# Primjena principa emocionalnog dizajna u razvoju edukativne aplikacije za rolanje

**Krapec, Ana**

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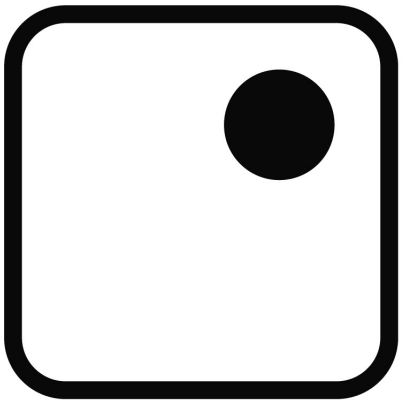

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MARTINA DOBROVOLJEC

# EVALUATION OF THE USER'S EXPERIENCE OF A MOBILE VEHICLE CONTROL APPLICATION

MASTER THESIS

Zagreb, 2022

Sveučilište u Zagrebu
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# EVALUATION OF THE USER'S EXPERIENCE OF A MOBILE VEHICLE CONTROL APPLICATION

MASTER THESIS

Mentor: Student:

Prof. dr. sc. Jesenka Pibernik Martina Dobrovoljec

Zagreb, 2022

The decision of approval of the thesis topic

# ABSTRACT

The master thesis questions how different research methods can improve the user experience of the mobile app. Methods used for evaluation are heuristic evaluation, moderated usability testing and desirability testing with reaction cards to access easiness and satisfaction of use of the mobile app for controlling a vehicle. The vehicle controlling mobile application allows car users to know and manage the status of the car at any time.

The planning, processes and methodologies of the mentioned methods are described. The paper presents the methodologies and research plans with specific goals and hypotheses for each method. Also, the main features of the mobile app as well as target users are presented. This study has both qualitative and quantitative characteristics. Testing results consist of data collected from 5 UX experts in the heuristic evaluation, 5 users in the usability testing and 33 participants in the desirability study. Analysis of gathered data gave insights into weak areas and places for improvement. Consequently, the redesign of needed features was started.

Testing hypothesis was confirmed so mentioned methods help validate the app's experience and uncovered areas users struggle with while using the app. Heuristic evaluation is a good starting point for testing. Usability methods complete and verify the first method with users. The final touch is desirability, which shows the user's attitude toward the interface.

**Keywords:** heuristic evaluation, usability testing, desirability testing, user research

# SAŽETAK

U ovom radu se propituje kako različite istraživačke metode mogu poboljšati korisničko iskustvo mobilne aplikacije. Korištene evaluacijske metode su heuristička analiza, moderirano testiranje upotrebljivosti i testiranje poželjnosti s reakcijskim karticama kako bi se procijenila jednostavnost i zadovoljstvo korištenja mobilne aplikacije za upravljanje vozilom. Mobilna aplikacija za upravljanje vozilom omogućuje korisnicima automobila da znaju i upravljaju statusom automobila u bilo kojem trenutku.

Opisano je planiranje, procesi i metodologije navedenih metoda. U radu su prikazane metodologije i planovi istraživanja s određenim ciljevima i hipotezama za svaku od metoda. Također, predstavljene su glavne značajke mobilne aplikacije kao i ciljani korisnici. Provedena testiranja imaju kvalitativne i kvantitativne karakteristike. Rezultati testiranja sastoje se od podataka prikupljenih od 5 stručnjaka korisničkog iskustva u heurističkoj evaluaciji, 5 korisnika u testiranju upotrebljivosti i 33 sudionika u studiji poželjnosti. Analiza prikupljenih podataka dala je uvid u slaba područja i mjesta za poboljšanje. Posljedično, pristupilo se redizajnu potrebnih značajki.

Potvrđena je hipoteza testiranja, što znači da spomenute metode pomažu u procjeni korisničkog iskustva aplikacije i otkrivanju dijelova s kojima korisnici imaju problema koristeći aplikaciju. Heuristička evaluacija dobra je polazna točka za testiranje. Metode upotrebljivosti nadopunjuju i validiraju prvu metodu testirajući aplikaciju s korisnicima. Završni dio procjene iskustva je poželjnost, koja pokazuje stav korisnika prema sučelju.

**Ključne riječi:** heuristička evaluacija, testiranje upotrebljivosti, testiranje poželjnosti, korisničko istraživanje

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# I. INTRODUCTION

The design thinking process is a user-centered way of problem-solving from understanding the users (sympathize, define), exploring ideas (ideate, prototype) to materializing design vision (test, implement). Each phase is iterative and puts users in the centre of the product development. It takes into account users' needs, objectives and evaluates design decisions according to usage simplicity and emotional satisfaction. [1]
To shape the product according to users, it is important to validate it at every step of the creation of the solution. There are a lot of research methods to answer different questions, but they can be overall viewed in 3 dimensions: attitudinal/behavioural, qualitative/quantitative and those according to context of use. Each dimension has various methods to get desired insight and fulfil the initial intention.
In attitudinal methods users' beliefs, attitudes and expectations are gathered, while in behavioural ones the user's behaviour is observed. Collecting data both about beliefs and behaviour by observing users is an aspect of the qualitative method. In the quantitative method, these data are gathered indirectly through numerical data of different measurements. The last important part is how the product is used, for example in natural, scripted, or limited surroundings.[2]

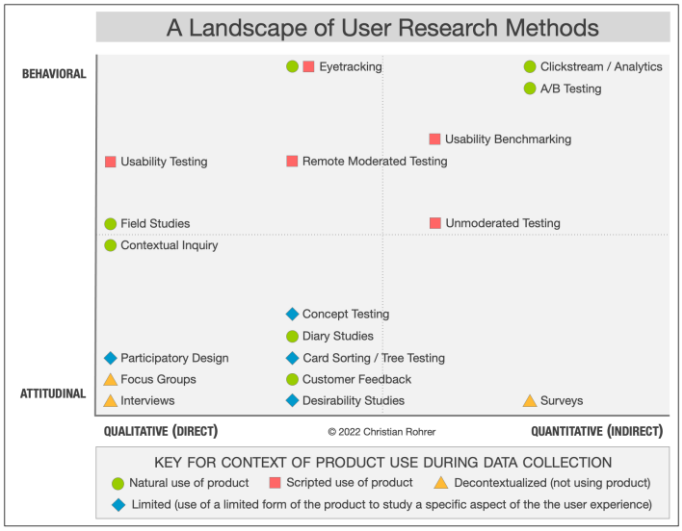


Image 1: Preview of User Research Methods in 3 dimensions
(https://www.nngroup.com/articles/which-ux-research-methods/)

In the master thesis evaluation of the user's experience of the mobile app for controlling a vehicle is going to be done by testing it with UX experts and the target users. Heuristic analysis, moderated usability testing and visual design testing are UX research methods that are going to be used to discover issues and improve the experience of the app. The mentioned methods are going to be conducted in the practical part to gather both qualitative and quantitative data like success rate, time on task and SUS results. Findings are going to help determine if the design concept aligns to target users, measure the app usability and find weak spots. At the same time, it is going to show whether the chosen methods are most effective for satisfying the experience in the validation phase of the user research process, which is the primary goal of the study. Users should be able to control the vehicle effortlessly and with enjoyment at any moment.

# II. THEORY

## 1. Usability framework

Usability is a second quality of user experience design after utility and before desirability and brand experience. It describes the level of which user can use the product in given context. It also applies to the research methods used to improve easiness of usage of a product during design process. Usability is defined by five components:

- Learnability: How easy can the user achieve a task on a design seen for the first time?
- Efficiency: How quickly can the task be done once the design is learned?
- Memorability: How easy can the task be performed again after some time?
- Errors: Does the user make many errors, which severity are they, can the user get back again?
- Satisfaction: How delightful is it to use the design?

When users use the product for the first time, they should be able to go through the product easily to accomplish the goal without needing additional expertise. Usable design can support the user to do the task easily and with the least amount of work (e.g. clicks).

Another quality is utility, which wants to find out whether certain function provides the service which users need. Utility and usability together determine if the product is useful. [3]
There can be a lot of products on the market that cover those two requirements. So, how can then the user chose which one to use? Desirability is what can help users to distinguish between the products, give confidence to users, make them happy and encourage them recommend the product.[4]


Image 2: Elements of Usability
(https://www.interaction-design.org/literature/topics/usability)

## 2. Research methods for improving the user experience

Every phase of the product's design cycle can be tested with UX methods corresponding the stage the product is in. This is important so that the design is not done just by guessing but rather aligned to the user's needs and expectations. User research should be done at every phase of the product development (from Discovery to Listening) and if that opportunity has passed, the stage the product is currently in can be a good starting point. Once it has been decided what is going to be tested, it is good to choose the proposed UX method for that stage. Some methods may fit better than others, but it depends on the type of product, its ripeness, goals and insights that want to be gathered. [5]

Since the product that is going to be analyzed in this study, the mobile app for controlling the vehicle, is in the testing stage of the design development process, UX methods appropriate to this stage have been considered. In the concept validation and testing phase, researchers want to test proposed design decisions and concepts with qualitative and quantitative methods. Built version of the product is going to be tested to gather feedback, optimize and complete the product. Most used methods in the Test phase are Qualitative usability testing, A/B testing, Multivariate testing, First click testing, Benchmarking and Accessibility testing.


