Project Management Report
PARKoUR
Parking Application Usability Redesign

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Introduction

MyCicero is a mobile application which offers services such as online Pre-paid parking fees, online booking and management of travels to a wide range of users. In the following lines, you will read and discover the usability and user experience analysis of this application most especially on the Parking section of the app. This project as stipulated by the guidelines is based on the motivation of use of the app. We had as a starting point the individuation of the factors for the lack of motivation of use by a segment of users and as a landing point the creation of a source of attractivity in the application for use by this same segment. As factors of lack of motivation for the use of the app MyCicero, we pointed out the none awareness of the existence of this possibility by many possible target users and the fear of online transaction payments. We focused less on the first factor because in our opinion, this is more a marketing issue than an issue of usability and thus we leave this to the company itself. As inferred already, the cause of lack of motivation we focused on is the financial fear many users have in online Pre-paid parking fees applications. Therefore in this light, we decided to analyse this point in order to in the end produce a final product which will be appealing to this segment and by so doing, we will be broadening the reached target users of the application.

1. Ethnographic research

1.1 Segmentation of the target

In order to develop our service, we first had to understand the target users and detect a segment which is not currently responding i.e. our focus target.
The application is thought for frequent users of technology, who are able to download it and carry out a procedure using it that involves an online payment. Among them, we can distinguish:

A. Those who use or would use the application for a third party;
B. Those who use or would use it for themselves, thus owners of a driving license and habitual drivers.

Both segments can be further broken down into:

1. Those who use or would use the application for a single occasion;
2. Those who use or would use it repeatedly.

In both subgroups, we identified five segments, on the age basis, that are distinguished also for the occupation, the living situation, the income and the inclination towards technology. All the segments can be broken down in smaller ones around these features. Gender and place of residence weren't considered a discriminant.

- **Under 18:**
  - In the case of segment B, they are drivers of a mini-car.
  - Occupation: students;
  - Living: with parents;
  - Income: low;
  - Technology: oriented.

- **18-30**:
  - Occupation: students, employees with a temporary contract, employees with a permanent contract, unemployed;
  - Living: with parents, with their partner without children, with roommates or alone;
  - Income: low or medium;
  - Technology: oriented or sceptic.

- **30-40:**
  - Occupation: employees with a temporary contract, employees with a permanent contract, unemployed;
  - Living: with parents, with their partner without children, with their partner with children, with roommates or alone;
  - Income: low, medium or high income;

    - Technology: oriented or sceptic.

- **40-65:**
    - Occupation: employees with a temporary contract, employees with a permanent contract, unemployed;
    - Living: with their partner without children, with their partner with children or alone;
    - Income: low, medium or high income;
    - Technology: oriented, sceptic or unable.

- **Over 65:**
    - Occupation: employees with a permanent contract, retired;
    - Living: with their partner without children, with their partner with children, with other relatives or alone;
    - Income: low, medium or high income;
    - Technology: oriented, sceptic or unable.

1.2 User research

1.2.1 Survey

The User research has the scope of understanding user behaviours, needs, and motivations through Market Research, Contextual inquiry and task analysis. At this point, we will focus on Market Research, which is a way to determine a potential market. It is an indirect source of data collection and it has two methods: survey or focus group. In the context of our project, we have decided to use the Survey Method to get information from the possible target users of Online Pre-paid parking fees applications using the platform Google survey.

We created a survey open to all, even to those who do not have a driving license or do not drive regularly, regarding online payment for parking services. The survey was placed on social media platforms such as WhatsApp or Facebook with the specificity of using the data received only for the purpose of our project and anonymously.

The survey was divided into two parts. The first part focused on information on the person and the second on information on the online payment of parking through applications. The questions in the first part were on:

- age,
- sex,
- profession,
- level of study,
- residence,

- patent,
- frequency drive,
- car ownership.

While the questions of the second part were on:

- the use of an application to pay for parking,
- the application used for that purpose,
- the towns in which it has been used,
- the frequency of use of these apps,
- the occasions of use,
- if the still uses that application,
- their point of view,
- if they were satisfied,
- if they used other applications,
- how was their experience compared to the application they had used before.

The survey was conducted over a period of one week and we received 103 answers, of which eight said that they have used an application for online parking payment. From the result of the survey, we concentrated our attention on the second part i.e the questions regarding the applications for the parking payment.

The most used application was “MyCicero” with a total of three users, the other applications used were: Easypark (2), TelepassPay (2) and Phonzie (1). The towns where the applications, in general, were most used were “Bologna/Siena” (2), the most common frequency of use was “often” (4), the most evoked occasion was “ work” (5), five of the eight users continued to use the application. For the point of satisfaction, four were satisfied. Only one of the users used another application and had a great experience with it.

Most of the users who have not used these apps had as a reason, the absence of knowledge on the existence of applications for online parking payment (52). While others don’t trust applications for online parking payment (3).

The survey made us realize that many people don’t know the applications for online parking payment regardless of their age, profession or residence.

1.2.2 Interview

As one of the starting points for our project realisation, under the context of User Research and precisely contextual inquiry, we conducted interviews as a direct source to obtain data from interaction with our possible target users. This process was done to a number of seven possible target users, in a virtual mode for six target users and in real life for one of the target users. The virtual model was through a call on a personal computer and the applications used were Skype, WhatsApp and mobile call. In both modes, we did a registration of the interview

using our cell phones to keep track of all the details of the interview. The interviewed were all living in different towns in Italy. Their age range varied from 23 to 30 years and their occupations were students, unemployed, trainees and workers. We first created the set of questions in which we created different patterns of questions based on answers provided for other questions. Then we checked their correctness and usefulness for our purpose. After all these checks, we then went ahead to carry out the interview. Here below is a representation of the interview questions and the answers provided by each individual.

Number of questions	18
Number of interviewed	7
Age	23 - 30
Profession	Student, unemployed, trainee, worker
Town	Bologna, Prato, Florence, Turin, Forlì
House location	In the city, out of town, in the suburbs
Tools used	Computer and cell phones
Model	Virtual and live

Interviewed: they are listed with numbers which are then used to represent their various answers to the interview questions.

1) A male, worker with a term contract, who lives with his parents, has a medium-income, lives out of town, is technology sceptic and is 24 years old.

2) A female student who lives with her parents, has a low income, lives out of town, is technology sceptic and is 24 years old.

3) A female, trainee who lives with her partner, has a low income, lives out of town, is technology-oriented and is 26 years old.

4) A male, worker with a term contract, who lives alone, has a medium-income, lives in the suburbs, is technology-oriented and is 30 years old.

5) A female, student who lives with flat-mates, has a low income, lives in the suburbs, is technology-oriented and is 23 years old

6) A male, unemployed, who lives alone, has a low income, lives in the city, is technology-oriented and is 28 years old.

7) A female, trainee who lives with her parents, has a low income, lives in the suburbs, is technology-oriented and is 24 years old.

Questions

Background information

1. **How old are you?**
    1) 24
    2) 24
    3) 26
    4) 30
    5) 23
    6) 28
    7) 24
2. **Your Sex?**
    1) Male
    2) Female
    3) Female
    4) Male
    5) Female
    6) Male
    7) Female
3. **What is your profession?**
    1) A worker with a term contract
    2) Student
    3) Trainee
    4) A worker with a term contract
    5) Student
    6) Unemployed
    7) Trainee
4. **If you wish, can you specify your profession?**
    1) Metalworker
    4) Database Administrator
5. **What is your level of studies?**
    1) Diploma superiore
    2) Diploma superiore
    3) Laurea Triennale in Lettere
    4) Laurea Triennale in Ingegneria Informatica

5) Diploma di liceo
6) Laurea Triennale in Ingegneria Informatica
7) Diploma superiore (ITT)

6. **What is your province of residence**
    1) Prato
    2) Prato
    3) Forlì
    4) Turin
    5) Bologna
    6) Modena
    7) Florence

Technology use

7. **Are you oriented or sceptical to technology?**
    1) Sceptic
    2) Sceptic
    3) Oriented
    4) Oriented
    5) Oriented
    6) Oriented
    7) Sceptic at times most especially on the issue of sharing personal data and the presence of untrusted websites.
8. **Do you do online payments? (if yes, with what frequency, types of payments -bus tickets, cinema tickets, general products etc)**
    1) Yes, once every six months: for musical objects, entertainment etc. Never for public transport tickets and cinema.
    2) Yes, once a week: for all except for dresses i.e. electro domestics, accessories, technology, transport tickets, concert tickets etc.
    3) Yes
    4) Yes
    5) Yes, once each month: for online phone recharge, home food delivery apps like Justeat and on websites such as Amazon, Netflix and Spotify.
    6) Yes, very rarely: for dresses, books, textbooks and shoes.
    7) Yes, on the websites she considers to be reliable e.g. Amazon, also for bus tickets and cinema tickets.

Product use

9. **Have you ever used an online application for Pre-paid parking fees?**
    1) No
    2) Yes

3) No
4) No
5) Yes
6) No
7) No

a) If yes, which one(s)?

2) ATAF
5) MyCicero

- **In which town did you use the application or are you using the application?**
  2) Florence
  5) Cesenatico and Cesena
- **With what frequency do you use the application?**
  2) Only once
  5) Only once
- **For which occasion did you use the application?**
  2) For a concert
  5) For summer holidays
- **Are you still using the application?**
  2) No, deleted the application the next day.
  5) No, because she was with a friend who uses the app.
- **Have you used other applications?**
  2) No
  5) No

b) If no, why?

1) Never used these types of applications, because he usually parks in the white spaces or either uses the parking machines.

3) No. Because she usually uses the free parking and if she is in a situation where she has to pay, she chooses the parking beside the parking meters.

4) No. Because he wasn't aware of the existence of these applications and so usually uses the parking meters.

6) No, because he was not aware of the existence of these applications.

7) Never used because she doesn't know them and most for the fact that she wasn't aware of their existence.

Objectives and motivations

If the answer to the question on the use of an application for Pre-paid parking fees is YES:

10. Why do you use/did you use the application?

2) By necessity, she had no coins.

5) Because it was convenient and immediate. It gave them the possibility to stop the parking session before the end which they did and the payment surplus was refunded.

11. **What are your expectations when you use/used the application? (example: speed, reliability)**

    5) The experience was good and from the error they encountered, they learned that it is important to verify the vehicle's plate number for which a user is paying.

If the answer to the question on the use of an application for Pre-paid parking fees is NO:

12. **Why would you use such an application?**

    1) Would not use the application because he has very few occasions in which these apps could serve him. In general, he has very little trust in online transactions most especially the ones with payment from a bank account. In a small municipality like the one in which he lives and the one in which he works, he wouldn't use the app even if he admits the fact that maybe it would be a lot easier to manage for the municipal police officers thanks to the presence of a small number of people.

    3) To avoid a fine. This would be in situations of having an urgent need for a parking session. Thus if she is able to pay for a parking session immediately and receive the receipt also immediately to solve her problem, it will be good.

    4) To be able to pay for a parking session in advance and also because it is convenient.

    6) Because it is convenient

    7) To convert herself to a payment method which will be that of the future and also to avoid theft risks. Also because the ability to control the parking meter remotely is a plus because you don't have any particular restrictions while doing the activities you have to do.

13. **What are the advantages you would expect from using this type of application? (example: speed, reliability)**

    1) He thinks that paying the parking session using coins already is something fast. The only case in which he thinks this application could be advantageous is: if the user has to park in a very big parking space and the parking machines are far away from his position. Nevertheless, he still wouldn't use the app in this situation.

    3) The simplicity related to the access to the application and the possibility to use the app in every situation i.e. before or after parking.

    4) The advantage of having a fast payment method and thus avoiding to cue for payment at the parking machine.

    6) The reliability and effectiveness of the application.

    7) The possibility to travel at your ease and not having to worry about where to park since it can be handled remotely. Also the tranquillity of doing things without worrying about the ending time of the session. The possibility to avoid a fine.

Pain points

If the answer to the question on the use of an application for Pre-paid parking fees is YES:

14. **Did you encounter problems?**

    2) It wasn't easy to use the app, they did not understand well the steps to follow.

    5) The app in default uses the first inserted vehicle plate number and so if the user wants to pay a parking session for a new car, you have to insert the new vehicle plate number which is normal. They did not remember this since her friend with whom she was, usually uses her mother's car but on this day they had to use hers and so they used the app paying normally as usual but unfortunately for them it was not a payment for the right vehicle and so, they were fined.

    - **How did you feel during these situations? (example: frustrated, looser etc)**

      2) She felt very wary while using the app because she wasn't guided while using the application.

      5) For the fine very bad. But according to her, the error was their fault not that of the app.
    - **Was the problem resolved?**

      2) Yes in the sense that she succeeded in using the app in the end.

      5) Yes, they paid the fine but learnt the lesson
    - **How did you react? (example: cancelled the app, reported the problems, changed the app etc)**

      5) It wasn't a problem of the app according to her and therefore she considers her experience to be a good one.

15. **Do you feel satisfied with your use of the app? And from the use of other apps? How was your experience compared to that of the previous app?**

    2) Not completely satisfied because she took a lot of time to understand the functioning of the app.

    5) In general, she feels very satisfied since the application is simple. They used the credit MyCicero for their payments and it was very convenient since it requires no entry of personal data.

16. **Which are the problems you would not, in any case, wish to face during the use of the app?**

    2) It should be fast, have secured payments, easy to use without many passages. In general, the fact that in the app you can pay exactly the number of minutes of the parking session is like the parking machines. What would really attract her is the possibility to postpone the end of a session.

    5) The transaction should have no bugs and go on successfully.

If the answer to the question on the use of an application for Pre-paid parking fees is NO:

17. **Which are the problems you would not, in any case, wish to face during the use of the app?**

    1) Problems of reliability with the payments: low trust from the part of the municipal police officer, with the parking tag it is more rapid. Even if he is aware of a convention with the municipality, according to him it will still depend on the municipal police officer that you find. Even if the app assures him that the transaction is safe, protected, he will be sure at 90%.

    3) Would not wish to :

    - Pay for the parking session and not receive the receipt immediately
    - Be blocked during the payment of the parking session
    - Be forced to pay for the parking session in advance
    - Not be able to contact the help service of the app in real-time and /or in one of the languages used by the application e.g. the app would probably be in English, so she would wish to be able to contact the help centre in English.

    4) Have any malfunctioning of the app during the use e.g. that the app bugs, becomes unavailable or becomes slow.

    6) Would not wish to have his personal data retained or any security issue.

    7) Do not wish that the communication between the app and the coupon be interrupted, but would wish that the information about the parking payment arrives on the coupon. Would not wish to have a fine.

18. **How would you react? (example: cancel the app, report the problems, changed the app etc)**

    1) If he faces a problem of reliability, he would report. But if he receives a fine as a result of this problem, he would delete the app after having reported without waiting for any correction. After such an incident, he wouldn't try to install a new app because he would have no trust in them anymore.

    2) If there were problems with security in the payment, then she will remove the app or maybe report. She will not for any reason become wary. If there were problems with speed she would not delete the app.

    3) Would delete the app

    4) Would immediately go and review the app on play store and if he encounters the same problem again, he would no longer use the app.

    6) Would uninstall the app and also report the problem.

    7) Would report the problem and would change the app.

1.2.3 Task analysis

In order to understand in detail how a task is performed to achieve a specific result, we developed a task analysis. This analysis helped us understand the context in which the tasks are performed and observe the sequence of steps and user interaction between the space covered by the product and other external factors.

We analyzed 8 tasks that correspond to the actions that can be undertaken in the section of the app "Parking and Car Parks". The tasks are the following:

- Save the credit card number
- On-street parking payment
- Extend the parking session
- Stop the parking session before the expected end
- Search and book/reserve a garage parking
- Search and book/reserve an off-street parking
- Purchase a periodical parking ticket/subscription
- Purchase temporary permissions for a ZTL area

Nonetheless, we focused our attention on 3 tasks, which are those related to the online payment of on-street parking: on-street parking payment, the extension of the parking session, stop of the parking session before the expected end. We decided not to go ahead with the payment in the other cases (garage, off-street parking, ZTL permission) because the prices were too high (and probably the user can only pay using the MyCicero's credit) and because in some cases for the completion of the payment procedure we need to be present on the site. However, we presume that the method is similar to the one we analyzed.
It is assumed that the user accesses to the application, already installed:

- Through his/her smartphone
- He/she is in an area covered by *MyCicero* service
- He/she already has an account with a registered car plate
- Is already logged in
- Has the GPS switched on

The pre-registration of the credit card number on the application is one of the preconditions to carry on the tasks, so we decided to write this as a preliminary task functional to the others.

Task analysis 0 – save the credit card number
Steps:

- Access the application using the smartphone;
- From the homepage, select the profile icon on the top right of the screen;
- Click on "Add a card";
- Insert the requested information in the available fields;
- Click on "Completa per registrare".

Task analysis 1 – On-street parking payment

Context and goal: You have just parked in an on-street parking area and you want to pay the ticket

Steps:

- Access the application using the smartphone;
- From the homepage select “Parking and Car Parks”;
- From the menu, select “On-street parking”;
- From the current page it is possible to access 3 sections: “Maps”, “List” and “Recent”.
- To select the area of interest, there are 3 options:
    1. From the “Map” page:
        a. Select “Search by address” and type the address;
        b. Explore the map until the interested area is found, then zoom on the area.
    2. From the “List” page:
        a. Select the search box and search the address;
        b. Select the parking area from the list.
    3. From the “Recent” page: select one item from the list of recent parking
- From the counter select the end time for the parking;
- Confirm clicking on “Confirm park beginning”;
- Choose the payment option from the floating window which contains: “Recharge”, “Active usage-based payment” and “Cancel”;
- Then back home clicking on “back Home”.

On the top of the homepage and in the notification area of the smartphone (if the notifications are enabled) a box will appear containing all the information related to the current parking session.

Task analysis 2 – extend the parking session

Context and goal: You cannot be back to the car in time for the end of the parking session and want to extend it.

Steps

- Access the application using the smartphone;
- From the box on the top of the homepage (which appeared after the payment of the parking) select the orange button “Extend”;
- From the counter increase/raise the time ;
- Click on the button “Extend parking duration”;
- From the new page select “back Home”;
- On the top of the homepage, a box will appear with all the information on the parking and on the modified time.

OR

- From the notification area of the phone select “Extend” (using this method the extension is of 30 minutes by default);

- From the new notification select “Extend”.

Task analysis 3 – stop the parking session before the expected end

Context and goal: You come back to the car before the ending of the parking and you want to stop it.

Steps

- Access the application using the smartphone;
- From the box on the top of the homepage (which appeared after the payment of the parking) select the red button “Stop”;
- Click on the button “Stop parking session”;
- From the new page select “back Home”;
- Verify if the box has disappeared.

OR

- From the notification area of the phone select “Stop” ;
- From the new notification select “Stop”.

Task analysis 4 – search and book/reserve a garage parking

Context and goal: You are in Rome or has to go to Rome and you want to book indoor parking or a garage

Steps

- Access the application using the smartphone
- From the homepage select “Parking and Car Parks”
- From the menu, select “Garage”
- From the current page, it is possible to access 2 sections: “Facilities List” and “Map”.
- To select the interested parking, there are 2 options:
    1. From the “Facilities List” page:
        a. Select the parking from the list
        b. Select the search box and search the address or the name of the garage
    2. From the “Map” page:
        a. Select the parking clicking on one of the pointers on the map
        b. Select the search box and search the address or the name of the garage, and then click on the box that appears on the top of the page
- Select the button “Request parking session beginning”
- Select the rate, the time and the day

Payment not carried out.

Task analysis 5 – search and book/reserve an off-street parking

Context and goal: You have to take a plane and in order to arrive at the airport you have to use the car, then you look for off-street parking near you to park the car for the period you will be out.

