5. **The system shall inform operators about the changes of the status of every car by changing the colors associated to each one and sending notifications only to those operators that work on the nearest charging station**
   1. Once they are logged in , the system shall allow operators to view (via the mobile app) the positions of all the cars on a list enlightening those rows that correspond to cars that need assistance (i.e. need to be recharged or repaired ) with the use of colors: GREEN is for charged (or currently on charge) and working car, YELLOW is for cars under 20% battery charge, RED is for cars that need some kind of maintenance or reparations. BLACK is for cars under 20% battery charge that also need some kind of maintenance or reparation, BLUE is for cars currently placed outside the safe area, PURPLE is for cars that other operators are already taking care of.
   2. When issues are found on a car and communicated to the system by users, the system shall send notifications to all operators via e-mail and the mobile app, and change the color of the corresponding row on the list.
6. **Operators shall select a car from the list and be able to take care of it.**
   1. Operators shall be able to communicate to the system they are taking care of a car by selecting a row on the list and tapping a button “OPERATE”. When this happens, the system shall mark that row as PURPLE. Once issues are resolved for a specific car (which is currently marked as purple), operators shall be able to communicate it to the system by tapping a “ISSUES RESOLVED” button (only available for cars marked on PURPLE). The system shall then mark the car GREEN again.

* 1. **Non-Functional Requirements**
* The system must be available 24 hours a day
* The system must respect Quality of Service (QoS) attributes .
* The system shall start all the required timers within 1 second after the user’s input.
* The system shall unlock the car within 5 seconds after the contactless card is placed near the car sensor
* The system shall start charging the users within 2 seconds after they start the car engine at the beginning of a ride
* The system shall stop charging users within 2 seconds after they tap on the “END THE RIDE “ button on the on-board computer, having the engine shut down, the car parked inside the safe area, and the car GPS signal available.
* The system shall change the colors the cars are marked of within 2 seconds from one of the following events: 1) A car switches from 20% to 19% battery charge 2)An operator taps the “OPERATE” button associated to an issued car to take care of it 3)An operator taps the “ISSUE RESOLVED” button associated to a care they took care of 4)a user taps on the button “ISSUES FOUND” on the on-board computer of a car, 5)a car leaves the safe area

* 1. **Scenarios**

**4. UML Model**

**4.1 Use case**



**Use case description**

In this paragraph some use cases will be described. These use cases can be derived from the scenarios and the use case diagram.

**User Log in**

**Name :** A user logs into the system logs in  
**Actors : User**  
**Entry conditions :** There are no entry conditions.

**Flow of events :**

* A user opens the user’s log in page in the web or mobile app
* The user inputs his credentials, consisting of a username and a password
* The usr clicks on the “LOG IN” button
* The system checks that the credentials are valid (they are associated to an existing user) and redirects the user to the User’s Home page

**Exit conditions :** The user is redirected to the User’s home page.

**Exceptions :** If the username or password inserted by the user are not valid, the system does not redirect the user to the user’s home page. Instead, it notifies him that the credentials he inserted are not valid and tells hime to try again.

**User visualizes a map of the cars**

**Name :** A user visualizes a geographical map where are enlighten the current positions of all available cars.  
**Actors : User**  
**Entry conditions :** The user must be successfully logged in

**Flow of events :**

* The user can visualize from the user’s home page, directly accessible from the login page, a map of Milan’s urban area, where are enlighten the current geographical positions of all the available cars

**Exit conditions :** The user is now aware of he positions of all the available cars (i.e. cars which can be reserved)

**Exceptions :** none.

**Location of cars whiten 1 km from a given position**

**Name :** A user inserts a specific location and visualize all near available cars  
**Actors : User**  
**Entry conditions : The user must be logged in**

**Flow of events :**

* The user inputs a geographical location (consisting of a street/postal code/building etc.) into an input area at the bottom of the user’s home page
* The user clicks on the “SUBMIT” button.
* The system dynamically changes the geographical area shown on the map, in order to highlight the cars within 1 km from the location inserted by the user

**Exit conditions :** The user can now see highlighted on the map the cars near the location he inserted

**Exceptions :** If the position inserted by the user is not recognized by the system as an existing location inside Milan’s urban area, the user won’t see any changes on the map, and the system notifies him that the location he inserted is not a valid one, telling him to try again

**Car reservation**

**Name :** A user reserves a car, choose among the available cars  
**Actors : User**  
**Entry conditions : the user must be logged in**

**Flow of events :**

* the user select a car on the map, among the available cars shown.
* The system shows a “RESERVE CAR" button near the selected car
* The usr clicks on the “RESERVE CAR” button
* The system reserves a car for the user, making it unavailable to others, and redirects him to the reservation page, where he can visualize a message confirming that the reservation has been successful timer that shows the remaining minutes before the reservation expires, the position of the car et al..