Image 3: UX research methods in the product & service design process

( https://www.nngroup.com/articles/ux-research-cheat-sheet/)

Methods picked to validate the user experience of the mobile app in the testing stage are Heuristic evaluation, Usability testing and Desirability testing. Based on the product, its features and concerns wanting to be tested, it is assumed that mentioned method will help evaluate the design concept and its usability to ultimately improve the user experience.

# 3. Heuristic evaluation

The heuristic technique has been used in psychology, mathematics, and law for many years as a way of fast problem-solving or self-discovery. Heuristics rely on the learnings from previous similar experiences to ease the decision-making process. [6] In UX (User experience) and product design field, heuristic evaluation, often referred to as a discount usability method [7], is a process where experts examine and evaluate the usability of a user interface using rules of thumb ("heuristics"). [8] One or more professional evaluators are going through the interface to identify usability issues and improve product usability. It is a good practice in the early design and development phases and also an opportunity to validate design decisions for companies lacking the resources to do proper user-testing. [9]

## 3.1. Heuristic evaluation and usability testing

Web usability pioneers Jakob Nielsen and Rolf Molich published the article "Improving a Human-Computer Dialogue" in 1990, defining common principles for enhancing the usability of the user interface today known as "10 usability heuristics". At the time of the introduction of the heuristics, usability testing was already a known method but just started to be broadly practiced. It was hard and expensive to find users and often required to be educated first to use the system and then test it. It was easier to follow a checklist to reveal shortcomings while consuming the product without the need for previous domain knowledge. [10] Nowadays, when both methods are precisely specified and a common ground for the usability field, heuristic practice is still a great low-cost alternative to detect issues when usability testing with real users is impossible. Also, after the evaluation refined set of heuristics can be used again for future validations.

In heuristic evaluation the facilitator can assist and help the evaluator when he/she does not understand a part of the interface which is maybe new to him/her because he/she has limited knowledge of that domain. On the other side, this isn't the case in usability testing, since the facilitatorr shouldn't interfere in the user's flow of understanding of

the interface to get as precise and honest results as possible. Also, user's questions asked during the testing should be answered by himself/herself while using the interface and not by facilitators. In the heuristic evaluation it would be contra-productive to let evaluators struggle to figure out a domain-specific feature rather than spend time accessing it from an expert point of view. Nevertheless, it is important only to help evaluators when they can't proceed with the examination and question the usability.

Furthermore, heuristic evaluation results can be shown soon because gathered insight can be organized without the need to analyze evaluator's actions. But after the usability session, an observer needs to be able to interpret user's actions to come across a potential usability problem which need further investigation and design assistance. [11] Extracted findings from heuristic session are valuable since the evaluator could spot a problem and propose a potential solution, but cannot replace the user perspective of the interface.

## 3.2. Methodology and different heuristic sets

In the preparation state, before conducting heuristic evaluation it is important to define the following:

- Scope of the product that will be testing, whether that is only one function or a whole interface. It is beneficial to include user scenarios and tasks that evaluators need to analyse.
- Goal of the test
- Target users' needs, goals, limitations and context of use
- Evaluators testing the product with usability expertise and some industry knowledge. They should not be end users of the product. Adding external expert can help envision the product with new perspective and ideas. [11]

According to Nielson 3 to 5 experienced evaluators can identify approximately 75 to 80% of all usability problems. Having more evaluators can add more costs than benefits because they will not necessarily discover new issues. [12]

- A defined list of heuristics (around 5-10) is used to test depending on type of the product
- The defined scoring system of different severity to distinguish minor, good-to-fix problems from major usability issues [11]

The most popular and used heuristic principles are Jakob Nielsen's 10 Usability heuristics for user interface design. They are:

- Visibility of system status - users shall be aware of system status through time-reasonable feedback
- Match between system and the real world - using interface needs to be natural, logical and speak with the user's voice
- User control and freedom – the user shall rapidly recover from a mistake or unwanted action
- Consistency and standards - interface needs to be consistent and pursue platform and industry principles
- Error prevention - eliminate the possibility to make an error or ask for the user's approval before committing an action
- Recognition rather than recall - make elements, activities, and choices for making desired action visible to avoid the need to remember
- Flexibility and efficiency of use - provide shortcuts and personalization
- Aesthetic and minimalist design - only essential information shall be visible
- Help users recognize, diagnose, and recover from errors - error messages shall be understandable
- Help and documentation - give help and entry to the documentation if needed. [13]

Other popular ones are Gerhardt-Powals' cognitive engineering principles, Shneiderman's Eight Golden Rules of Interface Design or Weinschenk and Barker classification. [11] It is also possible to define your own domain-specific heuristics for a particular product where general principles aren't fully applicable. These special heuristics can be defined after conducting competitive analysis and user testing of existing products. [12]

During one to two-hour evaluation session, evaluators go thought the interface several times. [11] On the first walkthrough evaluators can use the product freely so they can get familiar with the interface, interactions and recognize elements they are going to test. On the second pass they can start and judge interface elements against chosen usability checkers (the heuristics). Evaluators can choose their own way of examination, but it is recommended to go through the interface at least twice. While spotting a potential issue it is essential for evaluator to precisely explain why a specific element breaks a rule and which one. In the case that one element has multiple issues, all need to be mentioned separately by heuristic because not all problems have the same severity so some may have priority to be fixed in a redesign process.
Recording of the results can be in form of a written report were evaluators go through each heuristic and state the problem or can give comments to observer as they go through the interface and spot violation of some heuristic. Also, the observer can be beneficial if the evaluator doesn't have a lot of specific area expertise. [12]

The outcome of the heuristic analysis is a list of interface usability problems with their severity referenced to broken usability standards in design from evaluators point of view. This can give a good clue to an interface designer how to improve a specific element. Furthermore, heuristic evaluation can be extended by having a debriefing session to present findings and brainstorm redesign ideas of major usability issues and potential hick-ups design created. [12]

## 3.3. Pros and cons of the heuristic evaluation

Heuristic evaluation is one of the usability methods which can give good insight into design's usability and combined with user testing designer can be sure that the issues found are indeed usability problems users have. Like any method, it has pros and cons that are good to take into consideration.
In heuristic evaluation evaluators can focus on individual elements or sections of a product and spot its problems that could have negative influence on the usability. [9] It can be combined with usability testing to get a full usability overview of a product from both experts' and users' point of view. Also, compared with usability testing it is a more

ethical and cheaper option. Evaluators can also besides spotting the problems lead toward solution and improvements. On the other side, some of the issues evaluators find might not be actual usability problems. Also, since the heuristic evaluation relies on chosen heuristics, if they are misinterpreted, the results could be partial and subjective. Finding experts with both usability and some knowledge in particular industry could be hard and/or expensive. [12]

# 4. Usability testing

Usability testing is an UX research methodology intended to determine the extent an interface facilitates a user's capability to finish routine tasks. The test is usually conducted with a group of representative users either in a usability lab, remotely, or on-site and with or without the moderator. Users are asked to complete a series of routine tasks. Test sessions are recorded and analyzed to identify potential areas for improvement, places where they enjoy the experience and where they are confused. [14]

Usability studies are usually conducted with design iterations from the time the team has a functional prototype until the release of the product to improve and optimize it. [15] Even a professional UX designer can design the best interface, but it doesn't have to mean it will be usable and logical for the users. The interface is built on assumptions, so only real users who will use the product can judge its success of it. The goal of the usability testing depends on the product, but generally, it should:

- recognize problems in the product's design
- detect places for improvement
- discover user's behaviour, perception, and preferences. [16]

## 4.1. Types of usability testing

There are a lot of different variants of usability testing, but they all have in common that they observe users' usage of a product or service. This makes the usability test different from survey or interviews where only users' opinions are gathered. [17] Which

type of usability testing will be used depends on the resources, target users, goal and questions the design team wants to answer. There are two overall types:

- Qualitative or quantitative
- Remote or in-person.