Steps

- Access the application using the smartphone

- From the homepage select “Parking and Car Parks”
- From the menu, select “On-street parking”
- From the current page it is possible to access 3 sections: “Maps”, “List” and “Recent”.
- To select the airport of interest, there are 3 options:
  1. From the “List” page:
     a. Select the airport from the list
     b. Select the search box and search for the name of the airport or the place/city
  2. From the “Map” page:
     a. Zoom on the airport and select it
     b. Select the search box and search for the name of the airport or the place/city, then click on the box that appears on the top of the page
  3. From the “Recent” page select one of the recent parkings, if present
- If the parking areas in the surroundings of the airport are more than one, select the parking of interest from the list, otherwise, the user is redirected to the only available parking
- Click on “Prenota”
- Select the arrival and departure day and the time, if necessary select the extra services.
- Click on “Check the availability”
- If the parking is available, insert the requested information on the form
- Select the button on the “service conditions”
- Select “Choose how to pay”

Payment not carried out.

Task analysis 6 – purchase a periodical parking ticket/subscription

Context and goal: you are on holiday and you want to purchase a periodical subscription valid until the departure day.

Steps

- Access the application using the smartphone
- From the homepage select “Parking and Car Parks”
- From the menu, select “Discounts”
- Select the button “Purchase”
- From the list of cities, select the city or search for it in the search box
  1. From the list of areas, select the interested one
     a. The user is redirected on the page of the area
     b. From the list select the subscription type
  2. If the area is only one, the user is redirected in the page of that area
- If the starting date is not set by default, select it
- Click on the button “Choose how to pay”

Payment not carried out.

Task analysis 7 – purchase temporary permission for a ZTL area

Context and goal: you are in Senigallia and you need to go into the ZTL area with the car

Steps

- Access the application using the smartphone
- From the homepage select “Parking and Car Parks”
- From the menu, select “ZTL Permits”
- Select the button “Purchase”
- Select the city
- Select the validity of the permission
- Select “Choose how to pay”

Payment not carried out.

2. Assessment of existing resources

2.1 Expert Usability Review

2.1.1 Choice of guidelines

One of the important steps in the design or redesign process of a web application or of a website for a good usable product in the end, which will respond perfectly to target user needs is the Expert Usability Analysis. This is a review process of the system to be implemented/designed or of an already existing system by usability experts based on good design guidelines. In our case, the experts were us and the analysis was on an existing system i.e. the online parking application MyCicero. As the first thing to do before carrying out this analysis, we selected the guidelines to use. Having a variety of guidelines from general ones to specific ones, after a thorough reading of the various guidelines, we went for the 10 heuristics of Nielsen and Molich (1994) which in our opinion answers well to the many design recommendation standards which an application should satisfy at the minimum level and if done in full respect of the guidelines, the system produced will be very usable. Added to these guidelines, we introduced some guidelines from the 20 heuristics of Weinschenk And Barker (2000). This is because in certain cases, they provided the best explanations to the design worry present in the system.

The 10 heuristics of Nielsen and Molich

1. Visibility of system status
The system should always keep the user informed about what happens, through appropriate feedback provided within a reasonable time.

2. Match between the system and the real world
The system should speak the user's language, with words, phrases and concepts familiar to the user rather than system terms. It must follow conventions of the real world, and make information appear in a natural and logical order.

3. User control and freedom
Since the user often chooses system functions by mistake, he needs clearly marked "emergency exits" to leave the unwanted state without having to go through a complex dialogue. Support undo and redo.

4. Consistency and standards
Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

5. Error prevention
Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

6. Recognition rather than recall
Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

7. Flexibility and efficiency of use
Accelerators —unseen by the novice user —speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

8. Aesthetics and minimalist design
Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

9. Help users recognize, diagnose, and recover from errors
Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

10. Help and documentation
Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Used heuristics of Weinschenk And Barker

5. Linguistic clarity
The language used to communicate is efficient, clear and adequate to the audience.

7. Simplicity
The design does not use unnecessary complexity.

8. Predictability
Users will be able to form a mental model of how the system will behave in response to actions.

9. Interpretation
There are codified rules that try to guess the user's intentions and anticipate the actions needed.

14. Cultural property
The user's cultural and social expectations are met.

15. Suitable tempo
The pace at which users work with the system is adequate.

2.1.2 First inspection of the system

We carried out as the first step of the expert evaluation of our system MyCicero, a quick initial inspection of the system to understand the services offered/goals satisfied by the system, the target users and any key usability problem that can be immediately identified. This was done individually and then as a group, we then gathered all the points and the outcome is:

Red = points gathered with a created account
*** = points gathered without a car plate registration

Key problems of usability

Bad design

- The *back* icon is very close to the *home* icon; in this way is very easy for the user to make a mistake
- The user can reach the section on the right of the homepage by swiping right, but it is not very intuitive
- In the various sections of the app, space is not correctly occupied by the icons (e.g. non-symmetrical homepage icons; profile icon on the top); by the writing (e.g. left alignment; top of the profile page) and sometimes is too much/surplus (e.g. online assistance on the bottom; off-street parking conditions; push notifications occupy a whole section; the red box for the credit on the top of the page has an empty space on the left; recharge credit in the profile page).
- In the “Discount” page the dates are written in two different formats.
- In the “Update” page, inside the “Discount” page, there are two arrows with opposite directions that are also redundant.

Links' design

- In many cases the icons are links, but this is not easily recognizable (a problem of recognition) e.g. "info" in on-street parking has a grey colour, that is different from other icons which have a blue colour e.g. navigator in "Find my car".

Coherence

- There is no coherence/consistency among the sections e.g. the symbol of the account sometimes is present and sometimes it is not, and it changes in the different sections.
- There is no coherence among the different linguistic versions of the app e.g. in the section of the off-street parking of Bologna, the same parking is called in two different ways (park to fly – parking1); in "Discounts" the user cannot open the info section in the English version, he cannot go back because the purple band disappear.
- Without login, the app gets stuck in different parts of several sections (e.g. "Discounts" and "ZTL permissions")
- In "Manage affiliation" there is the possibility to set up the automatic popup, this does not make any sense.
- *** Once logged in, if the user does not save the car plate, he/she cannot see some sections which were visible without the login.
- In "Garage" if the user's credit is equal to 0, the app does not provide a price quotation, while it provides it in the other parking services.
- In the recharge section of the MyCicero credit, there is no more possibility to use coupons.

Linguistics

- Very often there are both linguistics and typographical errors (e.g. in car plate registration it is written "car descrption"; in "ZTL permits" in the info page of Senigallia the encoding is wrong e.g. you have "?" instead of "€").
- Even when the app is used in its English version, often there are some Italian words e.g. in "Off-street parking".

Meaningful design

- Colours are not meaningful, the only meaningful colours are those of the "Parking".
- Icons are not meaningful e.g. parking and ZTL permissions
- The table of rates and the schedules are not reflecting the differences existing between them (e.g. garage)

Wrong match between the expectation of the user and the result

- The button "Continue without registration" intuitively should mean "go ahead without some functionalities", while clicking on it the user comes back to the previous page.
- Sometimes clicking on the back button, the user comes back to two previous pages instead of the previous one e.g. homepage

- The icons of the services in the off-street parking seems links (because their colour is blue), but they are not links. The same happens in other cases (e.g. the icon of the trash in the profile page)
- While stopping the parking session, even if the expected amount is lesser than 20 cents, the user will pay at least 20 cents. The user was made aware of it in one of the previous pages, but in doing this process he is not reminded of that.

Missing guidelines

- With and without GPS, zooming and not zooming on the map, there are differences among the navigator, the search address and the bars under the compass symbol.
- An initial guide is missen.
- In the "Off-street parking" page it is not clear what the number near the kilometres refers to.
- Without the login, if clicking on "Find my car", an error message will appear (with no further explanations)
- At a first inspection in "Manage affiliations > shared number plates," it is not intuitive
- It is not explained where to take the coupons
- It is not explained where to find the list of cities in which the coupon is required

Missing customization

- It is not easy to understand when the user is logged in or logged out (profile icon)

User control and irreversible action

- When confirmed the beginning or extension of the parking session, the app gives a summary screen without any further possibility of confirmation.
- The user cannot delete the account on his own, he needs to contact the help centre

Goals

City customization

- The city is automatically found with the GPS
- There are additional section and services depending on the city

Multiple choice -Redundancy

- The app offers multiple possibilities to reach the same goal e.g. in the on-street parking, the selection of the area can be done in 3 different ways.

Management of parking session

- Once started the parking session, the box on the top of the page is very useful to manage the parking and it works well e.g. shortcuts.

Wide user base

- There are no limitations to the type of user

e.g. possibility to affiliate the car plate or the method of payment to other users; promoting in this way younger users.
e.g. there are many different ways to pay such as sisalpay (i.e. with no credit card).
e.g. there are no limitations to the addition of car plates (Italian and foreigners)

2.1.3 Direct analysis: system vs. guidelines

It is a systematic exploration of the application with respect to the guideline. The problems found page by page were mentioned in order of severity for Bologna. Firstly, the screens are in reference to the homepage of MyCicero that shows all the services available in the app, but afterwards, we focused on the part dedicated only to the car park. Due to their bulkiness, the various images referring to the following individuated usability problems in the app can be found in the folder "Direct Analysis Screenshots" in our project folder "Project management material" following the same nomination as in this document.

Black = Nielsen and Molich

Red = Weinschenk And Barker

Homepage

- The titles of the icons are written half in English and half in Italian.

  5. Linguistic clarity

- If you are logged in (or logged out), it's not very clear: the icon is simply white, no profile picture, no personalized welcome.

  1.Visibility of system status

- TPer exclamation point is useless. It seems a notification, but it is not.

  2. Match between the system and the real world

  7. Simplicity

- There are useless spaces below the icons.

  8. Aesthetics and minimalist design

Help - Homepage2

- To access this screen you must scroll right from the first screen.

  6. Recognition rather than recall

  4. Consistency and standards

- In FAQ, the questions present are not the same as the ones in Italian and in other languages (in English they are less)

  4. Consistency and standards

- The photo of Tper and Municipality look like icons but are not clickable.

  8. Predictability

  4. Consistency and standards

- By clicking on “online assistance” from an app in English, it sends you to the same page in Italian.

  5. Linguistic clarity

- In FAQ it seems that they did not use Unicode, there are a lot of special characters written in machine language.

  5. Linguistic clarity

- In “useful links”, there is the link to ATC where it is explained that it no longer operates in Bologna and now there is TPer, so there is an update problem compared to what happens in the real world.

  14. Cultural property

- "Online assistance": today it is written "online" so it suggests that it is not updated.

  14. Cultural property

- Their "documentation" is FAQ, but the questions are not about everything, for example, TPer is missing.

  10. Help and documentation

Both Homepage and Help - Homepage2

- Fonts and font weights are used without consistency.

  8. Aesthetics and minimalist design

- There is a low-quality image, and it isn’t clearly related to the city.

  14. Cultural property

  8. Aesthetics and minimalist design

- In the background, there is a half of the moustache of the logo, but it’s not clear at all.

  8. Aesthetics and minimalist design

News

- Italian and English alerts are different.

  4. Consistency and standards

- In the "Parking" alert there is a mockup that doesn't match the real one of the app.

  3.Match between the system and the system
  4. Consistency and standards

- The news might only be for the city where you are

  7. Flexibility and efficiency of use

- There's no way to clear alerts.

  7. Flexibility and efficiency of use

- There is no date in the alerts .

  14. Cultural property

- In the English news "Do you need help" should be a link but it is not.

  8. Predictability

- Error in the inscription, it was repeated twice.

  5. Linguistic clarity

Global issues on inner sections

- 3 different pages indicate 3 different prices, the app is not updated (in the Italian version e.g. Park to Air from the prices of 2018, in the English version from the prices of 2017) and therefore not reliable.

  2. Match between the system and the real world

- Without license plate registration**,** All except On-street Parking works. Now that you are logged in, you can no longer use any services, it asks to register the vehicle first. It's strange enough because you could have done everything before without an account.

  4. Consistency and standards

Menu-Parking-and-Cars-Parks

- The icons are not very significant.

  6. Recognition rather than recall

  14. Cultural property

- There is ‘Giornalieri e abbonamenti’ in Italian under ‘agevolazioni/ abbonamenti’, it is unclear.

  5. Linguistic clarity

On-street Parking

- They could disable the warning of the GPS not activated once seen (eg for expert users).

  7. Flexibility and efficiency of use

- The city of Numana is marked in the list of cities with MyCicero, but if you click on it it tells you that it is not served → maybe there are others. The same for Vieste (coloured areas are also marked here).

  4. Consistency and standards

On-street Parking - Map: Bologna and Abbiategrasso

- It is not clear that the info and compass icons are links.

  6. Recognition rather than recall

  4. Consistency and standards

- It is not clear what the info icon refers to (e.g. it explains how the system works, it tells you what the prices are in the various areas).

  6. Recognition rather than recall

- By opening info, there is no way to return to the previous screen in Android, that is the section with the list of managed parking spaces, subscriptions etc.

  3. User control and freedom

- It is not clear whether a link is active or inactive since its colour does not change.

  1. Visibility of system status

- It is not clear what you can and cannot do with “start navigator” and “search for address” in cities with MyCicero and without, with and without GPS.

  8. Predictability

- When zoomed in, the map loads later after the colours.

  15. Suitable tempo.

- The zoom indication is redundant (both as a warning at the bottom of the map and on the pointer).

8. Aesthetics and design

On-street Parking - Map: cities not served

- The warning could be clearer and more explanatory, that nothing can be done in this area.

5. Linguistic clarity

1. Visibility of system status

- Bars under the compass are unclear, maybe they stand for the accuracy of the compass

10. Help and documentation

On-street Parking - List: Bologna

In some phones, clicking on “on-street parking > city”, it opens the list, in others the map opens.

4. Consistency and standards

On-street Parking - List: **Abbiategrasso**

The language and fonts may be clearer, better written. Prices are not distinguished from timetables etc.

8. Aesthetics and minimalist design

On-street Parking - Parking Plan: Abbiategrasso-Zona 1

It would be better if explained below the timetable that the weather updates automatically.

1. Visibility of system status

On-street Parking - Payment: Abbiategrasso-Zona 1

If there isn’t a previously registered credit card, the "Activate usage-based payment" button does not appear. And the user may think that he can only pay with MyCicero credit.

10. Help and documentation

5. Error prevention

On-street Parking - Success: Abbiategrasso-Zona 1

After clicking on 'start parking', there is no pre-confirmation part, before the actual parking start. If the operation performed was not intentional, there is no going back.

5. Error prevention

3. User control and freedom

On-street Parking - Stop: Abbiategrasso-Zona 1

When you want to stop the parking session, an expected amount is reported, but when the confirmation is done, it becomes the minimum amount that must be spent.

Example: if the amount to pay was 10 cents, and the minimum amount is 20 cents. You are told that you must pay 10 cents but when you pay it becomes 20 cents.

The reason for this difference is not clear.

8. Predictability

10. Help and documentation

On-street Parking - Park Info: Abbiategrasso

- On the "contacts" page the number and the mail are links, but it is not clear why there is nothing to indicate it.

  6. Recognition rather than recall

  4. Consistency and standards

- The "stop info" page may have more pronounced colours that separate the areas.

  8. Aesthetics and minimalist design

  9. Interpretation

Garage - List: Roma

The colours green and red are quite explanatory, but it is not clear exactly what red indicates. It could be for closed parking for holidays, full, closed forever, ...

7. Flexibility and efficiency of use

Garage - Map: Roma

Since they are all car parks, instead of putting two icons for each car park that overlap and confuse (because the red icons also have a green part), they could put a more explanatory one.

7. Simplicity

8. Aesthetics and minimalist design

Garage - Example: “Gyeffe/Ippocrate” (Rome)

There is no organization of space, language and design.

8. Aesthetics and minimalist design

Garage - Payment: “Somalia” (Rome)

It does not show how much is spent if the credit is 0, in others yes (with the registered card yes).

4. Consistency and standards

Off-street Parking - List

- The info icon takes to a different page than the one you arrive by clicking on the rest of others info. But it is not easy to understand and it is not easy to understand that it is a clickable link. By clicking on the rest of the clickable area you get to the list of parking lots for the airport/port/station / etc.

  8. Predictability

  1. User control

  8. Aesthetics and minimalist design

- Elsewhere on the site that icon referred you to external sites, while now it refers you to internal sections of the app.

  4. Consistency and standards

  8. Predictability

Off-street Parking - Example: Airport of Bologna-Marconi

- The Km indicated above the price is presumably the distance between the parking lot and the airport. But it might seem that it was the calculation of your distance from the parking lot. Unlike the Garage section, where the indicated km indicated the distance between the user and the garage.

  5. Error prevention

  10. Help and documentation

  4. Consistency and standards

- The icons on this page are not understood immediately.

  5. Error prevention

  6. Recognition rather than recall

Off-street Parking - Fees: Bologna “Park to Air”

"Low and high season" could be more clearly highlighted.

8. Aesthetics and minimalist design

Off-street Parking - Fees: Bologna “ParkToFly”

They probably forgot about CSS or the HTML code has some errors. On the other pages of the fees, there is a table.

8. Aesthetics and minimalist design

4. Consistency and standards

Off-street Parking - Map: Bologna “Park to Air”

The map of the section of the single-car park only shows where the car park is located, while it would also be useful to show where the airport is located (as in the map in the previous section).

6. Recognition rather than recall

Off-street Parking - Conditions: Bologna “ParkToFly”

If there are no conditions, the section is not deactivated. It is only white below, so it is not clear why it seems to be loading.

5. Error prevention

Off-street Parking - Payment: Bologna “Park to Air”

The return flight code is required. If not filled, you cannot click on "choose how to pay". In this way, if you don't travel by plane and don't take the shuttle, you can't book.

2 scenarios:

- if they did it on purpose it should be an improvement
- if they did it without thinking it is an error

7. Flexibility and efficiency of use

Discounts and ZTL

- The "refresh" arrows go in opposite directions.

  8. Aesthetics and minimalist design

Discounts: Battipaglia

- Sometimes "info" doesn't work, e.g. from Italian to English.

  4. Consistency and standards

- There are two different formats for dates.

  4. Consistency and standards

- Sometimes the arrow to return to the previous page at the top disappears.

  3. User control and freedom

- On some phones, when clicking on the “infos” icon, the information displayed is overlapped.

  8. Aesthetics and minimalist design

Discounts: Bellaria

- The seasonal tickets proposed to the user are said to be valid from May, but from what is said, it can still be valid from the day of acquisition.

  4. Consistency and standards

ZTL Permits

- The "P" icon does not make sense, because these permissions are used to access and move within the ZTL. Parking is not the primary function of this section, indeed perhaps it is not even a function.
- Someone who thinks that paying for access also includes the payment of parking inside the ZTL could be misleading, while perhaps the user is fined.

  2. Match between the system and the real world

  5. Error prevention

Find My Car

- The icon at the top right, it is not understood that it is clickable, and it is not understood that it refers to google maps, the same for the icon on the left.

  6. Recognition rather than recall

  4. Consistency and standards

  2. Match between the system and the real world

- Having used one account for all, and registered our different positions, we individually don’t see this information on the system.

  2. Match between the system and the real world

- The line on the map refers to the same point.

  7. Simplicity

Profile

- The profile photo is small, and space is occupied incorrectly.

8. Aesthetics and minimalist design

- There is a link dedicated to changing the photo, but it could have been avoided by making the profile image clickable.

  8. Aesthetics and minimalist design

- The credit card icon is there even if the card number has not been entered. It is a standard template not customized to the user, there is no attention to the input.

  7. Flexibility and efficiency of use

  7. Simplicity

Profile Photo

- The trash icon can appear clickable but it is not.

  8. Predictability

  4. Consistency and standards

Profile - Manage Affiliation

- The "self-charging tax" section does not make sense that you are on this page, because this page is dedicated to affiliation management.

  2. Match between the system and the real world

- The term "affiliations" does not immediately give meaning to what it refers to.

  5. Linguistic clarity

Profile - Manage Your Cards

- By clicking on “add card” you are redirected to the MyCicero website and you do not stay on the app.

  2 scenarios:
  - If it is wanted an improvement is preferrable
  - if it is not wanted, it seems to be left halfway and so it is an error

8. Predictability

Profile - Top Up Credit

- There is no section that allows you to set a personalized amount.