**Exit conditions :** The user is redirected to the reservation page, where he can visualize the details of his reservation.

**Exceptions :** In case problems occur on the reservation process, an error message is shown, and the car remains available for other reservations

**Reservation cancellation**

**Name :** A user cancels a reservation he made  
**Actors : User**  
**Entry conditions :** the user must be logged into the system, and must have successfully reserved a car

**Flow of events :**

* from the reservation page, the user is able to visualize a “CANCEL RESERVATION” button
* The user clicks on the “CANCEL RESERVATION “ button
* The system cancels the reservation, making the car available to other users.
* The system shows a message to inform that the reservation has been correctly cancelled
* The system redirects the user to the user’s home page

**Exit conditions :** The user is redirected to the User’s home page.

**Exceptions :** none

**Open Car**

**Name :** A user opens the car he reserved  
**Actors : User**  
**Entry conditions :** The user must have logged into the system and have successfully reserved a car. The user has reached the car he reserved and has the contactless card needed to unlock the car with him.

**Flow of events :**

* The user places his contactless card near the car sensor before the timer expires
* The system retrieves the information about the card and verifies that it corresponds to the user that reserved that car
* The system unlocks the car

**Exit conditions :** The user has successfully unlocked the car

**Exceptions :**

* if the timer has expired by the time the user places the contactless card near the car sensor, the system denies access to the car, notifying the user with a message on the mobile app and with a red light appearing on the car
* if the contactless the user uses to try unlock the car is not belonging to him, the system denies access to the car and notifies the user with a red light appearing on the car
* if the car the user tries to unlock is not the one he reserved, the system denies access to the car and notifies the user with a red light appearing on the car

**Car issues signaling**

**Name :** A user communicate o the system weather there are issues on the car he reserved or not  
**Actors : User**  
**Entry conditions :** the user has successfully reserved and unlocked a car

**Flow of events :**

* The system reminds the user to check for issues on the car with a message on the onboard computer before letting the user start the ride
* The user checks if there are issues and do not find any
* The user taps on a button “NO ISSUES FOUND”on the on-board computer
* The system let the user know he can start the ride with a message on the on-board computer.

**Exit conditions :** The user can now start the ride

**Exceptions :** If the user find issues on the car, he communicate it to the system tapping a “ISSUES FOUND”button on the on-board computer. The system cancels the reservation, making the car not available to the current user as well as all the others. The system tells the user to leave the car with a message on the on-board computer. The user is unable to start the ride and leaves the car. The system informs operators about the issue by marking the car as “RED”.

**User start the ride**

**Name :** A user starts a ride with the car he reserved and unlocked  
**Actors : User**  
**Entry conditions :** The user has successfully reserved and unlocked a car, found no issues on that car and communicated it to the system.

**Flow of events :**

* The user taps on the button "START THE RIDE” on the dashboard of the car and starts the engine
* The users starts to be charged by the system
* The user starts to be able to visualize the updated amount of money spent for the ride on the on-board computer

**Exit conditions :** The user successfully started the ride

**Exceptions : none**

**Pit Stop**

**Name : the user makes a pit stop**  
**Actors : User**  
**Entry conditions :** The user has correctly started a ride on a car he reserved and unlocked.

**Flow of events :**

* The user parks the car and stops the engine turning the key
* The user taps on the “START PIT STOP” button on the on-board computer
* The user starts to be charged by the system for half the price of a normal ride
* The user can now leave the car parked for maximum 60 minutes, keeping it reserved for future use
* The user

**Exit conditions :** The user is redirected to the User’s home page.

**Exceptions :** If the username or password inserted by the user are not valid, the system does not redirect the user to the user’s home page. Instead, it notifies him that the credentials he inserted are not valid and tells hime to try again.