Qualitative usability testing focuses on gathering insights and findings that help improve the product. Qualitative data is descriptive or anecdotal and after taking out useful information to minimize biases, it can explain, for example, the reason and the kind of trouble of usage. This data is more subjective so it can clarify the background of quantitative results. [16] Qualitative testing can be done with less participants if the required insights are already gathered, and protocol for evaluating can be changed in the mid-test. Since there is no data gathering, participants need to think out loud while doing the tasks. Members of the development team and other involved parties observe the session. After the test the observer can analyze the notes and it can be decided what problems need to be fixed. [17] Typically for the qualitative testing of a single user group 5 participants are enough to reveal 85% of usability issues. [15]

Quantitative testing is focused on collecting numerical data to prove for example if the product is easy to use or if this version is better than the previous one. The most common metrics are task success rate and time on task. The test is very strict because the data needs to be collected carefully to provide reliable results. This means that a defined test protocol needs to be followed consistently for all the participants. During the testing interaction with participants needs to be reduced, and in extreme cases, participants sit alone in a room and the facilitator gives them instructions over an intercom, while an observer watches through a one-way mirror and records the data. Quantitative results are objective, and statistical and can be applied to the entire participant sample meaning it can be, for example, stated that x% of users had a problem with specific functionality. The number of participants needs to be large enough for statistical data to be relevant. [16]

Remote testing allows testing of a large group of users in different locations with fewer resources than required in in-person testing. Two types of remote usability testing are

moderated and unmoderated. Remote moderated tests are similar to in-person analysis. The facilitator gives tasks to participants and can interact with them accordingly, but they are not in the same physical location. For conducting this test screen-sharing software is used and useful information like heatmaps can be provided. On the other hand, in a remote unmoderated testing researcher uses online tools to prepare tasks and follow-up questions for participants which they can complete in desired time. Test recordings and metrics are provided by chosen tool after each test. In comparison to remote tests, in-person ones give more data like user's expressions and additional observations. [15]

## 4.2. Conducting the usability test

To run a usability test successfully it needs to be planned out because there are a lot of moving pieces. Most usability tests consist of the facilitator, the tasks, and the participant. The facilitator gives the tasks which participants need to solve. While executing the tasks facilitator observes the participant's behaviour and later asks follow-up questions. [18]

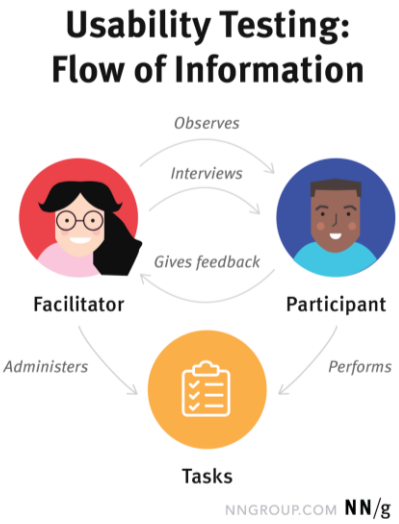


Image 4: Usability testing method
(https://www.nngroup.com/articles/usability-testing-101/)

### 4.2.1. Planning stage

In the planning stage, the scope and the goal of testing is going to be defined. It is important to define what and how many features need to be tested to achieve that goal. For the researcher to be able to prioritize what part of the product to test, he needs to ask himself: What was the development and design team insecure about? Are there any features the designers weren't sure about? Is there a part where the designer tried to be innovative and didn't stick to the recommended guideline, so he's not sure if it will pay off? Answers can be formed into a hypothesis to have a clear overview of what to test. [19]

The test can be conducted in the usability lab, meeting room or office with portable recording equipment, remotely, or anywhere as long as users can be observed while interacting with the product. After the team decides what is best for them, logistical demands is going to be apparent. Equipment needed for testing is going to depend on the type of testing. For quantitative testing needing metrics or raw data some recording devices, screen capture software and stopwatch is going to be needed. In some cases, a device with a prototype, pen and paper for observer to take notes will be enough. [19]

The schedule can be created ahead according to the availability of the team and known duration of each test. A good starting point is 60 minutes of testing with 30-minute breaks, and desired number of participants per day should not exceed the testing team. However, this depends on the team's preferences. [19]

Testing staff is going to include a facilitator and a few observers if needed. The observers don't interact with the facilitator, so anyone who can benefit from the research is allowed to be involved. The facilitator guides participants by giving them instructions, answers to their questions and asks follow-up questions. He is responsible that the gathered data is accurate, not compromised and without interference of participant's behaviour. Moreover, the facilitator should be good at talking with people and know where to start a conversation but be aware not to be biased. In remote unmoderated testing chosen software is going to replace the facilitator. [18]

Tasks in usability testing are real actions which participants take part in while using the product in real life. Research questions and the type of usability testing are going to determine if the tasks are specific or more general. The most important tasks with realistic goals should be given to participants to determine if chosen features are understandable and usable. Giving the task a context- scenario is going to help the participant to use the product naturally and not be pressured that they are tested. Also, it is very important how the task is structured. Using unclear phrases can lead participants to the wrong direction, trying to conduct an unwanted task or it can even influence their performance, which is in psychology called priming. During the test facilitator can read task instructions to participants or give a sheet of paper with the task instructions to participants to read them out loud, which ensures the facilitator they will read the task completely. [18] If a product is available on multiple devices, for example, both on desktop and mobile phones, it is good to break the test into more sub-tests.

When test goals and tasks the participant has to accomplish are defined, the researcher can know which data he needs to pay attention to when observing the participant. When the participant clicks something, was that expected or not? According to that data, some conclusions can be made, like 60% of participants completed the task successfully. [19]

It is important to know the target users to recruit the right participants. They should represent real users of the product meaning they can already be using the product in real life or have similar qualities and needs as target users. With questionnaires, user interviews, or community groups fitting participants can be found. If the team had been defined, customer pool participants can be chosen from there. While planning the recruitment the design team can ask itself questions like: How many participants are needed? How many do we have time for? What characteristics do they need to have? How should they be recruited? In qualitative usability test, five to ten testers will give good results and by adding more no discoveries will be found, but for a quantitative five participants can reveal the most problems. [19]

### 4.2.2. Moderating stage

Before conducting a usability test it is recommended to do the pilot testing with volunteer participants to test equipment and prepared materials like tasks scenarios or questions. It can be done one or two days before the testing, so if the team detects any difficulty there is still some time to change it. [20]

After the pilot testing is completed, issues are repaired, and the testing environment is set the facilitator and observers can start with the test. Participants can be observed to see if their direction is right, if they have issues, or are frustrated or confused. If participants perform a task incorrectly, the facilitator shouldn't correct them. That is valuable information for researchers. It is also important to mention to the participants before testing that they are not the ones being tested but the product. This could help them feel more natural and not to fall into Hawthorne Effect which describes that people can behave differently because they know they are observed. Even though it can be difficult and frustrating for both the participant and facilitator if they struggle, it is needed to gain real data. By recording a testing session, the team can recall and spot some parts that were possibly missed. Zoom, for example, except from video provides auto-transcription which is very useful when creating a report. [18]

The facilitator should encourage the participants to share their thoughts and opinions as they move along to determine if the designer's assumptions of the user's actions match their actual activities. Jen Romano Bergstrom in the article "Moderating Usability Tests" defined four moderating techniques that can be chosen based on testing goals:

- Concurrent Think Aloud (CTA) suggests that participants think loud while working on a task. The negative is that the time participant spend on tasks can't be measured and not everyone is aware of their thought processes.
- Retrospective Think Aloud (RTA) suggests that participants verbally repeat their actions. Usually, participants look at a replay of the testing session. There is a chance participant can't remember the thought at that moment.
- Concurrent Probing (CP) suggests that participants should be working on a task and facilitators can ask follow-up questions if something interesting or relevant pops out through the test. Occasionally interrupting participants could influence

the results. Conducting this method would take shorter than Concurrent think-aloud.