  7. Flexibility and efficiency of use

- It is not clear where you can get a coupon from.

  10. Help and documentation

- MyCicero credit top-up - convenient, (for example from managed parking, book, check availability) but no longer gives coupons as a choice.

  4. Consistency and standards

- When you recharge the credit, the division between payment cards is unclear.

  10. Help and documentation

  8. Aesthetics and minimalist design

Profile - Push Notifications

- They could add this button next to the item in the main list, instead of creating a page just for this function.

  8. Aesthetics and minimalist design

Profile - Preferences

- Title "Notification area integration" is unclear, it is not clear immediately what it allows to do.

  5. Linguistic clarity

Profile - Manage Yours Cars

- The icon at the top right seems to indicate two different actions (edit and delete), but the action to cancel is only possible if you have 2 or more plates.

  8. Predictability

  6. Recognition rather than recall

  8. Aesthetics and minimalist design

- The message of the MyCicero coupon to be sent to the user at the bottom of the page is repeated many times, but it is never specified when the email will be sent. The message is not adapted to the various levels of information sent to the user after action, this may make the user not understand the consequences of his/her actions.

  5. Linguistic clarity

  1. Visibility of system status

Without login

- If you click on "Continue without registration", it is expected to be able to do some action anyway, while the app takes you back to the previous page.

  8. Predictability

- You may need to add a "remember me" button to not repeat your credentials for the login every time.

  7. Flexibility and efficiency of use

  9. Interpretation

- Generally, almost nothing can be seen, but there is no consistency between the various sections because in some cases e.g. off-street parking you can see the following pages up to a certain point, in other cases e.g. garage you cannot do anything.

  2 scenarios:

  - If it is wanted, an improvement is preferrable
  - if it is not wanted, it seems to be left halfway and so it is an error

  4. Consistency and standards

- If you click on "Find My Car", there is just a message of error that doesn't specify what goes wrong and only gives the possibility of closing the windows. There should be the same window as the others.

  9. Help users recognize, diagnose, and recover from errors

  4. Consistency and standards

2.1.4 Reverse analysis: guidelines vs. system

After the direct analysis, we proceeded the other way round, by exploring the guidelines with respect to the system. The reverse analysis consists indeed of the systematic analysis, guideline by guideline, of the breached functions, together with the frequency and the impact of the violation.

Problems already listed in the direct analysis have not been repeated. For each guideline, problems have been ordered according to their frequency, since we assumed that being frequent would also mean having a bigger impact on the usage of the application. In case of problems equally frequent, we have listed them depending on their impact.

10 heuristics of Nielsen and Molich (1994)

1. Visibility of system status

The first and second problems have the same frequency and impact.

- After having clicked on an entry of the menu, the user can't properly understand the section in which he/she is because there is no correspondence with the colours of the menu's icons, nor a title at the top of the page;
- In many sections, it is not possible to understand if you are logged in, because the profile icon disappears;
- The difference between the profile icon if you are logged in or out is minimal (the former is overall purple, the latter overall white).

3. User control and freedom

When clicking to go back to the previous page, you are often taken two pages back or to the homepage.

4. Consistency and standards

In this case, to order the problems we decided to follow the impact criterion instead of the frequency. In fact, despite the fact that it is only present once, the first error we listed could cause serious problems. The second and the third ones can be found in several pages and they make it difficult to use the application. The fourth and the fifth are more common than the first we listed, but they appear to be the least serious.

- Off-street parking: in some cases (e.g. Aeroporto Bologna-Marconi), car parks' names are different between Italian and English versions;
- In many sections and functions of the application, there is no coherence in the functioning: e.g. although payment always works the same, if there is no credit, depending on the section, you aren't allowed to proceed to the next stage;
- Payment: in some zones, there is a time limit for the parking written in the information at the top. In some of these cases, the counter allows you to book beyond the time limit and there is no notification, while in others the counter is blocked – there is no standard;
- Off-street parking:
    - The descriptions in "information" don't follow a standard;
    - The layout of the fees section depends on the car park, there is no coherence from one another.
- Profile icon in the inner sections is different from that of the homepage.

5. Error prevention

In some cases, it is not clear whether a parking space has a time limit or not.

7. Flexibility and efficiency of use

- There is no initial guide for the user who uses the application for the first time;
- The patterns for users logged in and users logged out are unclear: not all actions are possible if you are logged out, but in some sections, you are allowed to act as if you

were logged in.

8. Aesthetics and minimalist design

- Most of the interfaces have remarkable problems for what concerns colours, layout, fonts, sizes and space;
- The design often is not meaningful;
- In many sections, the design is too minimal.

9. Help users recognize, diagnose and recover from errors

- When the user fails in doing something, the application usually doesn't help him/her understand what went wrong;
- The lack of error messages in many cases makes you think you are dealing with a temporary problem or with a random event, even when it actually is an error. For instance: in the Map section of On-street parking, in some zones "Search by address" doesn't work; some pages are empty, but one could think they haven't properly loaded.

10. Help and documentation

- The tasks you are allowed to carry out in the application almost totally lack helping information;
- When paying for a parking session, it is unclear if you would be refunded in case you stop the parking before the expected end;
- There is no initial guide for the user who uses the application for the first time;
- FAQs are incomplete and difficult to reach.

20 heuristics of Weinschenk And Barker (2000)

1. User control

The button to go back to the previous page is too close to that of the homepage: the user risks every time to get it wrong.

5. Linguistic clarity

Typographic, linguistic, translation, encoding errors are often frequent. Some words are not easily understandable.

14. Cultural property

The application doesn't seem to be updated frequently because much information provided is outdated.

2.1.5 Application ideas

In the context of the assessment of the existing resources for the realization of our project idea which is the identification of points of forces or weakness of a system which are then used as points of departure or correction for the new idea, we decided to take positive

inspirations from some existing applications which are competitor applications to our chosen application and other valid applications which have successful results on our chosen target users. These application ideas come as a solution to the many usability problems encountered during the previous analysis. We proceeded by first of all identifying the usability problems in our chosen application i.e the guidelines violated to which we gave a name, searched and proposed an application that best-respected this design imperative in its designed application and in the end we categorised these solutions under a precise guideline or guidelines from the 10 heuristics of Nielsen and Molich and also from the 20 heuristics of Weinschenk and Barker which will be implemented in the new design as answers to the worries in the previous version of the chosen application. Due to their quantity, the images of the selected applications can be found in the folder "Application Ideas" in the folder "Project management material" of our project zip file.

- **Problem:** Guidelines: missing initial guidelines
  Solution application: *Linkedin* mobile app (see fig.1)
  Particularity: in one of its previous versions which we selected, it provided tooltips as initial guidelines to users for the first time navigation. In this way, the user was helped during his first steps in the app and thus a good experience.
  Answering Guideline(s): 10. Help and documentation / 7. Flexibility and efficiency of use. (10 heuristics of Nielsen and Molich)

- **Problem:** Guideline: Visibility, the help section can be only reached swiping left from the homepage which is not intuitive.
  Solution application: *Intesa San Paolo* (bank) mobile app (see fig.2)
  Particularity: the app shows on every screen the help button on the top-right. This is useful to help the user every time he has a question or a doubt on the operations possible, functions available and curiosities.
  Answering Guideline(s): 6. Recognition rather than recall/ 10. Help and documentation. (10 heuristics of Nielsen and Molich)

- **Problem:** Payment: low presentation of information and the payment context is out of the app for "Discount" and "On-street parking".
  Solution application: *WindTre* mobile app (see fig.3)
  Particularity: this application separates clearly the sections of the page through boxes and colours. There is only one interface to choose the price amount and to pay. The payment is managed inside the application without any redirection.
  Answering Guideline(s): 8. Aesthetics and minimalist design and 4. Consistency and standards (10 heuristics of Nielsen and Molich)

- **Problem:** Payment: Insertion of payment data
  Solution application: *TRENITALIA* mobile app (see fig.4)

Particularity: This app provides well-structured payment information. By providing all the necessary fields to fill in regard to the necessary information in this step of its payment methods.
Answering Guideline(s): 4. Consistency and standards and 8. Aesthetics and minimalist design (10 heuristics of Nielsen and Molich)

- **Problem:** Payment: confirmation of payment
  Solution application: *TRENITALIA* mobile app (see fig.5)
  Particularity: this app provides a pre-confirmation interface of the payment with the summary of the previous step giving the possibility to go back to change something or continue to finalize the payment.
  Answering Guideline(s): 5. Error prevention and 3. User control and freedom (10 heuristics of Nielsen and Molich)

- **Problem: Layout**: Homepage and Parking section.
  Solution application: *Musement* mobile app, *Tabnet* mobile app, *Facebook Local* mobile app respectively. (see fig.6)
  Particularity:
  Musement mobile app shows a background image which is meaningful and uses a high-quality image of the reference city.
  Tabnet mobile app organizes the space in the menu using a grid.
  Facebook Local mobile app has the profile icon and the help icon visible at the top and the other actions are well described using icons at the bottom.
  Answering Guideline(s): 8. Aesthetics and minimalist design (10 heuristics of Nielsen and Molich)

- **Problem: Layout**: Parking section options organization.
  Solution application: *Parkr* mobile app. (see fig.7)
  Particularity: it organizes the activity options dividing them into macro areas.
  Answering Guideline(s): 6. Recognition rather than recall, 8. Aesthetics and minimalist design (10 heuristics of Nielsen and Molich)

- **Problem: Layout**: lists and visibility of the current page.
  Solution application: *ParkAppy* mobile app and *Texture* mobile app respectively. (se e fig.8)
  Particularity:
  ParkAppy mobile app gives us an example of how to list the parking zones in all the sections. However, what interested us is the layout of the page and not the amount of information contained in each row.
  Texture mobile app provides a clear and visible representation of the current section, which can be used in “on-street parking, discounts, ZTL and Find my car”.
  Answering Guideline(s): 8. Aesthetics and minimalist design and 1. Visibility of system status (10 heuristics of Nielsen and Molich)

- **Problem: Layout**: profile
  Solution application: *Pinterest mobile app* (fig.9)
  Particularity: its profile section shows the profile image on the top centre of the screen, together with the user info. In the remaining part of the page, the information is divided into sections.
  Answering Guideline(s): 8. Aesthetics and minimalist design (10 heuristics of Nielsen and Molich.

- **Problem: Layout**: maps
  Solution application: *TelepassPay* mobile app and EasyPark mobile app respectively.(see fig.10)
  Particularity:
  TelepassPay represents in a discreet way the identification of the location on the map.
  EasyPark represents the covered area with a very evident colour.
  Answering Guideline(s): 8. Aesthetics and minimalist design (10 heuristics of Nielsen and Molich)

- **Problem: Layout**: Timer.
  Solution application: *ParkAppy* (see fig.11)
  Particularity: this type of counter allows an easier and faster way to select the time range for the parking session.
  Answering Guideline(s): 7. Flexibility and efficiency of use (10 heuristics of Nielsen and Molich)

- **Problem: Layout**: Conditions in off-street parking
  Solution application: *OPHID CAP mobile app.* (see fig.12)
  Particularity: this app presents information in a box well structured with a link at the bottom for a further navigation possibility.
  Answering Guideline(s): 8. Aesthetics and minimalist design (10 heuristics of Nielsen and Molich)

- **Problem:** Icons and Linguistics
  Solution application: *EasyPark* (see fig.13)
  Particularity: under the "My parking" section are grouped also the permits. One name for everything related to the parking.
  Answering Guideline(s): 7. Simplicity and 5. Linguistic clarity

- **Problem:** Icons and Linguistics
  Solution application: EasyPark (see fig.14)
  Particularity: icon for "Off-street parking" which is a camera best representing the idea of surveillance.
  Answering Guideline(s): 6. Recognition rather than recall (10 heuristics of Nielsen and Molich)

- **Problem:** Icons and Linguistics
  Solution application: *ParkAppy* (see fig.15)
  Particularity: use of the word "subscription" rather than "Discounts" (used in MyCicero)
  Answering Guideline(s): 5. Linguistic clarity (the 20 heuristics of Weinschenk and Barker) and 2. Match between the system and the real world (10 heuristics of Nielsen and Molich).

- **Problem:** Icons and Linguistics
  Solution application: Phonzie mobile app (see fig.16)
  Particularity: the "save position" icon is more meaningful and has a visual representation of the concept.
  Answering Guideline(s): 6. Recognition rather than recall, 8. Aesthetics and **minimalist design** (10 heuristics of Nielsen and Molich).

- **Problem:** Icons and Linguistics
  Solution application: *ParkAppy* (see fig.17)
  Particularity: use of the world "zone" instead of "list" for the areas served by the app.
  Answering Guideline(s): **5. Linguistic clarity** (the 20 heuristics of Weinschenk and Barker)

- **Problem:** Icons and Linguistics
  Solution application: *ParkAppy and EasyPark* (see fig.18)
  Particularity: use of the word "history" instead of "recent".
  Answering Guideline(s): **5. Linguistic clarity** (the 20 heuristics of Weinschenk and Barker)

- **Problem:** Icons and Linguistics
  Solution application: WindTre (see fig.19)
  Particularity: the app makes a good us of a conventional word to express and operation i.e. "Logout" (word) and also a good representation of the concept in an icon.
  Answering Guideline(s): **5. Linguistic clarity** (the 20 heuristics of Weinschenk and Barker)

- **Problem:** Icons and Linguistics
  Solution application: *EasyPark* (see fig.20)
  Particularity: Inside the "Settings" section of the app, there is a separation of the different types of settings i.e. account settings, app setting, in other words, a categorization technique.
  Answering Guideline(s): 7. Flexibility and efficiency of use (10 heuristics of Nielsen and Molich)

2.2 Usability testing

2.2.1 Definition of the testing protocol

The testing protocol is a method used to evaluate a product by testing it on users. There are two ways to perform the test, the statistical way which requires an adequate number of individuals or the common sense which requires a much lower number of individuals and no specialized team. The principal methods used are discount or full usability testing.

Testing method

We selected the Discount usability testing, also known as guerrilla usability testing. This method is:

- Informal: a member of the team chats with the participant in front of the computer in a small room.
- Intuitive: the results should be considered as indicative and not conclusive
- Sequential: inputs from EACH test are evaluated and resolved before starting with the next test.
- Cheap: few users (3-4), no specialist, parallel to production.
- Useful as a formative test (identification of problems to be solved as soon as possible)

List of principal tasks

- Activate an on-street parking session
- Extend it before it ends
- Stop it ahead of time

We did four tests, on four users. There were approximated with the target user segments.

Testing methodology

The testing methodology used on the Discount usability are Scenarios (reduces the level of functionality to a minimum), Simplified Think-aloud (limited number of real end-users) or Heuristic evaluation (Experts). The technique used in this project is Thinking Aloud. At this step, we were considered as experts and assistants. We asked the participants to perform a task, we asked them to describe aloud what they were doing and in case of any difficulty, they had the possibility to ask for help and we helped them. Asan example we ask them:

- what are they thinking about,
- what are they trying to do,
- how do they think they should proceed,
- what doubts are coming to their minds,
- what they read and how this relates to the task.

Description of the expected results

Quantitative

Time isn't considered because we supposed it will be shorter than paying at a parking meter and using the think-aloud technique, users may spend more time since thinking and talking are not good pairs when time is concerned.

Success:

- We considered success the completion of a task without help or failure.
- We consider a failure: abandonment, moderator's interruption, wrong answer (to be evaluated if it's related to the user or to the system).

Errors:

- An error is a fact of selecting an incorrect option in a menu, performing an incorrect sequence of actions, not activating a fundamental action at the right time or at all.
- To handle errors that cascade into other errors, we considered errors that cause other errors (and ignore the latter ones).
- For repeated errors, we consider them with an increase in severity.

Efficiency:

- Parameters measured: The number of "useless" clicks (not for curiosity) to reach a certain point, starting from the moment in which the user accesses the Homepage.
- Start of the action: From the moment in which the user accesses the Homepage
- Count the actions: "Useless" clicks (not for curiosity).

Learnability:

Performance for users who have never been exposed to a system.

Problems:

- Are choices that lead the participant off track;
- An expression of frustration;
- Not noticing something that should have been noticed;
- A participant saying that a task is completed when it is not;
- Some text content whose purpose, meaning, the role is misunderstood;
- Perform an action that leads the participant farther away from the completion.

Qualitative:

Satisfaction:

There are a lot of metrics used for satisfaction. As an example, we have the psychometric scale for questionnaires (Likert scales), the After-scenario questionnaire (ASQ), or the System Usability Scale (SUS)… From the list of choices of techniques used to measure the satisfaction, we choose the System Usability Scale (SUS). It is a generic, simple and quick method, where the test is based on a protocol and standard evaluation criteria.

The questionnaire is composed of the questions below:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.

3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

The algorithm used for the evaluation to assign a value to a question from an answer according to a 5 levels Likert scale with the logic that for each question:
If the enunciation of a question is positive we assign a score of (selected choice - 1) (going from 0 to 4).
If the enunciation of a question is negative we assign a score of (5 – selected choice) (again, from 0 to 4)
At the end, we sum scores and get a value going from 0 to 40. We multiply it by 2.5 and get a value between 0 and 100, with increments of 2.5.

Choice of real subjects and relationship with the target audience

Matteo: Male, a worker with a fixed-term contract, lives with his parents, has an average income, lives outside the city, is sceptical to technology, and is 24 years old.

Alice: Female, a worker with an intern contract, lives with her parents, has a low income, lives in the suburbs, oriented to technology, and is 24 years old.

Matilde**:** Female, a worker with an intern contract, lives with her parents, has a low income, lives in the suburbs, oriented to technology, and is 22 years old.

Martina: Female, a student, lives with roommates, has a low income, lives in the suburbs, sceptical to technology, and is 23 years old.

Organization of tests
There are two types of tests: Formative (suggestions for improving the application) or Summative (verification of fulfilment of initial requirements). For this project, we used the formative test.

The Test scope can be Global (all functions for all tasks for all users), Vertical (all the features relevant to one or more tasks for one or more user types) or Horizontal (one or a few functionalities for all relevant tasks and all types of users affected). Our test scope was Vertical.

The Logistics of the test is based on three parameters which are:

- Setting:
    - Environment: at home, in a room or outside;

    - Equipment: phone, block notes, the app downloaded on the user's phone, an account provided by the testers;
    - Recording equipment: the voice recorder and the video camera of the phone.
- Assistants: alone with the tested user
- Participants:
    - Selection mode: relationship to target user;
    - Number of participants: 4
- Methodology:
    - Process data;
    - Quantitative and qualitative test;
    - Meaningful interpretation.

Initial introduction document
The purpose of user testing is to acquire data on the functioning of the MyCicero parking prepayment application and on any problems.

We ask you to complete three tasks through the app: pay for a parking space on the blue stripes; extend the paid parking; stop the parking before the end of the paid time. In carrying out these tasks, for each, we ask you to tell us aloud everything you think. In particular:

- what are you doing
- what are you trying to do
- how you think you should proceed
- what doubts you have
- what you read and how this is related to what you need to do

You have the opportunity to ask questions. We would like to point out that what is evaluated is not you, but the functioning of the system. Please be as natural as possible and don't be afraid to make mistakes. There are no right or wrong answers! Don't hold back to tell us what you think, even when it's negative.

The data you provide us will be used only for the purpose of this project and anonymously.
It will take about 30 minutes.

Final assessment questionnaire - System Usability Scale (SUS)
We used the ten questions of the SUS to assess the impressions of the experience of the user.

2.2.2 Usability testing

As we specified in the definition of testing protocol, we carried out the testings on four target users based on three tasks (on-street parking payment, extend the parking session and stop it before the expected end) according to the testing methodology Think Aloud.

Every test is described in detail below, with the related SUS scores for each task and a general one on the application.

Matteo

A male, is 24-years-old, an employee with a temporary contract, lives outside the city with his parents, has a medium-income, and is sceptical to technology.

The test took 40 minutes. It was conducted in Italian.