- Retrospective Probing (RP) suggests finishing the test without interference and asking questions about the participant's actions and thoughts in the end. The researcher takes notes of the participant's actions and asks questions at the end. This method is usually used with other methods. [20]

### 4.2.3. Analyze & create report

After the testing, the design team has data from notes and sometimes recordings. The notes can give valuable information like participants' facial reactions, body language, feelings, and subjective satisfaction (via questionnaire). After analysing this qualitative and quantitative data, like time needed for a task, success and failure rates, effort (how many clicks users take, instances of confusion, etc.), researcher can get information about participant's behaviour. This will help uncover patterns if there is consistency in participant’s actions. Did one or all participants have hiccups while trying to finish a specific task? Found patterns can point out to product’s problems. Problems can be ranked by severity, so it is clear which needs to be fixed or has negative influence on the product or which ones need more “cosmetic” changes. All this data can be summarized and written in a report together with proposed solutions. [19]

## 4.3. Rapid Iterative Testing and Evaluation (RITE) method

Another useful research method is Rapid Iterative Testing and Evaluation (RITE) which combines prototyping and usability testing into a single process. The method is similar to classic usability testing where participants finish a task while using a think-aloud protocol. Unlike in usability testing, the team doesn’t need to complete a test with all participants to find problems. In the RITE method, after the problem is discovered

(either if the test is done with one or two participants) the design will be improved and prepared for the next round of testing.
Tests are run regularly and the design goes each time into iteration. The goal of this testing is to find the usability problems and rapidly test created solutions by fixing recognized issues. The outcome is a flow that has been completely tested and approved by target users. [21]

The sample size of a RITE test is three for each iteration and five to complete the test. The test can be divided into 2 steps:

- Step 1: Testing a prototype with 3 participants
    - If issues are found, effort needs to be devoted to fixing them and repeating step 1
    - If no issues are found, continue to step 2
- Step 2: Adding 2 extra participants
    - If issues are found, effort needs to be devoted to fixing them and doing step 1 again
    - If no issues are found after testing the product with five participants, then
    - the process is completed. [21]

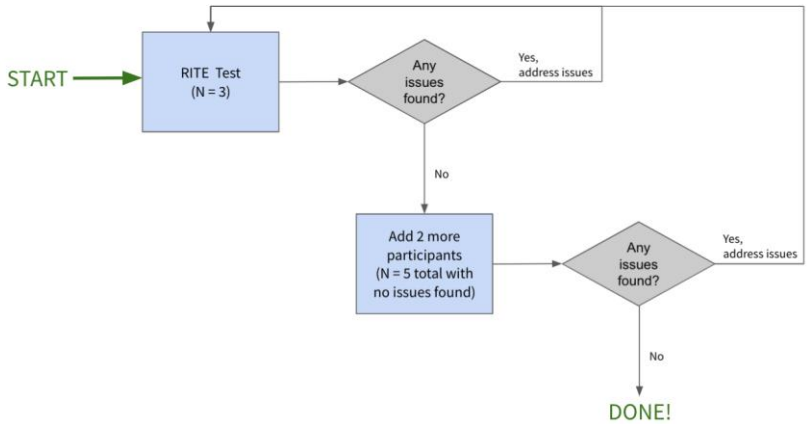


Image 5: Rite study approach
(https://about.gitlab.com/handbook/engineering/ux/ux-research-training/rite/)

Three participants per iteration are enough because running more iteration increases the number of participants and by then most usability issues will be found. Even if no new issues are found in the iteration it is recommended to add two additional participants to be sure all problems are discovered.

The RITE method can be very beneficial. Some reasons are: consistent and iterative user feedback is gathered, problems can be found early in the testing phase, a small number of participants are needed so the sessions are fast, and the team focuses more on the product's usability. On the other hand, the method is not good for finding complex usability issues, concerns about product definition or user motivation. Also, RITE requires a lot of commitment and involvement from the product team to be successful. [22]

## 5. Desirability (preference) testing

Desirability testing is an UX research method for discovering user's impressions towards a design or product. Aesthetic or emotional appeal of the design conveys specific message to users. Users' perception can show if this message aligns with the brand personality. Desirable product attracts users to interact with it and explore its features. Functional desirability serves important features and intuitive interactions and should be distinguished from emotional desirability which gives the look and feeling. Gitte Lindegaard and his associates found in the research that it only takes 50 miliseconds for a user to form an emotional opinion of the design. This shows how important visual design can be because of the „Hallo" effect. Users' first impression of a perceived design can influence their overall opinion of the product. Visually appealing design can make users ignore or forgive some negative aspects and be perceived as more usable. [24]

Asking users whether they like the design can give superficial and not very useful results to researchers. A better approach could be visual testing and measuring their reactions with open-ended or structured techniques. In an open-ended approach users

explain reasons behind positive feedback of a design or can describe the design with 3 to 5 words. On the other side, in a closed approach there is a list of terms they choose from. Another example of more structured method is numerical ranking of specific brand trait. [25]

Some of the methods for assessing desirability are: triading, impression tests, reaction cards, markup tests or tests that measure physiological activity. In triading approach participants are asked to select two design options out of three that they feel are different. The goal of this study is to see which attributes participants use to compare different designs.
In impression test or “5-second test” participants have 5 seconds to view the design and afterwards explain what has influenced their first impression and what information they have remembered. This test is used to check if the design conveys a clear and strong message at the glance.
Reaction cards by Microsoft is an approach of measuring desirability with cards with different adjectives where the participants can select the ones that apply to design.
The markup test requires from participants to examine the design and add different indicators like badges or colors to show which elements are understandable and good and which not. It is also important to prompt participants to think-aloud to understand why they have marked specific elements and after the test heatmaps can uncover designs' weak spots. [26]

## 5.1. Microsoft Desirability Toolkit

Microsoft Desirability Toolkit also familiar as Microsoft Reaction Cards is a method used to determine users' emotional attitude toward visual aspects of the product by using cards with chosen reactions that according to user’s perception best describe the product. Joey Benedeck and Trish Miner created a list of 118 both positive and negative words that describe a product. After showing an interface to the users they choose 5 cards which best describe it. Defined list of words needs to have target brand traits along with opposite and neutral choices. Gathered data can show researchers whether chosen adjectives align with desired emotions and brand attributes. This method can be

done in a one-on-one environment or as a survey. One-on-one method can give qualitative data like explanation of chosen words and additional insights whereas survey offers quantitative data since a lot of responses can be gathered. [27]

The full list of product reaction words is large and covers a lot of possibilities and that's why it needs to be adjusted with having following considered:

- Words needs to be chosen based on the goal of the study. List should have words that describe brand personality so it's important to add new ones that may not be on the general list.

- Since the goal is to measure visual appeal of the interface words that relate to functionality or performance should be removed (like "Hard to use" or "Too technical")

- List should have around 25 or less words to reduce the load and help focus on only essential words. Also, the order of words should be randomized for each user.

- Words should be negative, positive and neutral. This is important to get unbiased and real results from participants ensuring they are not influenced to select positive traits because there are for example no negative ones. Benedikt and Miner suggest having 40% of negative words.

- Participants can do the test by observing screenshots. There is no need to use the product because some functionality or content could catch a lot of unnecessary attention since that is not what is measured. [27]

Data can be analyzed by defining most-selected words in percentages. Also, Venn diagram can be used to present which design direction follows participants' responses, how different designs are described, or how different user groups perceive design. Results can be also presented by showing a percentage of users that described the product with at least one of the desired brand qualities.

Preference testing is natively subjective and it can be coupled with other methods like interviews or questionnaires to get valuable insights into reasoning behind participants' choices. If matched with A/B testing or behavioural analytics, more quantitative data can be gathered. [27]


Image 6: Microsoft reaction cards
(https://wordsevaluation.azurewebsites.net/welcome.html)

# III. EXPERIMENTAL PART

## 6.1. Methodology and testing plan

In the experimental part of the thesis data gathered from different usability testing methods are used to measure apps usability. Testing is done on the Nevera mobile app for a remote control of a vehicle. The design expert assesses the app against common guidelines to spot areas for improvement. Results from this heuristic study help define user tasks for usability testing. In usability testing target users use the app to work on assigned scenario tasks to uncover possible problem areas in the app. Qualitative data like user's feelings, comments and actions are going to be filled with quantitative data like task success rate, time on task and SUS score. Lastly, the desirability of the app's interface is tested. After gathering all these data, the design team can see the app's weak points and places for improvement by different severity. Based on that it can be decided what problems are critical to fixing or if the app will be hard and frustrating to use and which are only surface issues that would be nice to fix. After determining the problems that are going to be fixed a redesign of this elements can be presented. Tools used for testing are:

- Microsoft Word - heuristic evaluation
- Microsoft Word, screen recording, voice recording - usability testing
- Google forms - desirability testing.

## 6.2. Goal and hypothesis of the testing study

Primary goal of the study is to access the apps' usability with heuristic evaluation, usability, and desirability testing. Moreover, the aim is to get a full picture of the app's status, target visual or functional inconsistencies and weak points which could influence the usability of the app. Lastly, to learn about the target user's behaviour and preferences.

The analysis is used to identify apps' common usability issues so that the problems can be resolved, consequently improving the user's satisfaction and experience, and raising the chances of a product's overall success.

Based on the research goals following hypothesis has been set:

- Heuristic evaluation is going to uncover possible usability issues and propose solutions
- Usability testing is going to confirm if the issues found in the heuristic study are real issues. Also, qualitative, and quantitative data are going to show users' satisfaction and reveal additional problems
- Desirability testing is going to show users' attitude toward the visual style of interfaces.

Defined hypothesis is going to be tested through the analysis of collected testing data.

## 6.3. Nevera mobile application

The mobile app is an extension of the vehicle's infotainment system allowing users to manipulate the vehicle and preview its data at the desirable moment without the need to be near the vehicle physically.

With the purchase of the Nevera vehicle, customers get exclusive access to the companion Nevera mobile app, available on iOS and Android. The mobile app allows the users to manage and inspect the state of the vehicle at any moment. It communicates through connectivity with the vehicle to display the vehicle's state and near real-time values. Also, it enables users to use remote commands to control the vehicle or analyze historical data of vehicle usage.

### 6.3.1. Features

First time entering the app the user must go through the 2FA authorization process. To complete the registration process, the user must activate a passcode or a biometric authentication system to enable secure app usage. After the successful login process user is redirected to “My car screen”. In case the user owns multiple Neveras he will prior be able to select one and then enter the “My car” screen.

The Nevera app has 5 sections and a side menu. From the side menu, users can access different app sections (Image 7): User profile (A), Garage (B), Vehicle specifications (C), Services (D), Support (E), Software update (F), Settings (G) and Logout option.

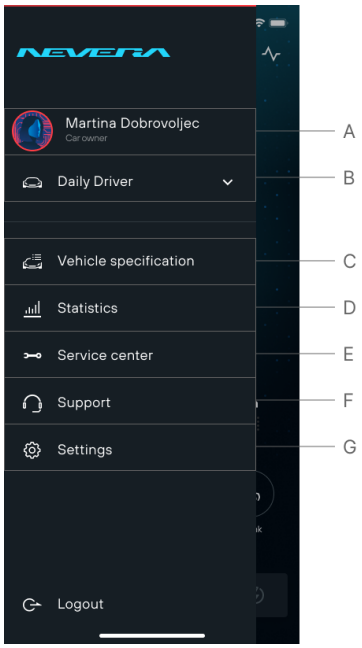


Image 7: Side menu options of the Nevera app

In the User profile section, the user can view his personal information like First name, Last name, e-mail, and phone number and change display name and avatar image as preferred.

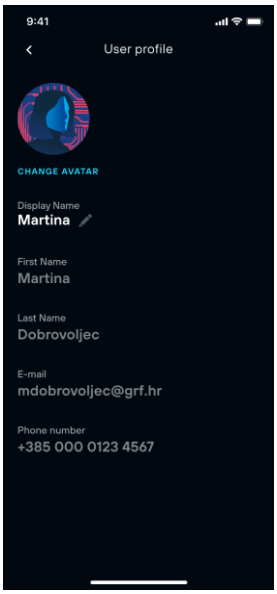


Image 8: User profile screen

In the Garage, the user can see all his vehicles with their name, VIN number and current software version. Users can rename the car, copy the VIN number or update software to the latest version.


Image 9: Garage screen

In the Vehicle specification section, users can view general specifications about each vehicle component like performance, chassis, powertrain, battery, aerodynamics, safety, ADAS and dimensions.


Image 10: Vehicle specification screen

In the Statistics section user can view a data summary of his driving activity like odometer, max driven speed, overall driving time, number of drives, average energy consumption, number of launches, acceleration during the launches, time spent changing, total energy regenerated, and energy charged.

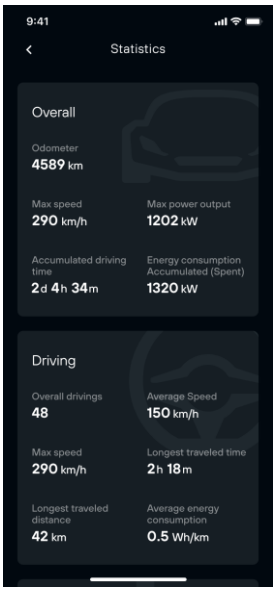


Image 11: Statistics screen

In the service section users can find nearby vehicle service locations, contact the service or navigate to it using an external application. On the Support page, users can see the location of Rimac Automobili and contact email to directly reach out for support.

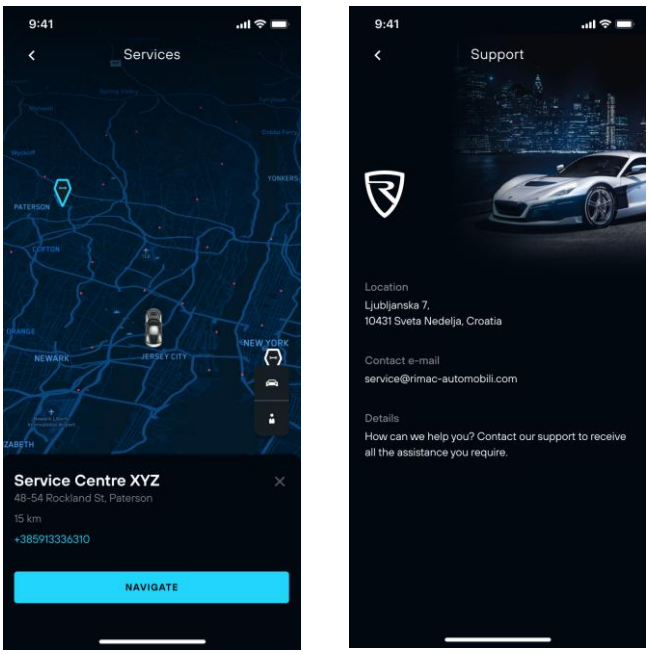


Image 12: Services screen (left) and Support screen (right)

In the settings section, the user can customise the experience by changing language, unit format or setting notifications about different vehicle events. Users can also view the User Manual, Terms of use, Privacy policy, and app details.

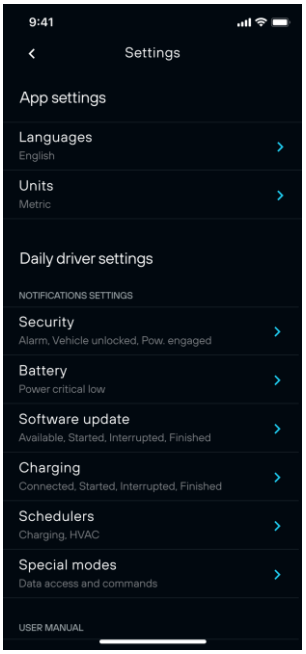


Image 13: Settings screen

The bottom navigational bar has 5 options: My car, Driving activities, Map, Climate and Charging. My car screen is the first segment where the user lands after the login process. The interface of My car screen changes depending on the vehicle's state. The vehicle can be in three states: parked, charging and driving. According to the state, the user will get the most relevant data and controls on the My car screen.

In the parked state user see (Image 14) vehicle state (A), current vehicle location (B), current battery state of charge with range left with the current state of charge (D) and use controls like keyless driving (C), lock/unlock the vehicle, blink&horn, open trunk (E), control lights (F) or rear wing position (G).

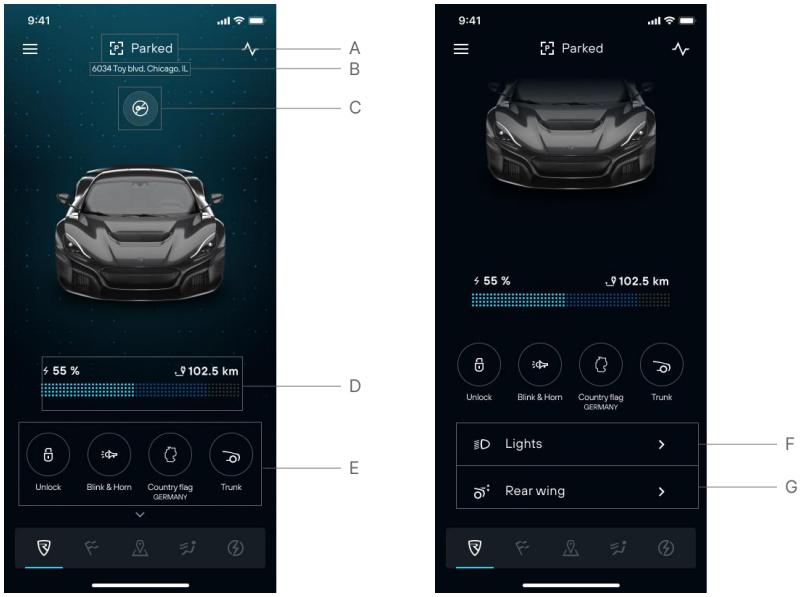


Image 14: Interface elements on My car screen in parked state

In the charging state besides from mentioned user has a charging widget with information about charging status, time until fully charged and the option to Start/Stop charging control.