Task 1 – On-street parking payment

In the homepage, he tried to scroll down in the empty space, acknowledging there was nothing meaningful there. After initial hesitation, he clicked on "Parking and car parks". The page opened on "List" and he typed the city in the box. First, he tried with Prato but giving no results, he typed Florence. While he was talking to the expert, the smartphone locked automatically. When he unblocked it, the system had brought him two pages back and he appeared surprised. Since the popup that had opened at the very beginning opened again at this moment, he said: "These pop-ups are bothering me". They appeared other times when the phone locked, but he never pressed the button not to show them again. When choosing Florence and the zone he acted fast and smoothly. He read aloud the info as the hour, the price and the plate number. He said: "The interface is quite immediate". When he read about the charge of the extra-credit, he thought to have found the scam. After a short hesitation, he clicked on "Start parking session" even if he was aware not to have credit. Since he didn't have the card registered, the system only gave him the choice between recharging or leaving. He was silent and uncertain about what to do. He clicked to recharge. He looked at the options, searching for a way to select a personalized import. He tried with "Set the automatic top-up" and "Transactions". He continued to click on every possible option for many minutes. When the expert asked him what he was trying to do, he said he was trying to recharge a predefined card given by the app. He went back to the homepage, on the menu. For a moment he thought of "Discounts", but he immediately realised it wasn't the solution. He went in the profile section and read all the voices of the list. He pressed on "How to pay" below the Parking and ZTL section. He read all the info inside. When he read "Usage-based payment", he thought to have found the solution. However, since he read the credit card he wasn't sure because he wanted to use a prepaid card. He had doubts about his discoveries and said: "Maybe it's not the right path". He went back to "Manage your cards" and added the card. About the menu, he commented positively on the presence of "Invoicing data". He tried again with "Top-up credit" but he understood it wasn't useful anymore since he had inserted the card directly. The app was very slow but he didn't blame the system, he considered it a network issue. He came back to the parking selection. However, he didn't understand the

page “Activate usage-based payment” so he was giving up to the idea of recharging. The expert stopped him and explained how to “Activate usage-based payment”. He commented: “This could have been much easier…”. The expert also had problems because the parking he chose wasn’t probably working at the time, so he had to change the choice. He read aloud twice about the coupon before confirming. He expected to receive an SMS from the card provider.

Task 2 – Extend the parking session
He clicked on the extend button from the shortcut box at the top of the page. He set another hour and clicked for confirmation. He read everything again. He was again expecting an SMS. He seemed surprised by the speed of the operation.

Task 3 – Stop the parking session before the expected end
He clicked on the stop button from the shortcut box at the top of the page. He read everything, especially the hour and the amount and exclaimed “Ah! They may charge you at the end of the parking”. He seemed surprised by the speed of the operation.

Alice
A female, is 24-years-old, a student, lives in the suburbs with her parents, has a low income, and is technology-oriented.

The test took 20 minutes. It was conducted in Italian.

Task 1 – On-street parking payment
In the homepage, she observes the various sections without going into them. Once found “Parking and car parks”, she enters the section. Then she observes the different sections and she finds interesting the “Find my car” option. Then she enters the section “On-street parking” and the “List” page opens. She does not notice the 3 sections (map, list, recent) on the top of the page. Once noted the “search-box”, she understands that it can be used to select the address, but she also says that it could be a problem if the user doesn’t know the address of the street where he is. Then she selects a parking area, asking herself what does the number near the name of the parking area mean (but she is not very interested in it, even if it is a doubt). She reads the conditions of the parking saying that they are not complete e.g. it is written the rate from 8 to 20, but not the one from 20 to 8. Then she clicks on one of the areas from the list of areas. Once on the screen of the parking, she sees the counter of the hours, she thinks that she needs to write the car plate. Then she clicked on “Change car plate”. She asked herself what does “Nome breve” means, she thinks that is the name of the car. Then she clicks on the back button but is redirected to the home page, not to the previous one. So she does again the procedure to arrive again at the moment of the payment. Once she arrived at the counter, she asked herself why the counter was pre-set one hour ahead, maybe it was the minimum time? She changes the time and clicks on “Confirm park beginning”. She reads the info on the parking and clicks “Back home”, but is redirected to “Parking and car parks”.

She likes the box on the top of the page and she notices that you can extend or stop the parking session.

Task 2 – Extend the parking session
She is on the "On-street parking" page. She clicks on "Extend" from the box on the top of the page. She extends the counter for another hour. She asked herself what "Amount" and "Balance future credit" mean (maybe the second is an amount of money on the app. Then she clicks on "extend", she reads the new info on the parking. Then clicks on "Back home" but is redirected to "parking and car parks".

Task 3 – Stop the parking session before the expected end
She is on the "On-street parking" page. She clicks on "stop" from the box on the top of the page. She reads the "expected amount" and "current amount", she thinks that it might be the price she is going to pay. Then she clicks on "stop". Then clicks on "Back home" but is redirected to "parking and car parks".

Matilde
A female, is 22 years old, a student, lives in the suburbs with her parents, has a low income, and is technology-oriented.

The test took 30 minutes. It was conducted in Italian.

Task 1 – On-street parking payment
In the homepage, she observes the various sections without going into them. Once found "Parking and car parks", she enters the section. Then she enters the section "On-street parking" and the "List" page opens. She clicks on the name of the city on the top and makes a mistake. Then she goes back and goes on the "Map" page. She searches for the address of the street where we are in the search box. The app opens on the "Map" page and loads it. On the top of the page appears a box with the name of the parking area, she clicks on it even if she is not sure if it is the right move. She chooses the time with the counter and confirms the beginning of the session. Then appears a box with two buttons: "recharge" and "cancel". She understands that the first button refers to some sort of inner credit of the app, so she clicks on "cancel". She understands that she needs to register the credit card, so she comes back and enters the profile section from the homepage. She enters the "manage your card" section and the clicks on "add a card". After registering the card, she goes back at the moment of the payment of the parking. Now she notices a new button, that is "activate usage-based payment" and she clicks it. At the top of the new page, she has to make a choice between "Credit" and "Usage-based payment". She stops for a moment thinking about which to choose, then she clicks on "Usage-based payment", but she notices that there are no confirmation buttons, so she goes back and then clicks again on the confirmation of the beginning of the parking session.

Task 2 – Extend the parking session
She is on the "On-street parking" page. She clicks on "Extend" from the box on the top of the page. She extends the counter for another half an hour. Then she clicks on "extend", she reads the new information on the updated box. Then clicks on "Back home" but is redirected to "parking and car parks".

Task 3 – Stop the parking session before the expected end
She is on the "On-street parking" page. She clicks on "stop" from the box on the top of the page. She reads "expected amount" and "current amount", she notices that there are two different amounts, but she does not understand their meanings. Then she clicks on "stop".

Martina
A female, is 23-years-old, a student, lives in the suburbs with roommates, has a low income, and is sceptical towards technology.

The test took 40 minutes.

The user first started by trying to explore the system in Italian for the parking to select after clicking on the icon of "Parking and Car Parkings".

Task 1 – On-street parking payment
In the execution of the first task, she goes to "Airport of Bologna" but does not understand how it functions so she goes out and starts all over. She selects the "On-street parking" section of the app which opens on the map of her current town and she is very surprised because she does not understand why. In the search of the parking zone offered by the app to start the parking session, she chooses to zoom on the map but identifies a problem which is the colours present on the map. She does not understand what they mean exactly and what is their difference. The user first selects on the map an area she wishes to park in the town of Bologna but it is free and since we want an area where it is necessary to pay for the parking session, the expert proposes to her to search for another town. So she selects the search box of the interface and is directed to the list of the towns where the app is present in Italy. She is then advised by the expert to select the town of "Abbiategrasso" where she is again redirected to the map of the town. Using the zoom, she selects an area where to park, the name of the parking appears as a pop-up which she selects and is redirected to the interface where she has to fill and select the details of her parking session which she does easily and everything seems clear to her. Gotten to the payment, she is proposed only the option of my cicero credit and she cannot find the option to pay using a credit card so she spends some time trying and almost lost patience so she asked for the help the expert who tried to help her using suggestions of some question of a possibility based on her previous knowledge of mobile applications but still she does not get the path chosen by the application. So, the expert tells her where to find the option and with a lot of surprises, she gets to the point but reveals that

on her own she would have never thought of that it could be in the profile section and would have just selected the payment via my cicero credit because it is intuitive and no need to struggle a lot. After the insertion of her credit card as a payment method, she goes back to the payment of the parking session she had selected but surprisingly for things go very fast and she does not even understand when the payment took place but she is just shown the confirmation of the parking session beginning. She says this is not good because she had no time to even confirm the procedure. In the end, she defines the task as complex and not really well explained how to complete that and since she has a friend who uses the app, she said she would ask the friend if she is aware of this method of payment but she is sure not and thus she thinks this is done on purpose by the application to induce users to use MyCicero credit to pay for parking sessions. And a user won't actually think to go through the profile to register the card since there may be a profile just made of a user name and the vehicle's plate number which are the things asked at the beginning.

Task 2 – Extend the parking session

The second which is the extension of the parking session, at first sight, she says for sure it will be a lot more easier than the previous one because on the screen of the homepage of the app there is the presence of two boxes of different colours with two information on the ongoing parking session i.e. extend and stop. So she selects the box with the writing "Extend" but she gets nothing happens and things she can't extend the session because the time which appeared on the screen, she thought it was already extended but she finds out that it is not the case and so she does the action to extend the time and it goes on well since the extend button becomes activated and she terminates the task.

Task 3 – Stop the parking session before the expected end

For the third task, she again selects a box with the writing "Stop" she is directed to the page where she is asked to confirm her wish to stop the parking session and she does. After the stop of the session, the sum she has to pay is different from the total sum she had to pay which is normal and from her credit card, the sum indicated is debited.

System Usability Scale of the four users

	Matteo	Alice	Matilde	Martina
Overall	22.5	70	55	42.5
Task 1	40	62.5	50	22.5
Task 2	82.5	87.5	82.5	95
Task 3	92.5	97.5	72.5	97.5

2.2.3 Analysis of subjective and objective data

On the basis of the description of the expected results we specified in 2.2.1, we carried out the evaluation of the user testings. The results are summarised in the following tables:

Matteo	Success	Errors	Efficiency	Learnability	Problems
Task 1	No - need of the expert for system's fault	Yes	No	Yes, apart for the final failure	Yes
Task 2	Yes	No	Yes	Yes	Yes, but due to the user's knowledge
Task 3	Yes	No	Yes	Yes	Yes

Alice	Success	Errors	Efficiency	Learnability	Problems
Task 1	Yes	No	Yes	Yes	Yes
Task 2	Yes	No	Yes	Yes	Yes
Task 3	Yes	No	Yes	Yes	No

Matilde	Success	Errors	Efficiency	Learnability	Problems
Task 1	Yes	No	Yes	Yes	Yes
Task 2	Yes	No	Yes	Yes	No
Task 3	Yes	No	Yes	Yes	Yes

Martina	Success	Errors	Efficiency	Learnability	Problems
Task 1	No - need of the expert for system's fault	Yes	No	No	Yes
Task 2	No - need of the expert due to the user's misunderstanding of the system	Yes	No	No	Yes, but due to the user's misunderstanding of the system

Task 3	Yes	No	Yes	Yes	No

The testings left us with a large amount of data that we needed to organize and describe. Therefore, we grouped together recurrent reactions of the users, positive notes and problems they encountered. These appeared to be the most meaningful findings.

We listed them below, making key usability problems in bold. For each problem, we indicated immediately after the violated guideline, from the ones that we choose for the expert usability review (10 heuristics of Nielsen and Molich and selected guidelines from the 20 heuristics of Weinschenk And Barker). This passage was useful in the subsequent steps to collect together, unify the results with our findings and build the urgency curve.

Task 1 - On-street parking payment

- Everyone has immediately clicked on Parking and Car Parks, after a quick check of the other choices;
- 3 out of 4 clicked immediately on On-street parking. Martina was searching for parking in general and entered at first Garage, but there may have been a misunderstanding with the expert;
- 2 out of 4 searched for parking zones from List, ignoring Map and Recent. Alice directly scrolled the list of zones, since the GPS already located her on the wanted city, Florence. Matteo typed in the search box the city because his current location was not served. As for what concerns the other two who used the map, Martina used it directly, by zooming it; Matilde used the search box on the map. Both the users that used the map from the beginning and Alice who explored it afterwards, they all affirmed it was **difficult to understand, particularly for what concerns the colours** (6. Recognition rather than recall);
- No one had problems on the page related to parking;
- 2 out of 3 of the ones that selected a paid parking **needed the help of the expert to understand how to pay with their payment card instead of MyCicero credit** (10. Help and documentation). Martina didn't manage to imagine a solution by her own and was redirected by the expert to the profile section to register the card so that the options in the procedure would change; Matteo arrived almost at the end of the sequence of steps by his own, inserting the card, but once arrived at the options, he had difficulties too in understanding them and needed the help of the expert in order to avoid recharging. Matilde has done everything by her own: despite a final doubt on the options, she managed to complete alone the task;
- **2 out of 3 of those that selected a paid parking expected a further confirmation before the beginning of the parking session** (1. Visibility of system status). Martina would have liked to confirm the inserted data; Matteo wanted an SMS confirmation on the payment. However, this factor is usually completely external to the application since it depends on the card provider; we inferred that the problem was related to the lack of knowledge of the user, due to his infrequent use of technology for purchases;

- **Everyone, although they pressed "Back Home", was redirected to the menu inside Parking and Car Parks** (8. Predictability).

Task 2 - Extend the parking session

- 1 out of 4 thought that, by clicking on "Extend" in the box on top, the parking session would have been automatically extended of a prefixed duration;
- Everyone completed rapidly the task through the shortcut box on top of the screen;
- **1 had doubts on the meanings of "Importo sosta" and "Saldo credito"** (5. Linguistic clarity). A similar problem occurred to two other users in Task 3, again with terms related to payment.

Task 3 - Stop the parking session before the expected end

- Everyone completed rapidly the task through the shortcut box on top of the screen;
- **2 had doubts on the meanings of "Importo sosta previsto" and "Importo sosta attuale"** (5. Linguistic clarity). A similar problem occurred to other users in Task 2, again with terms related to payment.

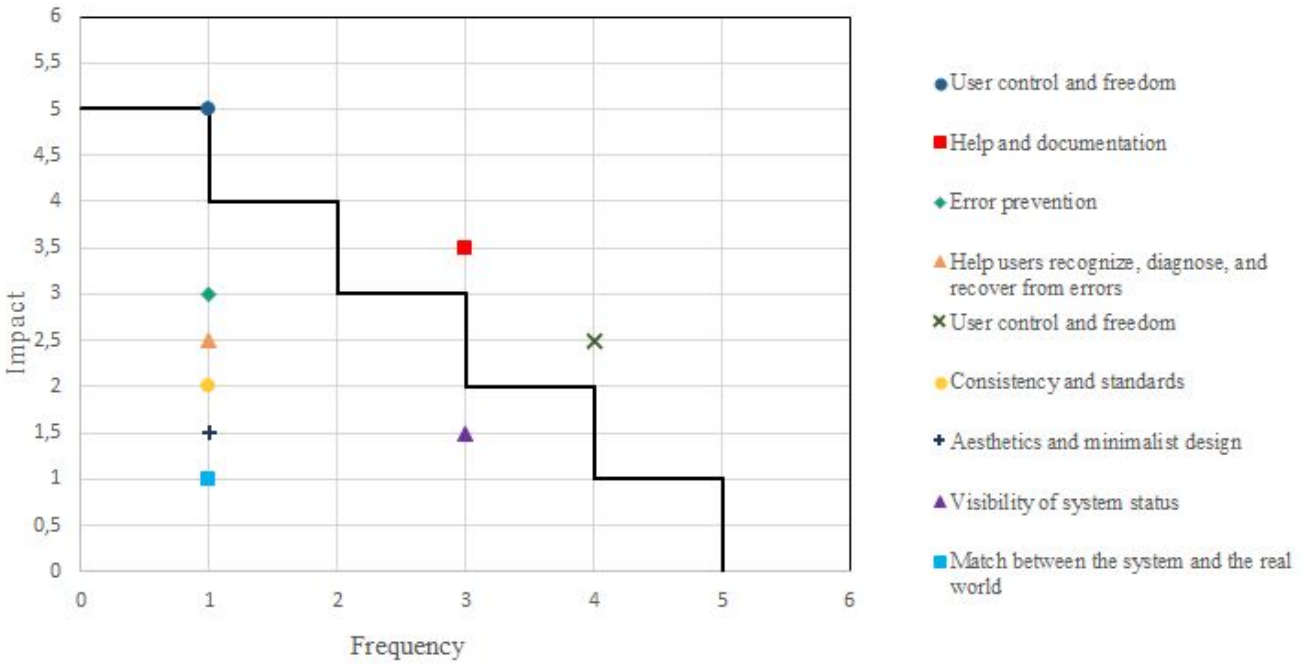
2.2.4. Urgency Curve

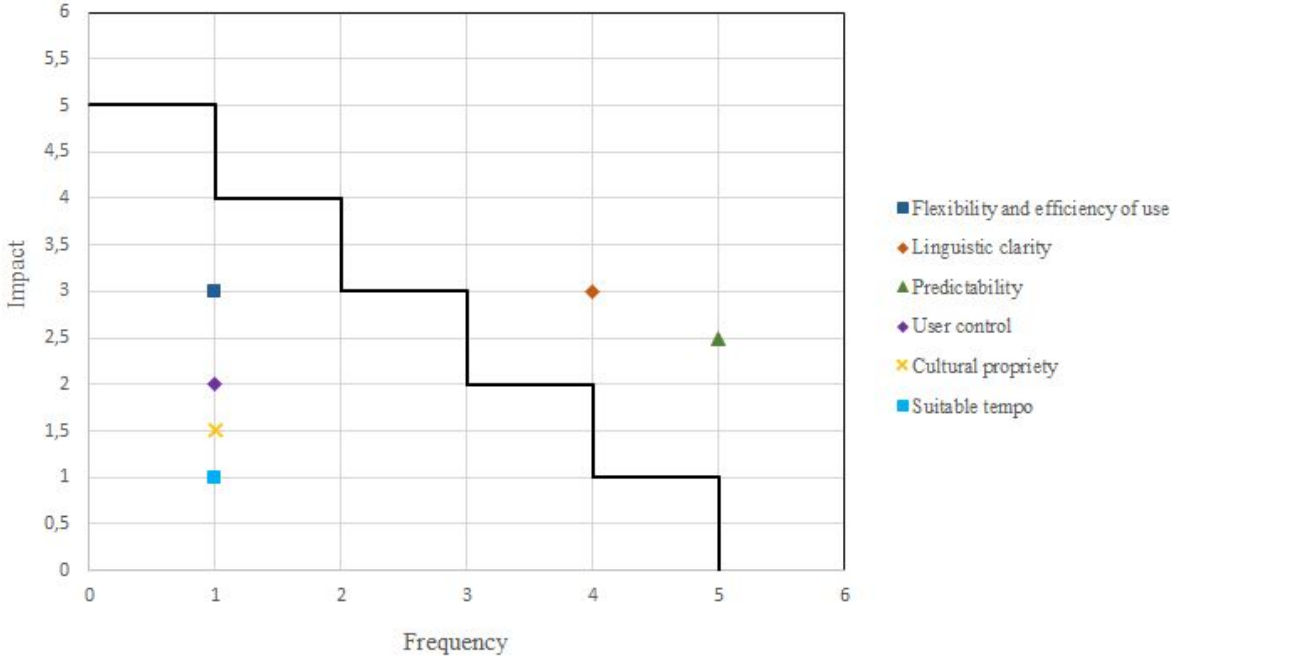
The urgency curve is a two-dimensional chart which is used to understand which retrieved errors are the most serious. In our case, the chart contains on the x-axis the frequency of the errors and on the y-axis their impact. The chart is diagonally crossed by an "urgency threshold" that states the limit for which an error is not considered serious. If the error is above the threshold, it must be fixed immediately.