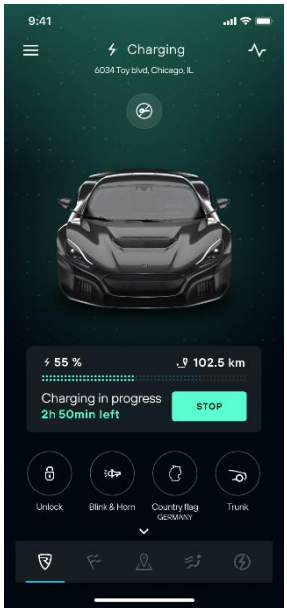


Image 15:  Interface elements on My car screen in charging state

While driving, the user cannot remotely use controls like unlock, blink&horn, trunk or keyless driving. Instead, the user can preview current data like speed, power output, travelled time from the start of the ride and range left with the current state of charge.


Image 16: Interface elements on My car screen in driving state

Regardless of vehicle state users can check vehicle health status by clicking on the right icon in the top bar. It provides information about vehicle security and physical components' health. The vehicle is secured if it has closed doors, windows, frunk and trunk. In that case, the “Car secured” indicator is visible above the vehicle visual. Health status can be OK, Warning or Error. By scrolling down users can see a list of physical components with information about technical warnings and errors.


Image 17: Health status screen

Besides these main controls, on scroll users can start valet mode, preview current car location, last driving activity and some statistics.


Image 18: My car screen on scroll

Driving activities is the second section of bottom navigation where the user can see (Image 19) a preview of all past driving activities (A) and a list of each activity (B).

Each activity is presented with a card (Image 20) containing information about the starting date and time of an activity (A), indicators of special modes (B), route preview (C), and trip summary data like travelled distance, duration and energy consumed during the drive (D).

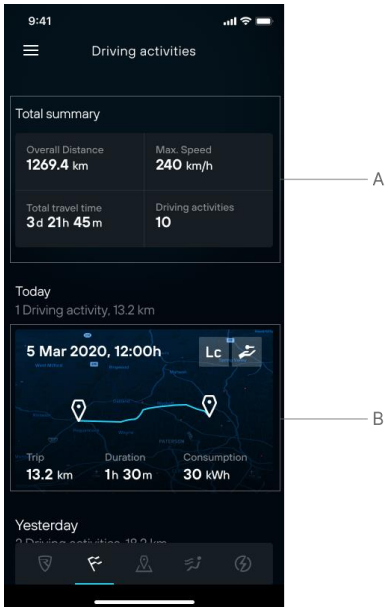


Image 19: Driving activities screen

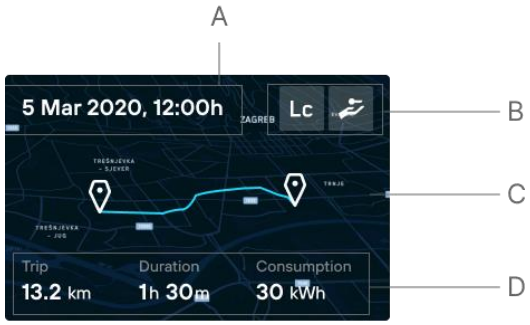


Image 20: Sessions card

By clicking on the desired activity card user will get a detailed summary with more information like route driving time, maximum speed, average speed, accumulated driving time and energy consumption.


Image 21: Summary information of a session

Users can also analyze data in depth with different values (Image 21) from the vehicle to compare, like speed, lateral G, longitudinal G and power through time., like speed, lateral G, longitudinal G and power through time. Graphs data can be changed by clicking on the “Change data set” button where the user can select one of the predefined sets or create a custom one. Also, the user can hide or reveal each data set by clicking on a graph legend. By scrolling the page user can see each graph individually displayed.

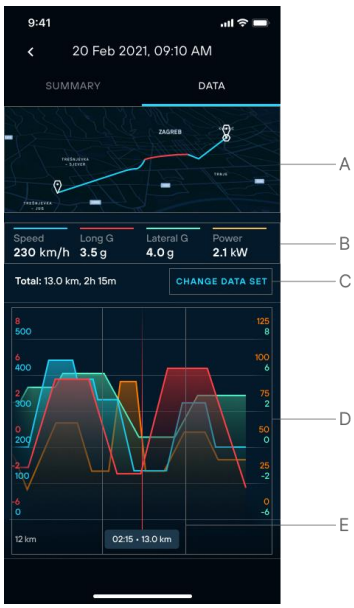


Image 21: Data tab of a session

On the map (Image 22), the user can see its (E) and vehicle's current location (D), and search for a location (A) of choice from predefined points of interest like home address, chargers, racetracks and service centres (B). Individual or multiple locations can be sent to a vehicle to start navigation from there or externally navigate to a location by using Google or Apple maps (Image 22).

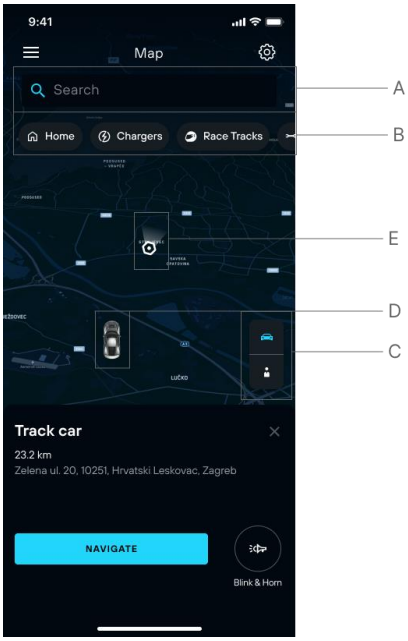


Image 22: Map screen

The climate section (Image 23) allows the user to adjust the seat heating separately for the driver (A) and the passenger seat (C), demist the windshield (B) and remotely control the heating, cooling and air conditioning of the vehicle (D). Users can also set a scheduler that desired preferences are met for the drive (E).

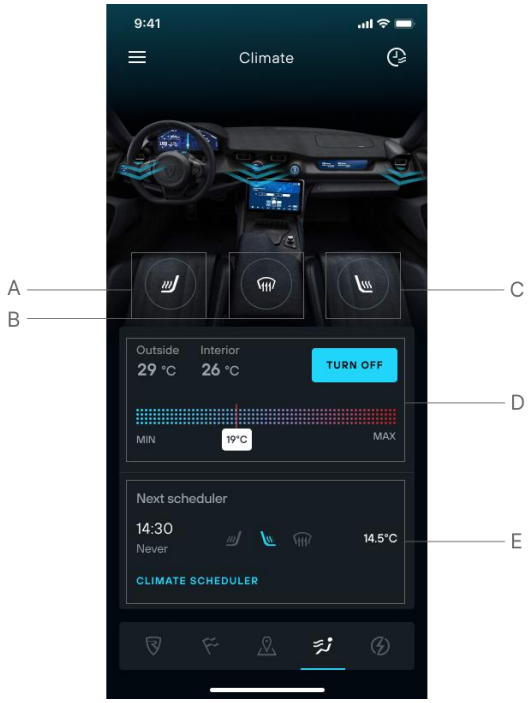


Image 23: Climate screen

In the Battery section (Image 24), the user can remotely set up the charging current, charging limit, start or stop charging, and unlock the charging port. Users can also see charging status (charging in progress, completed, stopped, error), charging speed, voltage, and charging stations near the vehicle location. Charger location can be sent to the vehicle to enable navigation to the station. During AC-charging user can set and control the charging current and charging limit, and during DC charging only change the charging limit. During AC-charging user will see the charging current, charging speed, charging power and charging voltage, and during DC-charging charging current is not presented.