Both on the frequency axis and the impact one we can see a numerical scale from 1 to 5. We established this scale according to the following criteria:

- **Frequency:** to establish the frequency we started from the analysis (direct and reversed) that we carried out on the system, considering ourselves as 1 user who inspected the system and found some errors. The other 4 users are real users who have been the subjects of our usability testings. In this, we reached a total of 5 users and we considered frequency 1 when one of the users found, at least once, a specific type of error (hence the breach of a specific guideline).
- **Impact:** to define the impact we relied on the classification proposed by Nielsen, who defines 5 types of errors: cosmetic, minor, major, catastrophic, implementation. To each of these errors, we gave a score from 1 (cosmetic) to 5 (implementation) and we associated one of these scores to each of the errors detected in the previous phase. Finally, we indicated the values on the chart.

Since the identified guidelines were 15, we decided to draw two separated charts: one containing the breached guidelines among the 10 of Nielsen and Molich; the other containing the ones among the 20 of Weinschenk and Barker.


Impact
Frequency
0
0,5
1
1,5
2
2,5
3
3,5
4
4,5
5
5,5
6
0
1
2
3
4
5
6
User control and freedom
Help and documentation
Error prevention
Help users recognize, diagnose, and recover from errors
User control and freedom
Consistency and standards
Aesthetics and minimalist design
Visibility of system status
Match between the system and the real world


Impact
Frequency
0
0,5
1
1,5
2
2,5
3
3,5
4
4,5
5
5,5
6
0
1
2
3
4
5
6
Flexibility and efficiency of use
Linguistic clarity
Predictability
User control
Cultural propriety
Suitable tempo

3. Feasibility study

3.1. Context of use

In the identification of the context of use, we focused our attention on the accurate description of:

- The intended users
- The tasks
- The technical and environmental constraints

This step is useful to be sure that all the factors affecting the use of the system are identified before the actual beginning of the design work and to provide a base for designing usability tests.

The intended users

- Males and females,
- Aged between 18 and 30,
- Students, employees with a temporary contract or unemployed,
- Live in the suburbs or outside the city, since it is more likely they use the car to reach places where MyCicero service is available, instead of moving with public transport,
- Live with their parents, with their partner without children, with roommates or alone,
- Have a low or medium income,
- Are frequent users of technology,
- Are technology-oriented or adverse because of scepticism (not inability),
- Have a driving license,
- Drive,
- Have the availability of a car, whichever may be the provenience (car sharing, property car, etc.),
- Don't use the prepaid parking application,
- Would use the application for themselves.

The tasks

- Parking on the on-street parking ("strisce blu") in a few steps:
    - Knowing the name of the parking area
    - Knowing the location of the parking area
    - Selecting an already made parking
- To extend rapidly the parking session
- To stop rapidly the parking session
- To insert the credit card at the moment of the payment
- To visualize a summary page with all the information related to the parking session, before the final confirmation
- To visualize an initial guide that explains the functioning of the app

- To have the possibility to access to a “help section” in every moment

The technical constraints

- The user must possess a smartphone
- With an internet connection
- With *MyCicero* app already installed and logged in
- In some cities the user must have previously printed the coupon of the app
- In some towns it is mandatory to have previously printed the parking coupon of the app.

The cultural constraints

- The user must know the functioning of the car parks in Italy

The environmental constraints

- The user must have a car with a car plate
- The user must be in an area served by *MyCicero*

3.2. Scenarios

Luca in a rush

Luca’s working contract will expire soon. He decided to take advantage of the situation to change his job, so he sent his CV to many businesses. One of them called him back and set an interview at 11 a.m. today in the city centre of Florence. Unfortunately, it is 10.40 and he is still stuck in traffic. After 10 minutes, he manages to find a car park a few minutes away from the interview building. While he heads to the building in a rush, he opens the app he is used to paying parking fees with and in a few steps he pays the parking session with his credit card. This had already been registered in the profile section since he uses the app so frequently. The minutes he saves in paying the parking with the app allow him to arrive at the interview in time.

Ilaria without coins and card

Ilaria Is out for dinner with her friends. One of them arrives late, blaming the queue at the parking meter. Usually, in that zone, there aren’t this kind of problems, but tonight there is a concert nearby. Inspired by this episode, another friend tells her she downloaded and started to use an app for online parking payment and she feels satisfied. The other friends, intrigued, ask her the name of the app and some of them download it. Since Ilaria is sceptical and prefers analogue over digital, she isn't particularly interested. Two days later, Ilaria is parking to meet with an old friend, but she finds out she doesn’t have coins with her and the parking meter doesn’t give the possibility to pay with a credit card. She is very worried and thinks back of the app her friends were talking about two days ago, whose name she remembers because it resembles Cicerone. Despite her scepticism, she downloads the app and surprisingly, thanks to the simple introductory guide, she easily manages to pay for the parking with her prepaid card.

Giulia's shopping

Giulia has a free day from work and from the suburbs where she lives and works she decides to go to the city centre of Bologna to look for a pair of shoes that she couldn't find elsewhere. She parks the car along the "Viali", paying with the app for an hour, and goes to a famous shop. Here the saleswoman tells her that the shoes are not available, but she could find them in another store of the chain that is 20 minutes far by feet. Finally, she arrives there and she is able to find the shoes. While she is trying them on, on the phone appears a notification from the app to warn her that the parking is close to expiration. Momentaneously gripped by anxiety while talking with the saleswoman, she extends the parking session in just one step, thanks to the simple interface, for another hour, planning to dedicate more time to shopping after the current purchase. However, once she is out of the shop, she receives an urgent call: one of her roommates is locked outside the flat without keys! For this reason, Giulia comes immediately back to the car. Since the parking session was supposed to be longer, even though she is in a hurry, in just one step, thanks again to the simple interface, she manages to stop the parking session before the expiration, and only the parking time she consumed is debited from her account.

3.3. Personas

Luca

Luca is 27 years old and stopped studying after graduating from a professional hotel establishment. In the following years, he had many work experiences on cruise ships, restaurants, tourist villages. In one of his last trips, he met Laura, a girl from Florence, with whom he got engaged. So he decides to stop travelling and go home. With the savings he has put aside over the years, he goes to rent a flat in Cerbaia where he lives with Laura, who has a degree in Digital Humanities and has been working for a year. He is working in a bar in the centre of Florence and has a fixed-term contract which will expire in a month. Luca has understood that he wants to try to enter the world of catering, so he has noticed the owners of the bar and is sending his curriculum to various companies. Luca frequently uses technology, even for things that could be done in analogue, to the point that his boss has instructed him to manage the bar's Instagram page. Although he goes to work on public transport, he often uses Laura's car during his spare time. For this reason, he inquired about the apps that could offer him some advantages, even economically as he has to be careful with the expenses, and he has discovered the online parking apps, with which he can pay exactly the actual parking time.

Ilaria

Ilaria is a 22-year-old girl enrolled in the Faculty of Philosophy in Rome. She lives with her parents in the suburbs of Rome and reaches the university by public transport, but often she goes out to the centre with her friends and goes by car during the weekend. She has never followed fashions, not even in high school, and has chosen philosophy even though she knows that she may not find work easily. Although she uses the phone and technology and has no difficulty in doing so, she prefers to do things in analogue whenever possible and when it comes to paying online Ilaria is sceptical because not seeing who the money goes to makes her think she might be scammed.

Giulia

Giulia is 25 years old and originally from Rimini, but has lived in the outskirts of Bologna with roommates since she started attending the university; she recently graduated from the master's degree in Languages and won the call to work for one year in the civil service, teaching Italian to foreigners. Her parents allowed her to bring her grandparents' car to Bologna. She is a dynamic and active girl and always tries to make her day off well. She often uses technology and the internet mainly to keep herself informed about her students' culture and to create material for her work. In addition to this, she likes to use social media to share her everyday activities. While inquiring for the civil service on the website of the municipality of Bologna, she came across the advertisement of an online parking app. Being a girl open to novelty, she was intrigued and downloaded it. She started using it enthusiastically for her frequent movements.
http://www.comune.bologna.it/news/il-parcheggio-si-paga-con-il-cellulare

4. Design proposal

4.0 Adoption of a design model

In the design of our new app proposal most especial the part of the app we have chosen to focus on, we have opted for a draft model i.e. CAO = S which is used to adopt a goal-oriented design approach in economically constrained projects. This practice is appropriate when there is no budget for: a systematic analysis of the target users, to involve an outside expert in usability or to involve users in the design process.
It is based on the study of the information types (Concepts) that the application must manipulate on behalf of the user types (Actors) by providing commands (Operations).

A correct analysis of these allows to generate the three types of Structures managed by the model:

- Views (display screens of properties of the concepts)
- Data Structures (patterns for the persistent storage of concepts properties) and
- Navigation (mechanisms for navigating from one view to another)

This model allows a good quality development team without specific experience in the field of usability to avoid at least the most frequent errors in designing usable applications. It is based on a simplified implementation of a goal-oriented model, where the analytical part on the intended target users is simplified into a simple analysis of a few of their fundamental characteristics.

4.1. Information Architecture

As an element of our design proposal, we have as a first step the design of the information architecture. This is in substance how information items are related to each other in the system. Working on an existing system, we first described the IA of the system and then described that of our new system how it would be. In this description, we based ourselves on the concept of information ecology which is composed of three components: context, content and users.

Information Architecture of the existing system

Context
The context is a specific business context which is that of providing the possibility of paying for pre-paid parking fees online.

Content

- Control: in the system, the content is distributed in departments. There is also the use of content from external parties such as Google maps for the map used in the system.

- Format: the information format present in the app are: text, icons and images.
- Structure: the content is ever-growing since there is the possibility of new cities being added as areas covered by the app. The level of granularity of the content is medium-high since we have information on every city covered by the app, the zones in the city and so on.
- Metadata: the content is described manually and there is no possibility for users to create their own models.
- Volume: the documents present are of large volume, for example, we have many pages with many information for the single zones, airports, garages etc.
- Dynamicity: volume will grow as services in new cities will be implemented but control, format, structure and metadata will probably follow what we said; however, they could add new services in the app or new services related to a specific city: in these cases, the control, format, structure, metadata could change.

Users

The information needs satisfied are for:

- Those who look for something in particular;
- Those who explore the system for answers

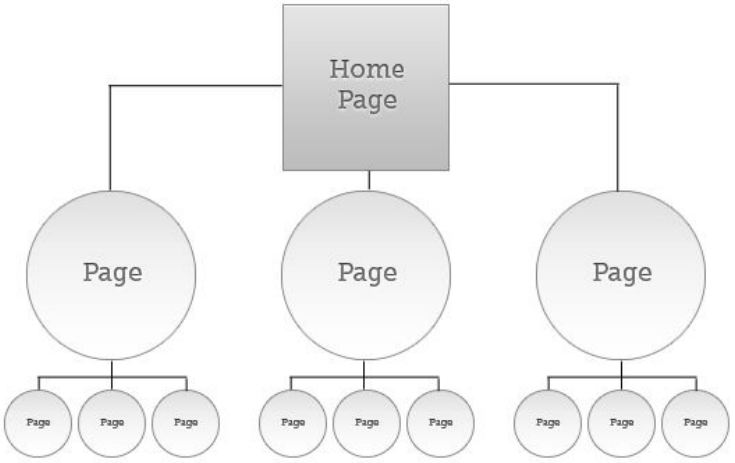
Visual structures analysis

According to Morville and Rosenfeld's principles, we analysed the app MyCicero as follows:

- **Browsing aids**
    - Content organization system: the system is organized by task.
    - Hierarchies and groupings: elements on the page are grouped but there is no hierarchy, they follow a flat structure.
    - Navigation (global, local and contextual): navigation within the content
    - Orientation systems: no palettes, no identifiers on top to indicate where you are etc.
    - Guide: lack of a guide and so needed
    - Wizards: generally speaking yes, e.g. with parking, range of choices at the beginning and then wizards to complete the payment
- **Search aids**
    - Search interface: yes
    - Query language: no
    - Query builders: suggestions, based on similarity and contiguity of the word
    - Presentation of results: list with clickable results
    - Issues in queries:
        - if syntactically incorrect, no results provided nor suggestions
        - if no results provided, blank page
        - if just one result, still a result in the list which has to be clicked to be redirected
        - no filters

- **Content and tasks:** there are headings, text chunks and lists.

Our hypothesis is that the current system has been designed according to a top-down approach because the content is hierarchically divided into categories, each with its internal organization based on the data it contains. When you start exploring the system, you cannot know the content you will find inside it until you get there. Furthermore, our hypothesis seems strengthened by the fact that new categories are gradually being added, with their internal hierarchy maintained. Finally, the more internal contents, such as the individual car parks, do not seem to have a logical block organization, but it seems that the information is added in sequence, for example, the various rates, timetables, etc.



At the moment the organization is strictly hierarchical: there are no links between the sections. To be able to visit other sections, you must, therefore, return to the previous menu.

The information architecture of our new system

Since each section of the app has its own internal structure different from the others, we have decided to continue following a top-down approach. In fact, the problems that emerged from our various analysis of the system were never related to the links and hierarchy of the different pages but rather were related to the elements of the single page.

So, within the single sections of the app, we have decided to integrate the bottom-up approach, this to standardize the innermost pages between them for example, individual car parks.

For the organization, we have decided to maintain the existing structure, strictly hierarchical, because the sections are not interconnected with each other as each contains information on a specific area, different from the others.

4.2 CAO = S model

4.2.1 Concepts

Concepts are information managed by the system and the way in which users perceive their organization in the application. They are closer to the user's perception of information than to a data structure point of view. The interface must indicate operations on the concepts, and not functions of the data structures. We have problems when data concepts and structures differ. Some problems that we may encounter are Standardization problems, Lexical differences, Conceptual differences and Polysemy.

In our project, we have three concepts:

- Parking intended as a session of parking (hour, price, plate number, payment etc) - *(parking)*,
- Parking intended as a place where to park (zones, on-street, off-street, garage etc) - (*parks)* and
- Account.

We found one problem at the level of the concept of Parking, defined as Polysemy (the same word is used by the same actors to describe different things). To resolve it, we decided to use two different names with specific meanings:
Parking/ Parks.

4.2.2 Actors

One of the fundamental components of the low budget design model CAO = S is the actors. They are the categories of users that act on the application interfaces to perform their tasks by manipulating the data structures interpreted as concepts of the system. There are two types of actors: direct and indirect actors. Direct actors are the people whose opinions and needs are at the centre of the design objectives of the system and will be using the system personally. Indirect actors are actors who have a say in the specification of the characteristics of the design of the system but will not use the interfaces directly.

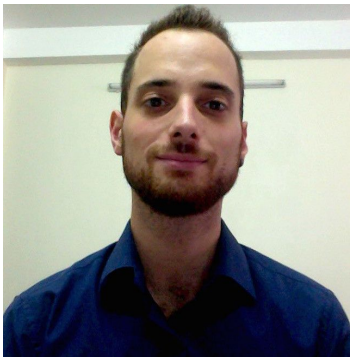
In the context of our project, we defined our indirect actors as the professor who will be the project manager and evaluator, the city councils of Italy in which the app will be served, the companies managing the parking areas of the cities, the municipal police and the ministry of transports. As direct actors, we defined the people who drive and wish to park and also the people who are with somebody who drives and wishes to park. Since the direct actors are our main focus, we concentrated on our actors who are representative of our target users.

As a requirement for the definition of the actors in this design model, we are to assign a score from 1 to 5 to six predefined features representing the competences and of each of our actors necessary for our project. In the definition of these features, we decided not to assign scores

of 1 or 5 because in ur opinion our target users in the various competencies shouldn't be too expert or at the extreme.

- **Technical competence:** We defined this competence at the level of knowledge of computational devices and the payment of services online. In our target users, we have people sceptical to technology and technology-oriented at the two extremes.
- **Domain competence:** We defined this competence on the basis of the knowledge of the functioning of the parking activity in Italy and in the various city councils. Our target users have high scores for this competence because we estimated that they are used to parking since the drive. The only exception we individuated are foreigners who may have difficulties in understanding the Italian parking system.
- **Language competence:** we defined this competence based on the nationality of the actor and the level of education
- **Physical ability:** This competence was defined on the physical capabilities of the actors and their health conditions. We considered the case of colour blindness as a physical inability.
- **Motivation:** this competence being the core of our project, we defined it based on the actors need to park resulting out of circumstances, personal wish and fear of online payment. So to this competence, most of our actors have a low score.
- **Concentration:** this competence was defined according to the situation in which the actor can find himself. That is in the car, walking, in a hurry and with people.

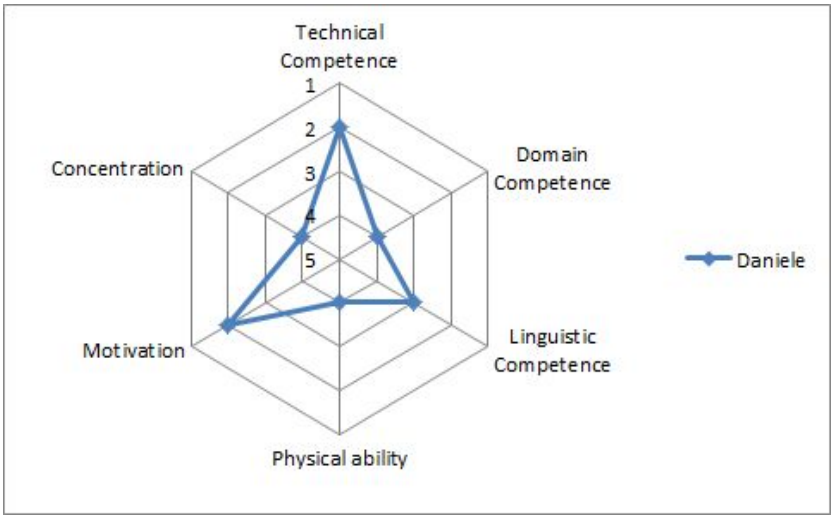
Actor 1



Daniele Palazzi is a 23-year-old boy, he lives with his parents and his brother in a small town outside Lucca. He graduated from the technical institute in mechanics and after a few months, he was hired in a company about ten kilometres away from home, first as an intern and then, at the end of the contract, as an apprentice. In the little time he has left from his daily activities, he dedicates himself to playing the guitar to perfect his riffs, in view of his rehearsals with the band, or he finds himself with his longtime friends for endless Dungeons and Dragons campaigns. As soon as he puts some money aside, he runs to his friend Leonardo, who has set up a real nerd shop, to buy new manuals, because when it comes to looking for rules on the computer, there is always something that goes wrong ... Daniele is not very technology-friendly: he always thinks that the computer has it with him because it freezes and when he is forced to buy something online he always suspects that someone is trying to cheat him. His friends often make fun of this and try to convince him to install apps that could make his life easier, especially in the search for musical instruments, but for the moment he is convinced only on the tuner and on the prepaid card app, from which he checks that money is not stolen from any online transactions. He goes to work every day with the car and goes out with friends to Lucca during the weekend. Driving relaxes him and he usually prefers to take the car than public transports, even when it

comes to having to take the highway or going to crowded places like concerts. If he forgets his card or coins, when he is close to home, he is confident that he can take risks of not paying for parking, because checks in the village are rare. But the big cities put him in trouble and he does not want to risk fines: at the Lucca Summer Festival, he found himself having to use, in spite of himself, an app for the payment of online parking, because he had no coins, nor money on his card.