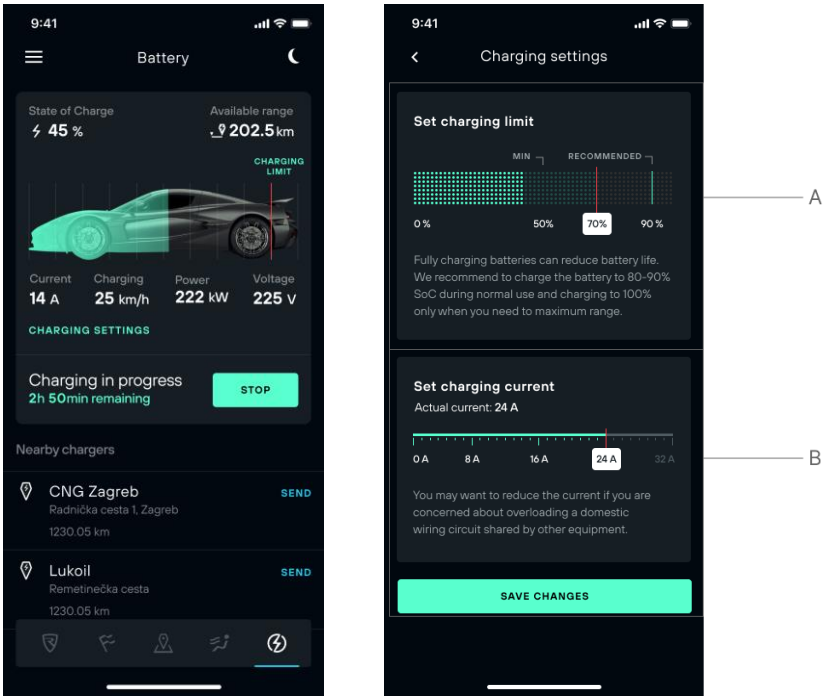


Image 24: Battery screen (Left) and Charging setting screen (Right)

## 6.4. Target users

Understanding customers and their needs is essential to creating exceptional products. User personas help a product team to match user expectations and demands with the final product and benefits minimizing user concerns and frustrations. By listening to users and satisfying their needs, the experience with the product will be pleasurable, and users will always come back.

Nevera app users are vehicle owners. They seek exclusive, unique, usable mobile app that makes them feel empowered and in control. In the images below are described two user personas.

The primary persona is Lucas. He represents an archetype of a thriving athlete with a passion for cars. A more detailed description of the primary persona:

Lucas is a professional athlete for an international club with a love for collecting cars. His day consists of multiple training a day. Between the training, he is attending press conferences and job-related events. He is a car collector and prefers unique pieces. In

his collection are 30 luxury, exclusive, exemplary performance, and personalized cars. Each car is handpicked art piece and a status symbol.
Having a healthy lifestyle is very important to him. He likes to spend his free time experiencing the cars, travelling in one of his private yachts and staying on personal properties with friends and family.
He is present on social media and has a few million followers. Among endorsement deals with famous brands, he promotes products from his brands.

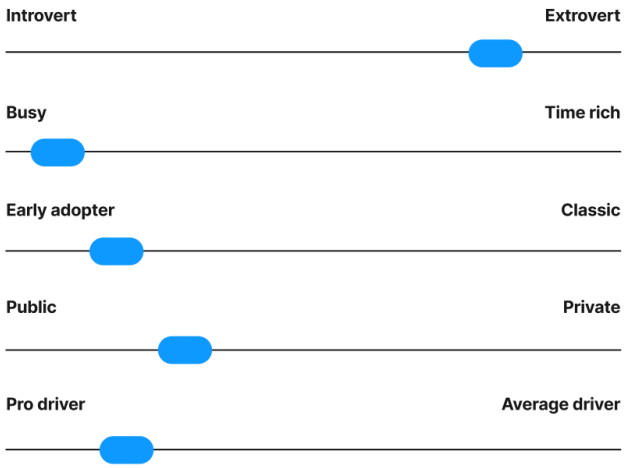


Image 25: Personality traits of Primary persona

Interests of primary persona are to improve athletic skills, buy luxury items, invest in real estate, assets and cars, collect exceptional, breathtaking cars with top-notch specs, enjoy life, spend time with family and friends and maintain an indulgent lifestyle.

Primary persona needs and expects to deliver the best performance during a game/match, be surrounded by reliable, trustworthy people and brands, have highly professional service, exclusive access and groundbreaking experience and expect fleet managers to prepare all cars for the drive.

The motivations and goals of primary persona are to be the best athlete in the class, sign supreme sports contracts, endorse deals and business investments, own a highly functional, aesthetically pleasing and emotion-evoking pieces. He aims for luxury, power, uniqueness, and effortless craftsmanship of the vehicle.

Pain Points/Frustrations of primary persona are to deliver a poor performance in a game/match, conduct an unhealthy lifestyle, not be at the top of the category, waste time, have poor service and disrespectful behavior, and not be praised and admired.

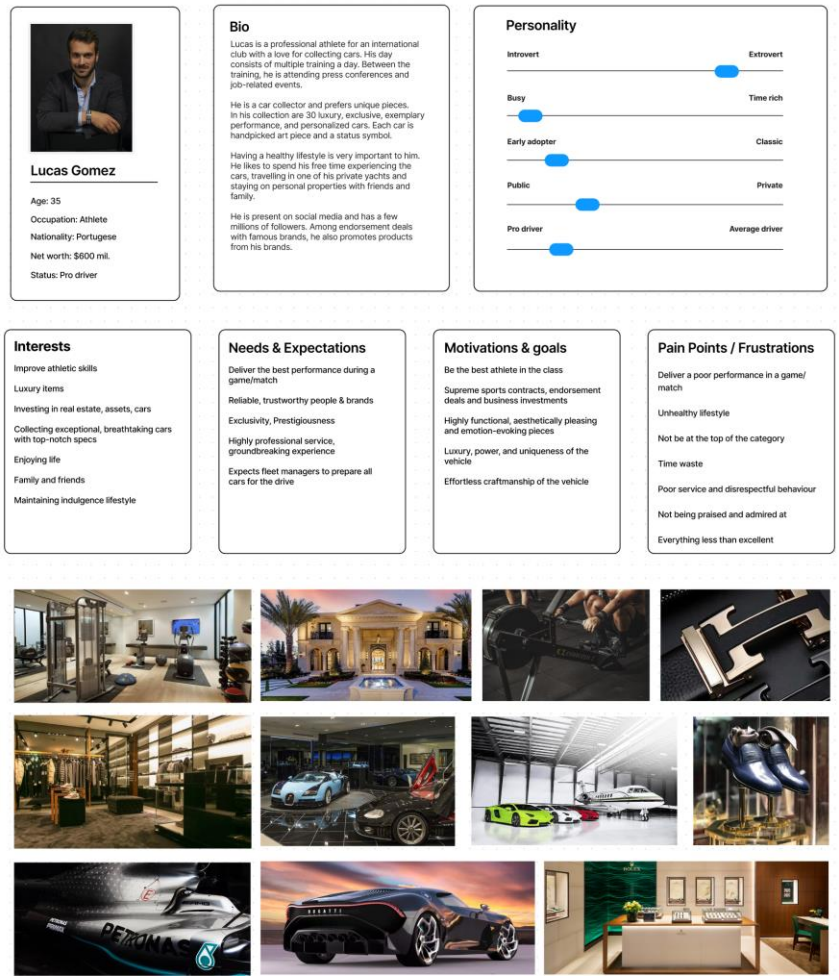


Image 26: Primary persona profile

The second persona is an archetype of the visionary entrepreneur. John is a businessman, investor, philanthropist, and car and technology enthusiast seeking special driving experiences. A more detailed description of the secondary persona:
John is the CEO of multiple companies concerned about emerging technologies and sustainability to create a better, more equal, and prosperous world.
He works on different businesses and side projects simultaneously, so time efficiency is essential. Work is what drives him, and cars are his passion. In his garage are only

special pieces from which recently high-performance hypercars. He is a car nerd paying attention to details, but his driving skills are average.
He likes to attend technology conferences and car-related events. He is a visionary who enjoys technological advances but also values the quality and craftsmanship of classics.

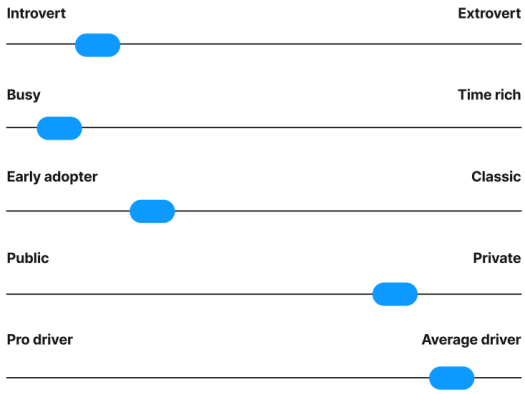


Image 27: Personality traits of Secondary persona

Interests of secondary persona are technological progress (VR, AR, MR, apps, gaming), sustainability, smart investments, racing, drifting, yachting with friends and car events. John is also interested in hybrid and electric engines, collecting supercars and following the supercar market, news and deals.

Secondary persona needs and expects to finish tasks quickly & efficiently, have the best and newest technology, high-quality products, and pay attention to details. He expects fleet managers to prepare all cars for the drive, to get the desired car immediately, know the car's status at any point and preview specific driving data.

Motivations & goals of the secondary persona are technology advances for better social and economical benefit, short-term returning investments, creating a climate-neutral environment, great life experiences, and exclusive and trustworthy brands. He also strives for intuitive, exceptional interfaces and exciting and fun experiences. His ultimate goal is to have the best supercar collection.