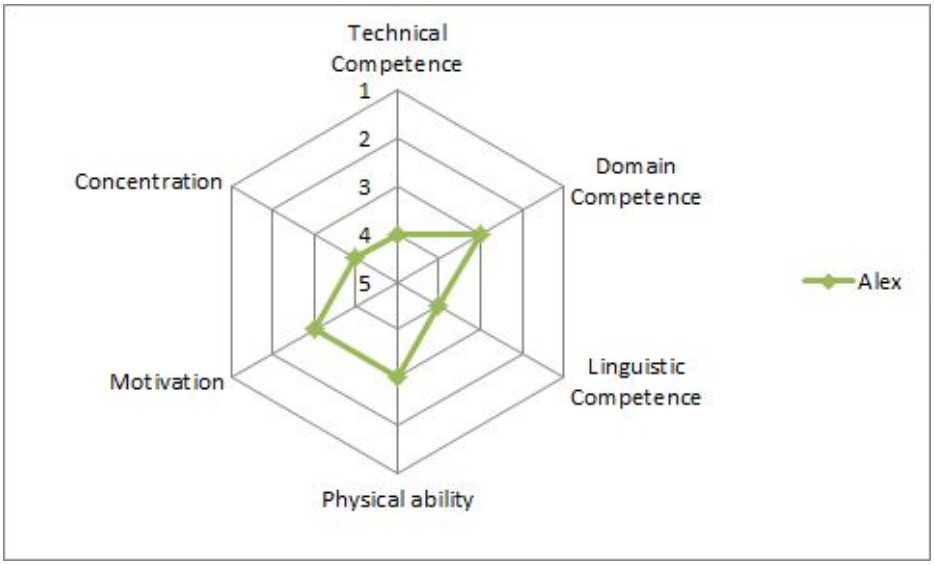
Technical competence*:* 2
Domain competence*:* 4
Language competence*:* 3
Physical ability*:* 4
Motivation*:* 2
Concentration*:* 4



Actor 2

Alex Nkono is a young graduate in computer science engineering of 29 years, he lives alone in the city-centre of Siena. After obtaining his bachelor's degree, he decided to take a year off just to work and return to school for the next academic year of 2020/2021 for his master's degree in Data Science Engineering. During this free period, he has been up to many things. He wishes to obtain an English language certificate level B2 which will be necessary for him tomorrow in his domain and so during his free time he studies, reads and listens to English content. He also has been following training academies for young engineers who wish to perfect themselves or get a job in mobile app development. He likes running and other sports activities like playing football with his friends. He is very technology-oriented and is fond of computational devices and does frequently some shopping online. But also he loves vehicles and has a great love for the activity of driving. He usually over the weekend goes out with his best friend Joel who has a car to catch some fun and they usually travel to visit other cities and frequently, they do ride exchanges. Most of the time during their outings, they pay for a parking session at the parking meter but recently, he discussed with one of his friends who talked to him about online parking pre-paid apps which he has tried and liked and therefore, he would love to try that the next time he visits one of the towns in which this is possible to discover the management of data in the app for all tracking activities, registration of personal information and customization

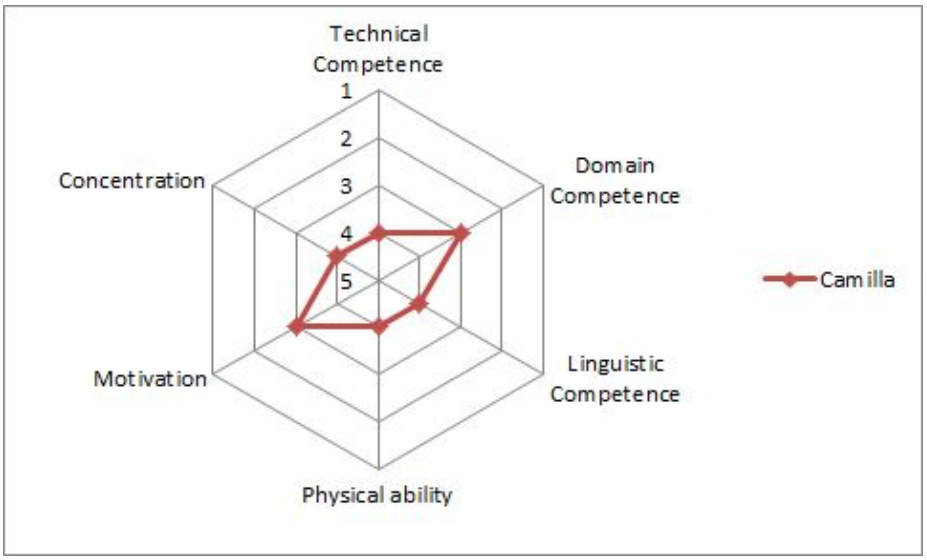
Technical competence*:* 4
Domain competence*:* 3
Language competence*:* 4
Physical ability*:* 3 (color blindness)
Motivation*:* 3
Concentration*:* 4



Actor 3

Camilla Palermo is a 24-year-old girl, she lives with her mom and sister in the outskirts of Florence. After graduating from high school, where she studied English, German and Spanish, she decided that continuing to study is not for her, and for a couple of years, she worked first as a waitress and then as a saleswoman, developing the ability to relate with customers, even with those who would have made anyone lose patience. But at some point, she realizes she wants something more and manages to be admitted to a post-diploma course in the fashion environment. The course also includes an internship that aims at placing her in the work environment, and Camilla carries out this internship in a renowned fashion company. Working in the office, she finds herself having to learn how to use many programs to do her job. Camilla is a highly motivated girl who cannot be easily knocked off; several days a week she jogs in her city park. Use the smartphone and tablet with which she visits social media, watch TV series, etc. every day although she got her driving license when she was 19, she never had the chance to drive because she didn't have the availability of a car. Thanks to the work she did, about a year ago she was able to buy a used car with which she goes everywhere. Since she is not a long time driver, she is not yet an expert on all the rules of the road, such as the operation of the on-street parking or parking lots. A friend of hers told her about the existence of online parking apps and Camilla tried to download one. After some time she found herself forced to use it because she had no coins with her and the parking meter did not accept credit cards. Fortunately, the payment was successful and the app worked, but until the end, she was not sure that everything had gone well. For this reason, she decided to keep the app installed but without using it, except on exceptional occasions.

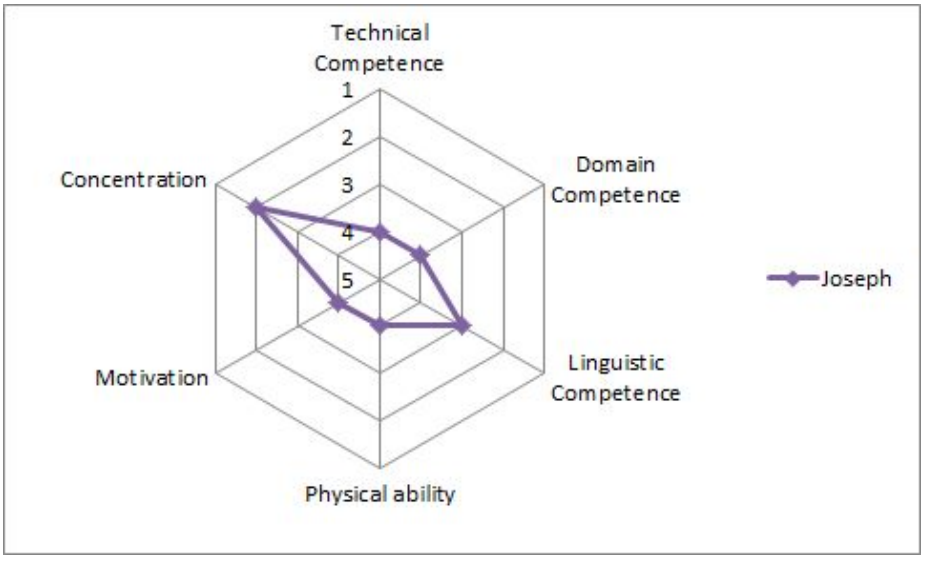
Technical competence*:* 4
Domain competence*:* 3
Language competence*:* 4
Physical ability*:* 4
Motivation*:* 3
Concentration*:* 4



Actor 4

Joseph Kana is a 30-years-old Cameroonian who lives alone in Turin, in an apartment on the outskirts. He works as a data administrator in a bank and likes beautiful cars, reading and sports. From childhood, he has always dreamed of travelling and coming to Europe to continue his studies. For this reason, he learned in addition to French which is his native language, English in Cameroon, but for Italian, he learned it in Italy when he started working since his study programme was in English. When he arrived in Italy, he studied and worked at the same time to achieve his goals. Having already had his license in Cameroon, he did it again here to be able to drive without problems. For this reason, once he finished his studies and after finding a stable job, he bought a car in order to go to work more comfortably. While often on the phone in his spare time, he often happens to buy things for the home, shoes, clothes and books online. Since he is often late for work because of parking, he would like to use the online parking payment app. He is working hard to make his dreams come true. Joseph is a very joyful, sociable, calm, curious, unpredictable person who often travels or suddenly goes out in the evening with friends to drink.

Technical competence*:* 4
Domain competence*:* 4
Language competence*:* 3
Physical ability*:* 4
Motivation*:* 4
Concentration*:* 2



4.2.3 Operations

The operations are operations on the concepts. Every command, every label, every widget must include terms associated with the concepts. Operations are tasks interesting for the actors on the concepts, accomplished through the system functions.

The operations according to CAO = S are of four types:

- Creation: consists in the generation of one or more instances of concept in the initial state,
- View: to display one or more instance of the concept in an understandable way,
- Update: it is the modification of one or more properties of one or more instances of the entity, without creating new ones,
- Remove: it is the removal of one or more entities from the system or from the attention of the user.

Parking

Creation: manual, single instance, persistent

- **Park selection**
  - *Default:* current position with GPS switched on
  - *User memory:* recent; suggestions on the basis of the query input
  - *Failure notification:* if the park does not exist; if the name is wrong.
- **Time selection**
  - *Default:* current hour
- **Car plate insertion**
  - *Default:* preferred car plate or the one inserted
  - *User memory:* list of inserted plates
  - *Failure notification:* when a new plate is inserted and the user is not authorized to or the plate is not valid
- **Payment**
  - *Default:* method; previously chosen card; invoicing data
  - *User memory:* list of inserted cards
  - *Failure notification:* with insufficient credit; with an empty card; with invalid card

View

- Summary of the data before the payment *(full individual view)*
- Box on the top of the page *(multiple view - summary)*

Update

- Extension of the parking session, in particular, just time update *(specific update)*
- Change car plate *(global update)*

Remove: archival in “Transaction list” section

- Stop the parking session
- Automatic end of the parking session *(executing the choice of the user)*

Parks

View

- List of parks *(multiple views – list)*
- Map of parks *(individual reduced view) / (multiple views – lookup)*
- Recent *(multiple view – list)*
- Info in the parks *(full individual view)*

Remove: elimination

- Deletion of recent parks

Account

Creation: manual, persistent

- Profile creation
- Insertion of the car plate and, if shared, with whom
  multiplicity: the car plate and with whom it is shared
- Insertion of the credit card and, if shared, with whom
  multiplicity: the credit card and with whom it is shared

View

- Summary of personal data *(individual reduced view* for the data below the profile photo) and invoicing data *(full individual view)*
- Summary of credit cards: credit cards activities; credit cards; shared credit cards *(individual reduced view)*
- Summary of MyCicero credit: credit activities; remaining credit; auto-recharge; recharge *(individual reduced view)*
- Summary of car plates and shared car plates *(individual reduced view)*

Update

- Changing of personal data; invoicing data and profile photo *(global update)*
- Changing of profile options
  - Notifications *(global update)*
  - Preferred city *(global update)*
  - Preferred car plate *(specific update)*
  - Preferred credit card *(specific update)*
  - Credit card or MyCicero credit *(global update)*
- Changing of car plate; car plate sharing and with whom *(global update)*
- Changing the sharing options of the card and with whom *(global update)*

Remove: *elimination*

- Removal of the car plate and of the sharing options
- Removal of the credit card and of the sharing options
- Account deletion

4.2.4 Structures

The study of Concepts, Actors and Operations produces the Structures, i.e. :

- Views: screenfuls of the Concepts' properties, comprise also of commands to be activated during view and navigation-related commands;
- Navigation: the mechanism for switching from a view to another;
- Data Structures: persistent storage of the Concepts' properties.

At this stage of our study, we created a table and filled each cell with annotations on how the person who is parking (Actor to whom the table is referred) should be able to perform the Operation (specified on the header of the x-axis) on the Concept (listed in the header of the y-axis).

The person who is parking	Parking session	Car parks	Account
Create	Single: possibility to select just one park, hour, plate number, payment method, card at a time. Manual: free selection and insertion of the necessary information. Persistent: it lasts beyond the operation. Default: for the park, current position (with GPS switched on); current hour; only plate number inserted or favourite plate number; default or favourite payment method; favourite card or last used; invoicing data if inserted. Constraint: every voice mandatory. Only hours after the current one, valid city and valid card.	No. New instances can't be added by the users.	Manual: free insertion of the necessary information. Persistent: it lasts beyond the operation. Constraint: mandatory fields in the creation of the account (name, surname, email); valid card.

View	Full individual: summary of the parking session data. Multiple: zone selection and payment. Summary: box after the payment.	Full individual: information on the park. Individual reduced: in the selection of the park from the map, a reduced information view appears, which can be expanded. Multiple - lists: history and parks list. Default: in the park selection, if GPS is on, current park.	Full individual: personal data summary and invoicing data. Individual reduced: every other summary is expandible (account settings, cards, plate numbers).
Update	Global: change plate number. Specific: parking extension limited to the hour. Default: proposed extension starting from 30 minutes after the previously selected hour. Constraint: extension starting from the selected hour.	No, since new instances can neither be created by the users.	Global: change account data, account settings, plate numbers, cards, sharing settings of plate numbers and cards. Specific: selecting a favourite plate number and card. Default: push notifications activated; no favourites; MyCicero credit as payment method. Constraint: valid card and a valid city. Minimum credit 5 euros. Mandatory fields in the account data (name, surname, email).

Remove	Archival: ended or stopped parking sessions can be found in the movements' list inside the account, while the park goes in the history section. Constraint: parking sessions cannot be deleted from the movements.	Elimination: possibility to delete last parking from the history.	Elimination: delete plate numbers, cards, shared plate numbers and cards. Delete the account.

4.3 Interaction design

A design framework of the overall system clarifies unambiguously what services are available and a clear hierarchical organization of the functions of the system. The content must be catalogued correctly so that information can be recalled effectively.

The new app design will take into consideration only the sections related to the tasks that we have previously analyzed: on-street parking, parking extension and stopping of the parking. The available services in our design proposal to be incorporated with the existing system are:

- on-street parking and
- (account)

The organization of the functions in the application will be described in two parts: one part for the general structure of the system and the second focused on the parking plan. The general organization of the system is as follows:

- From the system's homepage, it will be possible to login, access the "Help" section or access the "Parking" section. At the bottom, will also be a button dedicated for information on MyCicero credit (this will allow you to make this option clearly visible to the user, in the interest of the company MyCicero).
- If you access the "Help" section, you can view all the questions on the system divided into sections according to the sections of the app. The icons for contacts (email and social) and online assistance can be found at the top because the page of questions will be extended and may be difficult to find. The "Help" section will be accessible from all parts of the system and from time to time the user will be referred to a different section of the questions based on the section in which he clicked on the help icon, but he will always have the option to scroll the page to view the other questions.

- If you log in, you can access the profile page by clicking again on the icon at the top right of the homepage. Some more important data about the user and the MyCicero credit icon with the remaining credit will be immediately visible on the page (this will allow this option to be clearly visible to the user, in the interest of the MyCicero company). The page will, in turn, contain two sections. The first concerning user information: personal data such as name, surname, email and photo; any billing information; any card; license plate; plate and / or card shares; list of past parking lots. The second section will give the possibility to make choices on the management of the app: activation of notifications; default payment method with any card or credit top-up method if credit is selected; favourite city; favourite car plate number. From "Account" it will also be possible to log out and delete the profile.
- If you access the "Parking" section, among the various sections it will be possible to choose "On-street parks". In each internal section, in the purple band at the top from the left, we will find: an icon to go back, an icon of the home, the name of the section you are currently viewing, the profile image, help icon.
- From the “On-street parks” page, you can access 3 different sections (List, Map, History). Parking areas can be accessed from all 3 sections with different display modes.
- By clicking on "List" the user can access by default a list of parking areas, based on the user's geographical position if the GPS is turned on. If the city in which the user is located is not served by Mycicero, the system indicates that the area in which he/she is located is not served and the list below will show the areas of the closest city served. If the GPS is not turned on, the app will suggest the city which in some way is connected to the phone (e.g. internet connection or other applications). If this information is absent, then the list will report the parking areas of Rome. If the user has selected a favourite city in his profile and the GPS is off, the areas of that city will be shown. At the top of the page, will be a scrollable list of cities served, which can be filtered in alphabetical order (default) or based on cities in the proximity of the user. As it is possible now, when entering this list, the user also has a "Search city" search box. To the right of the box, will find the icon referring to the information on city parking. Below the list, under the "Select a park" band, the search box "Search by address or park name" will be available. In the single zone, the colour used will be the same used to indicate it on the map. When we click on a zone, more information about the area is shown. It will be possible to click on it to continue with the parking session.
- By clicking on "Map" (default), if the GPS is on, the user will be positioned on the city in which he is currently located. If the city in which the user is located is not served by Mycicero, the system indicates that the area in which he is located is not served and the user will be positioned on the nearest served city. If the GPS is not turned on, the app displays the city map which is connected to the phone in some way (e.g. internet connection); if this information is absent, then the map will be positioned on the city of Rome. If the user has selected a favourite city in his profile

and the GPS is off, the map of that city will be shown. The parking areas are highlighted in different colours on the map following the colours of the different parking areas. The colours, together with other information on the areas, are explained in the section related to the city accessible via the "Info" icon. The user can zoom the map and / or click directly on the area. At the top, the box with information on the area will appear, on which it will be possible to click to continue with the parking. At the top of the page, there will be the scrollable list of cities served, which can be filtered in alphabetical order (default) or based on cities in the proximity of the user. Below, the user also has a search box "Search by address or park name". To the right of the box, you will find the "Info" icon. At the top of the map, two icons will be available: one at the centre to display on the map your current position (icon active only with the GPS on); one to open the navigator application and view the route to the selected point.

- By clicking on "History", a list of zones will appear. Each area will have information on times and prices, as in the other sections, and will be preceded by the date on which it was last carried out. By clicking on it, you will be redirected to the page to park in that area. At the top of the section, the "Trash" icon will be available, which unlocks the ability to delete areas from the "History" list.

The second organization of the functions in the system focused on the parking plan is as follows:

- By clicking on an area, the "Parking plan" page opens, with an indication of the step next to it. In each step, at the bottom left is the "Cancel" button to cancel what has been done and return to "On-street parks". At the top you will find information on the area, followed by the selected car plate (which can be changed), the time of the parking to define (by default, the minimum planned stop, under which you cannot set a parking duration- the case is accompanied by a small explanation) and the total expected cost (which updates over time i.e. every minute, as in the current system). At the bottom of the page, there is the "Proceed" button, with the total due on the above.
- By clicking on "Proceed", the payment page opens, "Payment method", with the indication of the step next to it. Inside there are three sections: "MyCicero credit" (default), "Card", "Other". If the user has selected a preference for a method in the profile, the page will open by default on that section.
- In the "MyCicero credit" section, the remaining credit is shown. If this is sufficient for the purchase, the button for the next section is enabled. Below is the "Recharge" button. By clicking on it, a section opens "Recharge amount", from which it is possible to select preset numbers (5, 10, 20, 50), insert a personalized figure (not below 5 euros) or insert "Coupon" for a recharge. In the latter case, after clicking on the coupon button, a box appears in which the user has to enter the coupon data. In all other cases, after clicking on their various buttons, the user is shown a page on which there is a list of possible payment methods. If you select "Card", a section appears

below with a list from which you can select already inserted cards. By default, if you have selected a favourite card or if you have used and saved it, the one will automatically be shown (if there are many, the last one used). If you have never inserted a card, the list is not there. Below is the button to add a new card. By clicking on it, a section opens with fields to fill: "Card number", "Expiration date", "Security code", "Cardholder". At the bottom, there will be a checkbox to select "Remember the card".

- The "Card" section is the same as the "Card" section located under "Recharge" in "MyCicero credit".
- In the "Other" section, you will find the remaining payment methods.
- At the bottom of the page, there is the "Proceed" button, with the total due above. If you pay by card, the notice concerning the surcharge will be present before and during the confirmation of the parking beginning.
- Clicking on "Proceed" opens the summary page, "Overview", with the indication of the step next to it. Here you will find the data related to the chosen car park, with the "Back" button to return to step 1, and the payment data, with the "Back" button to return to step 2. At the bottom is the "Begin parking" button.
- Once the payment has started, a visible fixed box at the top of all pages will appear, containing the data of the active parking i.e. the car plate number, time, zone, the price paid and the buttons to extend and stop the session will appear as already is the case now in the app.
- By clicking on "Extend", the "Extension plan" page opens, where there will be at the top the information on the parking that cannot be changed and the most relevant part of the page will be occupied by the time selection. Below it will be written how much has been paid, what is the price with the extension and the balance (the difference between the two to be paid effectively). By clicking "Proceed", the payment page opens again which will be by default to the payment method selected for the current parking. The user has the option to change or directly click "Proceed", with which he is referred to the summary page, "Overview". Here, he finds all the data on the parking, the payment method, the extended timetable and the total balance and has the possibility to go back to change. Otherwise, by clicking on "Extend parking", you confirm. Then the user can click on the “Back to park menu” to view the new ongoing parking app notification.
- By clicking on "Stop", the "Stop parking" page opens with a summary of the parking data, the expected time and the end time by stopping the parking, the amount due without stopping and the new amount by stopping and the balance between the two amounts. By clicking on "Stop", a choice verification appears, to make sure that the user is sure he wants to stop the parking. If confirmed, the parking lot will be stopped. Regardless of the time spent, a minimum of 0,20€ will be debited. Only the amount spent for the time of the parking session will be debited from the method of payment. A notification on this information is always accessible via an icon close to the expected amount to be paid when it is less than 0,20€ and it also appears when a user

does for the first time a parking session. This alert can be closed forever if the user wishes.

- By clicking on the back button from the home, a dialogue box opens that asks the user to confirm the desire to leave the app. If you confirm you will be taken out of the application but if you cancel you will remain on the homepage.

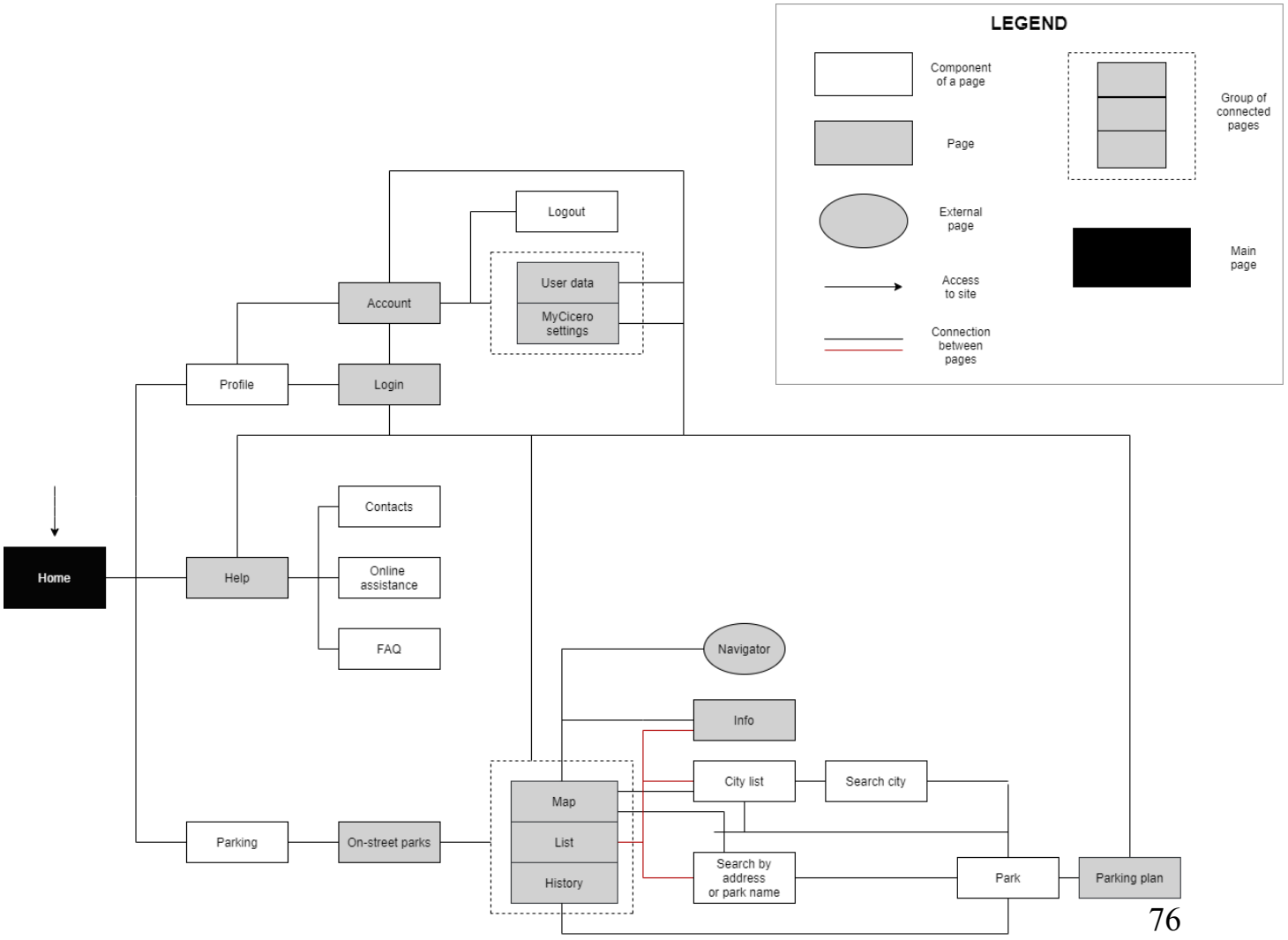
4.4 Structure Blueprint

Through the use of the blueprint, we wanted to define and show:

- The component for the organization of the content
- How the components are connected to each other

In particular, we followed a top-down approach, firstly defining all the component parts of our system (on a superficial level) and then refining them adding all the details.

In order to make our blueprint intelligible, we provide the corresponding legend.



4.5 Wireframes

With the aim of redesigning the final system, we created the wireframes, i.e. the layouts of the pages that demonstrate which interface elements will exist on them. The wireframe describes the page layout, its functions, and its possible states. The purpose of a wireframe is to:

- Keep the concept user-focused: they allow to understand how the user would interact with the interface and help the designer to understand what feels intuitive for the user and create products that are comfortable and easy to use;
- Clarify and define website or application features: wireframes allow the clients to see how the pages will function and what purpose they will serve;
- They are incredibly cheap and easy to create: they can be done with a pen and paper or with a tool.

To draw the wireframes we used the tool Balsamiq.

We designed:

- The homepage;
- Some sample pages for the initial guide, which would be in the final prototype extended for the whole system;
- The account section;
- The help section;
- All the pages which are necessary to carry out the payment of on-street parking, the extension of the session and the interruption of the session before its expiration time.

In order to make it easier for our future testers to use the system in the most realistic way, whenever it was possible we added the links connecting wireframes.

Due to their high number, the series of wireframes we created can be found in the file “Final design.pdf” and in the folder “Final Design sources” in PNG format.

5. Evaluation of the design

5.1 Inspection of the project

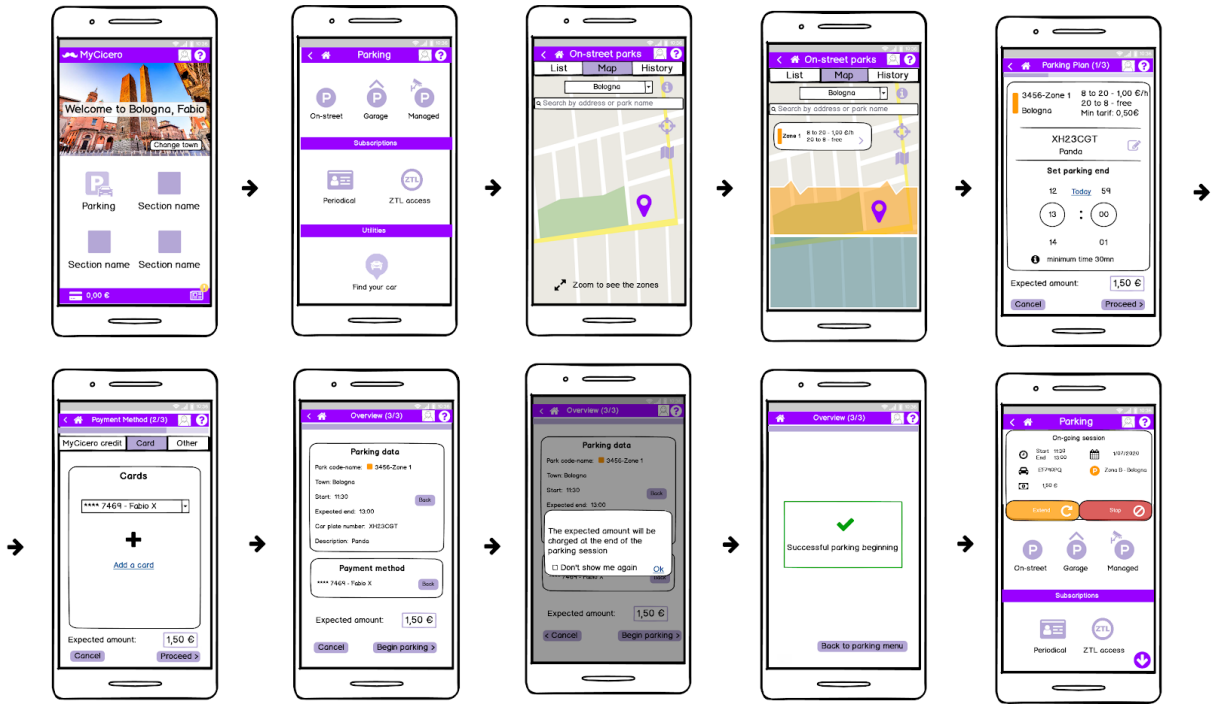
The inspection phase takes place within the design team. It is a rather cheap technique (but also rather inaccurate). There are three techniques relevant for this purpose: Cognitive walkthrough, Action analysis and Heuristic analysis. For our project, we choose the cognitive walkthrough which is a fictional and step by step execution of a task, and an empirical evaluation of the performance and validity of the use case story. We created three fictional stories of possible use of the interface and checked their validity in regard to the real use of the new app. In case there were any ambiguities on the design following the stories, we made the consequent changes.

Cognitive walkthrough

Task 1: On-street parking payment

Interface

- Homepage with login
- Parking menu
- Map
- Zoomed map
- Parking plan
- Payment method with card already inserted
- Overview
- Payment notice at the end
- Parking plan success
- Parking menu with the box of the ongoing parking



User

Giuseppe is 26-years-old and works in a pizzeria in the center. The closest parking lot is very large and Giuseppe got tired of always having to do the long distance by foot to pay at the parking meter. For this reason, he downloaded MyCicero, which he had heard about from a friend. Last week he made his first parking with the app. He registered and, thanks to the initial guide, he easily completed the task paying with his credit card. Now he wants to use the app for the first time without guides after a week.

Happy path

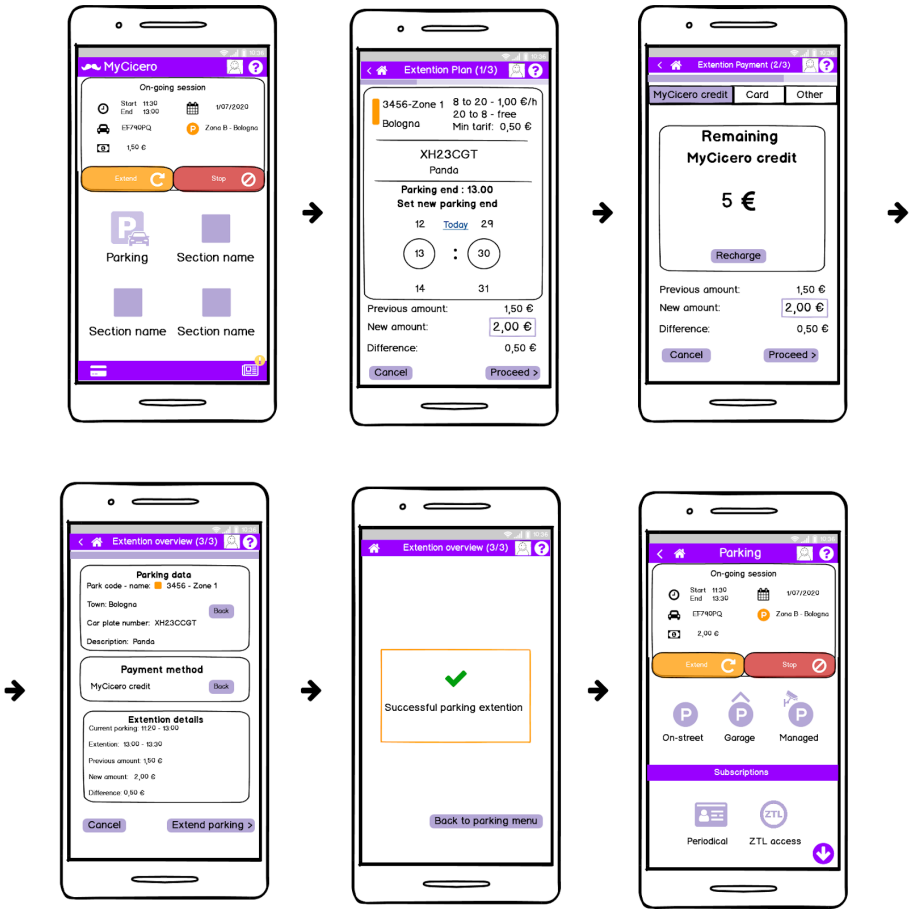
- Giuseppe enters the app. Having not logged out last time, he is already logged in, as he can see from his name in the welcome message and from the profile picture instead of the login icon;
- By default, the welcome city is the one in which he is located, given that the GPS is on. Wanting to park in that same city, he doesn't change it.
- He selects the parking section from the home menu;
- He selects On-street from the Parking menu;
- On the map that opens by default he understands that he has to zoom thanks to the indication on the screen and the area in which he is currently located is displayed;
- He selects the box that appears at the top with information on the parking area in which he is located;
- On the Parking plan page that opens, he checks the parking information, checks that the license plate is correct (he had entered it the first time) and selects the end of parking time. Below, he checks the price to pay before proceeding;

- In the payment method, the card section opens. The card he would like to use is already selected in the list, since he had inserted it the first time. So he quickly selects "Proceed";
- In the "Overview" section, he checks the data entered and clicks on the “Begin parking” button;
- He closes the warning window on how to charge;
- He receives feedback from the application on the success of the operation and clicks on the button to return to the Parking menu;
- Here he now has the box with the information on the parking from which you can choose to extend or stop it ahead of time;
- He presses the phone home to exit the app. Here it has the notification of the current parking.

Task 2: Extend the parking session

Interface

- Homepage with the box
- Extension plan
- My cicero credit already sufficient
- Overview
- Extension plan success
- Parking menu with box



User

Marco is 27 years old and is a part-time cashier in a supermarket. During a lunch break, he found a MyCicero coupon in a newspaper and, intrigued, he downloaded the app. The following day, to go to work he takes the car and makes a parking payment fee with MyCicero, which is currently ongoing, recharging the app's credit with the coupon. The courier with supplies arrives late and Marco has to wait for him at work. He therefore realizes that he cannot get back to the car in time, so he makes an extension of the parking lot.

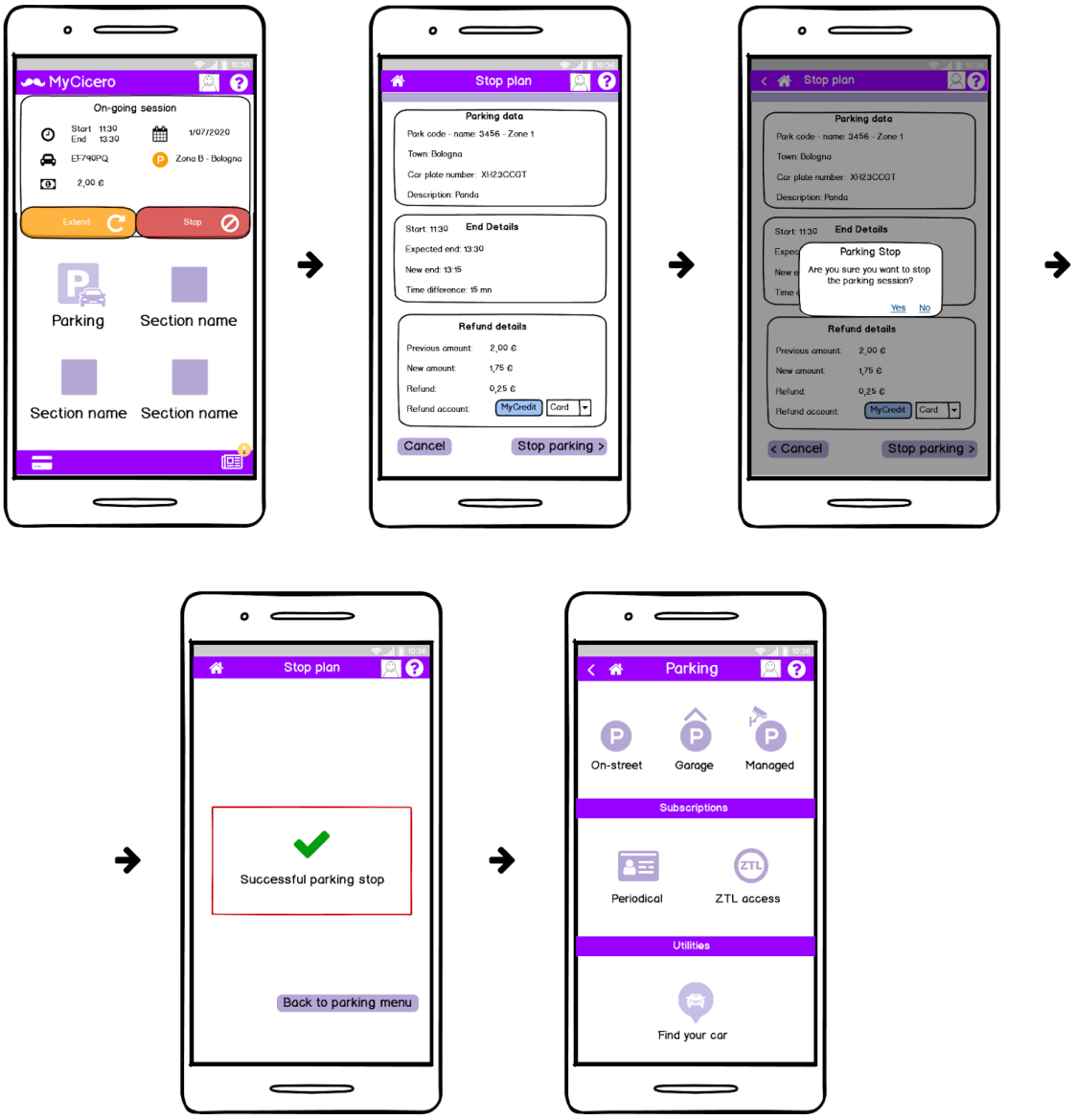
Happy path

- Marco enters the application's homepage where at the top there is a box containing information on the ongoing parking;
- From here, he clicks on the orange "Extend" button;
- On the "Extension plan" page that opens, he sees the information on the area and the license plate which are unchanged and cannot be changed and selects the new time ending for the parking. Below he views the difference in price to pay and clicks on the "Proceed" button;
- In the default "Payment method" the section of the mycicero credit opens, since it is the method with which he paid the current parking. The money he has on his MyCicero credit account is sufficient for the purchase, so he clicks on the "Proceed" button directly;
- In "Overview" the page which opens, he checks that the data entered is correct and clicks on the "Extend parking" button;
- He is redirected to the Parking menu with the box of the parking in progress with the new information on the end and the total price;
- He presses the phone home to exit the app. Here he has the notification of the parking in progress with the updated information in the extension.

Task 3: Stop the parking session before the expected end

Interface

- home with the ongoing parking box
- stop plan
- User choice confirmation
- success alert
- parking menu



User

Alice is a 21-years-old student. Her father is a company manager and often travels to other cities for work. For this reason, he downloaded the app MyCicero. Given his positive experience, Alice also started using the app. She made a parking lot using the Mycicero credit to go for an exam, but she finished earlier than expected with a beautiful mark. So she can't wait to go partying and wants to stop the parking session earlier than expected.

Happy path

- Alice enters the application's homepage where at the top there is a box containing information on the ongoing parking;
- From here she clicks on the red "Stop" button;

- The section "Stop plan" opens and she checks the information on the end of the parking and the total amount she has to pay. Since everything is fine, she clicks directly on the "Stop parking" button;
- She confirms her intention in the alert message that appears;
- She receives feedback from the application on the success of the operation and clicks on the button to return to the Parking menu;
- The box representing the ongoing parking has disappeared from the top of the Parking menu;
- She presses the phone home icon to exit the app. Here also the notification of the current parking has disappeared.

5.2 Usability testing

5.2.1 Definition of the testing protocol

Testing method: Discount usability testing.

List of principal tasks

- On-street parking payment
- Extension of the parking session
- Stop the parking session before the expected end

We have done four tests on four users. They were approximated with our target user segments.

Testing methodology: Thinking Aloud.

Expected results
Quantitative
Time isn't considered because we supposed it will be shorter than paying at a parking
Meter and of course thinking and talking are not good mates.

Success:

- We considered a success, the completion of a task without help or failure.
- We considered a failure: abandonment, moderator's interruption, wrong answer (to be evaluated if it's related to the user or to the system).

Errors:

- An error is the fact of: selecting an incorrect option in a menu, performing an incorrect sequence of actions, not activating a fundamental action at the right time or at all.

- To handle errors that cascade into other errors, we considered errors that cause other errors (and ignore the latter ones).
- For repeated errors, we considered them with an increase in severity.

Efficiency:

- Parameters measured: The number of “useless” clicks (not for curiosity) to reach a certain point, starting from the moment in which the user accesses the Homepage.
- Start of the action: From the moment in which the user accesses the Homepage
- Count the actions: “Useless” clicks (not for curiosity).

Learnability: performance for users who have never been exposed to a system.

Problems:

- A choice that leads the participant off track;
- An expression of frustration;
- Not noticing something that should have been noticed;
- A participant saying that a task is completed when it is not;
- Some text content whose purpose, meaning, and role is misunderstood;
- Perform an action that leads the participant farther away from the completion.

Qualitative

Satisfaction

There are a lot of metrics used for satisfaction. As examples we have the psychometric scale for questionnaires (Likert scales), the After-scenario questionnaire (ASQ), or the System Usability Scale (SUS)… From the list of choices of techniques used to measure the satisfaction, we opted for the System Usability Scale (SUS). The questions can be found in the section 2.2.1 of this report.

The algorithm used for the evaluation in order to assign a value to a question from its answer according to a 5 levels Likert scale is with the logic that for each question: if the enunciation of a question is positive, we assign a score of (selected choice - 1) (going from 0 to 4); if the enunciation of a question is negative: we assign a score of (5 – selected choice) (again, from 0 to 4).

At the end, we sum scores and get a value going from 0 to 40. We multiply these scores by 2.5 and get a value between 0 and 100, with increments of 2.5.

Choice of real subjects and relationship with the target audience

Dani: Female, worker with a fixed-term contract, lives with roommates, has a middle income, lives in the suburbs, is oriented towards technology, and is 24 years old.

Lorenzo: Male, 24 years old, is a student, lives with his parents outside the city, has low income, is technology oriented.

Federico: Male, 24 years old, is a student, lives with parents near the city center, has a low income, IS technology oriented.

Nicole: Female, 24 years old, is a student, lives with her parents outside the city, has a low income, and is sceptical towards technology.

Organization of tests

We used the formative test.
Our test scope was Vertical.
The Logistics of the test is based on three parameters which are:

- Setting:
  - environment: in a room or outside;
  - equipment: prototypes on the pc of the team member, block notes;
  - recording equipment: voice recorder of the phone
- Assistants: alone with the user
- Participants:
  - selection mode: relationship to target user;
  - number of participants: 4
- Methodology:
  - process data;
  - quantitative and qualitative test;
  - meaningful interpretation.

Initial introduction document

“The purpose of user testing is to acquire data on the functioning of the redesigned prototype of a part of MyCicero prepaid parking application and on the *eventual* presence of issues.

We ask you to complete three tasks through the app: pay for an on-street parking session; extend the paid parking; stop the parking before the end of the paid time. In carrying out these tasks, for each action we kindly ask you to tell us aloud everything you think.

In particular:

- what are you doing
- what are you trying to do
- how you think you should proceed
- what doubts you have
- what you read and how this is related to what you need to do.

Not all links are functioning, because it is a prototype. You will notice the pointer icon when it is possible to click. You will be guided if you encounter problems or incongruences and the team member will provide an explanation for if necessary. We please ask you to imagine being able to select at your taste some options which are inserted in the prototype by default, that we will point to you at the given moment.

You have the opportunity to ask questions. We would like to point out that what is evaluated is not you, but the functioning of the system. Please be as natural as possible and don't be afraid to make mistakes. There are no right or wrong answers! Don't hold back to tell us what you think, even when it's negative.

The data you provide us will be used only for the purpose of this project and anonymously.

It will take about 20 minutes.

We will like to conclude with some precisazioni on the application, which would be included in the initial guide: it is possible to pay the parking on MyCicero through the application's credit, a payment card (debt, credit, etc) and other methods (like SisalPay)".

Final assessment questionnaire: System Usability Scale (SUS)
We used the ten questions to permit our selected users to give their impressions on the experience.

5.2.2 Usability Testing

As we specified in the definition of testing protocol, we carried out the testings on four target users based on three tasks (on-street parking payment, extend the parking session and stop it before the expected end) according to the testing methodology Think Aloud.

Every test is described in detail below.

The tests were carried out sequentially and after each the expert team gathered to discuss the emerging usability issues of the prototype and solved them before proceeding with the following test, this was in accordance to our test type and also to make sure that in the subsequent test, the user could interact with an improved version and help us find other and new issues.

At the end of this section we reported for each user the related SUS scores for each task and a general one on the application.

Dani

Female, worker with a fixed-term contract, lives with roommates, has a middle income, lives in the suburbs, is oriented towards technology, and is 24 years old.

Before the start of the testing, I tried to explain what she had to do and that some links were not working since it is only a prototype. So, she asked why there was the message "welcome Fabio" on the interface and I explained to her that it is supposed to be her name in the normal functioning app, which was supposed to be already logged in but she was not convinced and wanted an initial guide. So I said I was there, and if in doubt she could ask me anything.

Task 1 – On-street parking payment

She started by clicking on the other icons, then I had to repeat the stuff of the clickable icon or not. She selected the parking icon. Then inside she asked me the difference between the On-street parking and the other types of parking. I answered. Then she clicked on "On-Street". The map appeared, and she was trying to write in the search box. But since it wasn't working, she clicked on Zoom, once the area appeared, she asked me why there was only one area. I replied that it was due to the fact that it is a prototype. At this point it didn't come to her that the color of the area had a meaning. By clicking on the appeared area, she was being redirected to the section "Plan parking", she read all the information very carefully. She asked me if she had to choose the time but I replied that she had to consider that the time was already chosen. Then she asked me what was the beginning time of the parking session, I didn't know it, then doing the calculation in her head she deducted the starting time of the parking. Then she clicked on "proceed" and went to the second stage of the payment. There, she made a 5 € Mycicero credit top-up and asked no questions about how to put a card and it went quickly because her data was already registered, she trusted the app. Then she went ahead and asked me where she could verify her credit and if the rest of the credit will go back to her card. At this point I explained that the credit is removed after the end of the parking and that the rest remains as residual credit in the app. (She didn't notice that she had recharged MyCicero's credit, she thought it was a payment by credit card.) With the payment finished, she clicked on "proceed" and arrived on "overview" she clicked on "cancel" and she returned to the map without warning. Then she had to start all over again, complaining a little, but finally she did everything. Once the parking was done, she expected her credit (difference of the top-up and the price of the parking) to be visible somewhere, she went back to the home to search but there was nothing and she didn't like it.

Task 2 – Extend the parking session

For the second task, first she did the overhead calculation to make sure there were no additional costs to do the extension and then she was still asking for the rest of her Mycicero credit, but seeing nowhere, I got it explained that we didn't do that part. She clicked on "proceed" and arrived on the part of the payment, already having sufficient credit. She clicked on "proceed" and came to "overview", and did the extension successfully.

Task 3 – Stop the parking session before the expected end

Before stopping, the same goes for the calculation and the rest of the credit. She did the "proceed" and came to "overview", she selected Mycicero credit for the refund. Then she clicked on "cancel" out of curiosity and remained on the "overview" page. Then she confirmed the stop.

Corrections and improvements on the prototype

- We modified the initial speech by asking the user to imagine being able to change some pre-established information. We also explained the payment methods provided by the app, as information that would be contained in the initial guide that we have provided. Finally, we reassured the user about our intervention in case of inconsistencies to be explained;
- Consistency of information about parking from a screen to another;
- Profile icon more evident because the x made her think about a way to exit;
- In the box the starting hour was not clear, so we added the labels "Start" and "End" before;
- We have changed the titles inside the mycicero top-up to make it clear, especially in the choice of card, the fact that the mycicero credit is being top-up;
- We added an alert to the cancel click which asks for confirmation of the desire to exit the process and redirects to the map;
- We added the possibility to logout, so that the icon can be clear. Before returning to the home without a login, there is a warning asking to confirm the logout.

Lorenzo

Male, 24 years old, is a student, lives with his parents outside the city, has low income, is technology oriented.

Task 1 – On-street parking payment

He opted for “Parking” in the homepage and then “On-street” inside the menu. He read aloud the voices of the first section of the menu. He selected “On-street”. Reading aloud the title of the page and that of the tabs, he immediately understood that he could choose the park either from a list, from the map or from the parks selected for old parking sessions. He explored the sections to make sure he was right, but then got back to the list, which was his initial choice. He selected a park from that. He read aloud the information. On the car plate number, he had a doubt: At first he thought it was the name of the park; after having read the name of the card below he understood he was wrong and justified the mistake with the fact that he hadn’t inserted it. Understanding the parking time took a while, but he imagined it would have been very intuitive selecting it for real. Once in the “Payment method”, he decided to pay with MyCicero credit, so he proceeded with the recharge through the selection of 5 euros from the available choices. He inserted the card to pay and everything made sense to him. He proceeded to the “Overview” where he read the information. He proceeded, dismissing the popup message about the charge timing, to the menu.

Task 2 – Extend the parking session
He pushed the "Extend" button from the box. In the "Extension Plan", he lingered on the parking end selection, because he didn't understand at first that the default hour had already considered a 30 minutes extension. In fact, he had already forgotten the previous expected end. He proceeded to the "Extension overview" and he quickly read the information. He concluded the task by clicking on the last "Proceed" and coming back to the parking menu.

Task 3 – Stop the parking session before the expected end
He clicked on the "Stop" button from the box. He read the "Stop plan". Everything made sense to him, even the "Refund details" section. He quickly went on, confirming the message.

Corrections and improvements on the prototype
We made more evident the alert about the surcharge in the price by choosing payment by card. While previously the alert was limited to a popup that appeared by clicking on the exclamation point next to the amount, we added the popup also for the first time that the user opens the card section, with the possibility to close the popup forever.

Federico
Male, 24 years old, is a student, lives with parents near the city center, has a low income, IS technology oriented.

Task 1 – On-street parking payment
From the homepage he explored the system to see the structure by clicking on the help section, and then on the profile section to see if he had some money on the credit. Then he came back to the homepage and clicked on "Parking". Once in the parking section, he said that in his opinion the word "Managed" to indicate the managed parking is not very clear because even the garage is a sort of managed parking. Then he clicked on "On street" and arrived on the "Map" page, he didn't explore the other two sections (List and History). From the Map he clicked on the zoom message and saw the colored zone. Then he read the info on the zone from the box which appeared on the top of the page, and then he clicked on the arrow in the box, saying that it was not very clear but that he clicked on it because it was the only possible thing to do. In the parking plan he read the information and then proceeded to the payment. He explored the different payment possibilities and in the end he said that in his opinion it does not make sense to use a method other than MyCicero credit, since using the Card method will require a surcharge. Then he selected MyCicero credit using the card and proceeded in the steps until the overview of the payment. Then he clicked on the confirmation button and started the parking session.

Task 2 – Extend the parking session
From the box in the parking menu which contained the info on the current parking, he clicked on the extend button. He read the extension details and clicked on "Extend parking". He didn't notice the updated parking information in the box.

Task 3 – Stop the parking session before the expected end
From the box in the parking menu he clicked on the stop button. He read on the next page that the parking will be interrupted 15 minutes before the initial term. He said that in his opinion the word "Refund" is misleading because in one of the previous alert messages he read that the amount for the parking would have been paid at the end of the session. Then he clicked on "Stop parking" and then on "Yes" from the alert box.

Corrections and improvements on the prototype

- In the map we added the possibility to see some information for a different zone, in order to make the functioning of the map clearer. Moreover, the functioning would have been explained in the initial guide;
- We made the arrow button in the box with the info of the zone (in the map page) larger, so that it would be more visible;
- We changed the overview of the Stop plan because of the inconsistency generated by an initial message which said that the amount of the parking has been paid at the end of the parking session and the word "Refund" in the Stop overview. Instead of "Refund" we used "Difference". While reviewing the various overviews of our design, we noticed some inconsistencies and ambiguities in their layout and proceeded in their uniformization.

Nicole

Female, 24 years old, is a student, lives with her parents outside the city, has a low income, and is sceptical towards technology.

The user evaluated herself as not very fluent in English, so during the testing some misunderstanding of the voices were related to her language proficiency. She asked whenever in doubt to the expert.

Task 1 – On-street parking payment
She opted for "Parking" in the homepage and then "On-street" inside the menu. She lingered on the map, trying to understand it, then she read "List" and opted for it. She selected a park and not having read the other information and the small title she at first thought that she had to select the beginning hour. She went on to the payment section, where she decided to pay by card. Given the surcharge she was warned about, she commented that, using the app in real life, she would have probably chosen at that moment the credit. However, she went on with the choice of the card. Once inserted the details about the card, she pressed several times the disable button "Proceed" instead of "Confirm". Everything went smoothly until the end of the task: she went on to the overview, she closed the popup message about the charge timing and she went back to the menu.

Task 2 – Extend the parking session

She commented positively about the box of the on-going section, which she found very intuitive to understand, especially thanks to the buttons. Once clicked on "Extend" and having "selected" the new hour, she proceeded to the "Extension overview" and she read aloud the information. She was satisfied with the fact that she had the comparison with the hour previously selected and the difference of price between now and then. She concluded the task by clicking on the last "Proceed" and coming back to the parking menu.

Task 3 – Stop the parking session before the expected end
She underlined again that she found it very intuitive, despite her difficulties with English, to understand how to carry out these actions. She quickly proceeded from the "Stop plan" on, confirming in the message.

Corrections and improvements on the prototype
In this test no new usability worry or system malfunctioning was detected. However, during the wrap-up of the problems encountered, we recalled a problem concerning the minimum fee for the parking session: in MyCicero there was an initial reminder about the fact that, whatever may be the expected amount, the user couldn't be charged less than 20 cents. Nonetheless, in the following steps of the procedure, the user was not reminded of this, so it was easy to forget about it. For this reason, we decided to insert an alert, at the very beginning of "Parking plan", which can be closed and not be shown again respecting the user's choice. It is always reachable through a warning icon next to the expected amount. The same choice was applied for the "Stop plan", in case the amount results less than 20 cents.

SUS of the 4 users

	Dani	**Lorenzo**	**Federico**	**Nicole**
Overall	37,5	85	85	92,5
Task 1	52,5	80	77,5	90
Task 2	85	90	85	87,5
Task 3	95	92,5	87,5	90

5.2.3 Analysis of objective and subjective data

After the conduction of our various tests, since these tests were based on discount usability testing with a formative purpose, the various information noted from the experience of the

user and from the user has been better elaborated in the section of the testing since we performed iterations of the design of our prototype after each test. Thus reporting here again the common and specific problem won't be necessary. We report here below a series of four tables representing the outcome of each test according to our set description of expected results in our testing protocol.

Dani	Success	Errors	Efficiency	Learnability	Problems
Task 1	Yes	No	Yes	Yes	Yes
Task 2	Yes	No	Yes	Yes	Yes
Task 3	Yes	No	Yes	Yes	Yes

Lorenzo	Success	Errors	Efficiency	Learnability	Problems
Task 1	Yes	No	Yes	Yes	Yes
Task 2	Yes	No	Yes	Yes	Yes
Task 3	Yes	No	Yes	Yes	No

Federico	Success	Errors	Efficiency	Learnability	Problems
Task 1	Yes	No	Yes	Yes	Yes
Task 2	Yes	No	Yes	Yes	Yes
Task 3	Yes	No	Yes	Yes	No

Nicole	Success	Errors	Efficiency	Learnability	Problems
Task 1	Yes	Yes	Yes	Yes	Yes

Task 2	Yes	No	Yes	Yes	No
Task 3	Yes	No	Yes	Yes	No

6. Conclusions and recommendations

Our purpose was the redesign of part of an app for the payment of pre-paid parking fees online, i.e. MyCicero. From our preliminary analysis, we discovered that this kind of applications are not very used and we unexpectedly saw that younger people, even those who are aware of this type of application, are not responding. When asking them if they would use these applications, they answered negatively and gave us reasons: scepticism and lack of trust in these applications.

Our hypothesis is that paying parking fees is a rather simple activity to do in the traditional way and, even if there are many advantages in paying the parking fees with an app (e.g.the use of a credit card, make an extension of the parking session, save money thanks to the fact that you pay only for the effective time), nevertheless, these advantages cannot convince the user.

Following this line of thought, since the users under consideration are young-adults, one of the sources of lack of concern could be linked to the payment activity, because most of the time this procedure is not very clear and the user could be worried of some kind of errors during the transaction that could lead to other consequences, such as real-life fines.

This hypothesis was confirmed by the analysis that we carried out on the app and the tests we conducted since we personally experienced this problem of low clarity in the online payment of parking fees. In addition, there was a difficulty of interaction with the interface because it was not very well structured, user-friendly and consistent, and thus leading to various usability problems.

For this reasons, we decided to focus our design of the application on the transparency and the reliability of the procedure to undergo to pay for parking fees online, i.e. trying to make all the steps clear and unmistakable, most of all those related to the payment, and structuring the choice of the payment of the parking in a simple and user-friendly way.

During our work, we tried to solve the usability problems we found during our analysis.

The involvement of users as testers of the app (those who carried out some tasks on the app, revealing to us some problems) during our work helped us in seeing the enhancements we made since the testing have been performed both on the initial version and the prototype with the new design.

As we can see from the SUS tests, performed before (2.2.2 User Testing) and after (5.2.2 User Testing) the redesign, the scores have increased.

From the tables of the analysis of the results, we can see that, while in the tests on the original app (2.2.3 Analysis of subjective and objective data) a greater part of the users was in trouble to such an extent that they didn’t manage to finish the task without the help of an expert; in

the final prototype (5.2.3 Analysis of subjective and objective data) everybody managed to complete anything on their own. These results can be interpreted in a positive way, even if further improvements from the point of view of reliability could be made.

The reliability of the result could be increased by performing extra tests on a larger number of users, with a wider range in the target space.

No further functionalities are needed, since there is already an excessive number of them which ranges from very heterogeneous areas, generating disorientation and confusion in the user mental model of the app.

From the point of view of usability, it would be interesting to extend the redesign to the other section of the app we didn't focus on.