Pain Points/Frustrations of secondary persona are not to be the best version of himself, have memory load and low attention span. Also, plain, ordinary and overcomplicated things and experiences frustrate him. He is also annoyed by poor quality and usability, car waiting lists, car malfunction, low car battery and bad car-mobile connectivity.

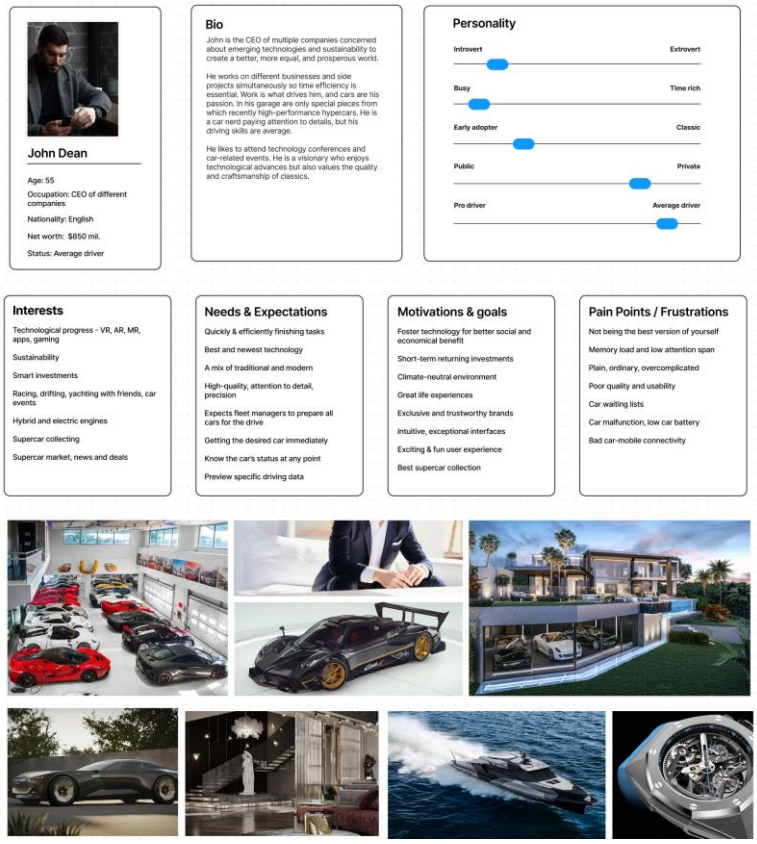


Image 28: Secondary persona profile

## 6.5. Conducting the test: Heuristic evaluation

### 6.5.1. Heuristic evaluation methodology

Heuristic evaluation of the Nevera mobile app was conducted in the Bugatti-Rimac office. Phone was used to record audio and laptop to fill out the heuristic template. Test facilitator was guiding participants and capturing data. Design experts from the UX/UI field with at least 5 years of experience were recruited from different digital companies in Zagreb. Some participants were reached out from the in-house Design team and some via LinkedIn. The ones who had enough experience and were willing to contribute were asked to come to the office.
Each individual session lasted approximately 90 minutes. During the session, the facilitator gave an introduction on the Nevera app, its functionalities and target personas. Evaluators were asked to give their honest opinion. While using the app participants were giving comments where the issues with the interface were coming from. Evaluators were analysing the app against evaluation guideline which had the list of heuristics and appropriate questions for each heuristic. This helped them frame what to look after while using the app.
After interacting with the app, they clearly pointed out patterns which had been used in the app and had been causing problems, inconsistency as well as satisfaction and pleasure. After discovering the issue evaluators could also give suggestion how the problem areas could be fixed.

Five participants were scheduled over five testing dates. Of the five participants, three were male (60%) and two were female (40%). The pool of testers was comprised of young adults, aged 25-35. The job roles of the participants were as follows:
In-house:

- 2 senior UX/UI designers (40% of testers)

External:

- 1 Product Design Director (20% of testers)
- 1 UX Researcher (20% of testers)
- 1 Head of the Design department (20% of testers)

### 6.5.2. Metrics

The results of the heuristic evaluation are presented in the following format:

- Discovered problems
- Severity of a problem: 5 levels; 0 - no usability problem, 1 - cosmetic problem, 2 - minor usability problem, 3 - major usability problem, 4 - usability blocker
- Evidence that supports the problem
- Recommendations

### 6.5.3. Used Heuristics

Participants were evaluating the whole app according to 10 heuristics. Each heuristic had short description, follow-up questions to help the evaluator know what he needs to look after and recommendation section to give suggestions how they would improve the experience. Heuristics chosen for the testing were adapted Nielsen-Molich heuristics. They were chosen considering the specific use cases and the nature of the app.

The following heuristics with follow-up questions were used in the testing:

1. Visibility of system status
    - Is there some form of feedback for every user action? (e.g. success or error message, new screen, visual/textual change of the UI element, selection, pinch)
    - Is continuous communication between the user and car established? (Car response to a user action - action has been completed, the system is in progress, the system is waiting for additional user action)
    - Is the navigation placed at noticeable position?
    - Does the user know the current state of the UI element? (e.g., enabled/disabled, selected/not selected, on/off)
    - Is it clear which element is selected and which can be deselected if possible?

2. Match between a system and a real world
    - Are user expectations what will happen when they act met?

- Do menu items/functions fit logically into the same meaningful category?
- Do buttons with similar names or appearance perform similar actions?
- Is the language/tone of the voice used in the app appropriate to users? Are icons, shapes, and images clear, informative and familiar to the user?

3. User control and freedom

- Can the user move backward and forward among sections in the app?
- Are close, exit and cancel signs clearly labelled and positioned so that the user can easily find them where they expect them?
- Is the user aware where he is and how he can navigate?
- If the app displays overlapping windows, is navigation between windows simple and visible?
- Is there an “undo” function for a single action, data entry, or group of actions?

4. Consistency and standards

- Are headings, navigational items, and call-to-action buttons consistent across the app?
- Is the placement of modals and buttons inside consistent? Are controls used the same way, and do they mean the same thing, in all parts of the app?
- If user input is required are industry standards used that the entry is prior formatted?
- Is the font size legible and number of fonts balanced?

5. Error prevention

- Does the app offer contextual suggestions? (e.g. search suggestions)
- Does the app have good defaults? (especially when users have to perform repetitive actions, or in situations where they need to use precision)
- Does the system prevent users from making errors whenever possible?
- Are touchable areas sufficiently big? (both visible and invisible space that if a user hits will still count)
- Is crowding targets avoided?

6. Recognition rather than recall

- Are prompts, and messages placed where the eye is likely to be looking on the mobile screen?
- Are the relationships between controls and actions apparent to the user?
- Are sections separated by spaces, lines, color, bold titles, or shaded areas?

- Are size, underlining, color, shading, or typography used to show importance of different screen items?
- Is white space used to create symmetry and lead the eye in the appropriate direction?

7. Aesthetic and minimalist design

- Is only information essential to decision making displayed on the screen?
- Are labels brief, familiar, and descriptive?
- Is layout clearly designed avoiding visual noise?
- Does the use of images and multimedia content add value?
- Is there good color and brightness contrast between element and background colors?

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

- Are error messages worded so that the system, not the user, takes the blame?
- Do messages place users in control of the system?
- Do error messages suggest the cause of the problem?
- Do error messages indicate what action the user needs to take to correct the error?
- When signaling an input error in a form, is the text box that needs to be changed specifically marked?

9. Help and documentation

- If menu choices are ambiguous, does the system provide additional explanatory information when an item is selected?
- Is there context-sensitive help?
- Does the app provide the user with an interactive help?

10. Pleasurable and respectful interaction with the user

- Are the app’s gestures intuitively discoverable?
- Does the mobile app’s UI provide an alternative method of interaction in the case if the primary method failed?
- Are mobile app's UI elements placed at a comfortable and ideal position?
- Has the system an intuitive GUI?

### 6.5.4. Executive summary

After completing the heuristic evaluation of the Nevera application, seven problem areas that violate usability principles have been identified. These problems have been prioritized below, with their severity levels. The Nevera app has the most of usability problems in the area of “Visibility of system status”, “Match between the system and the real word” and “Consistency and aesthetics”. Map interactions violated heuristic “Match between the system and the real word” with a severity of 4, which means they are a usability blocker and an imperative to fix this before app release.

Problem areas that were found are:

1. Lack of feedback for user’s actions and unclear states of interface element
2. Actions and interface elements give unexpected results
3. Exit options are not prominent enough
4. Inconsistent actions create friction in the experience
5. App tends to create error-prone conditions without offering help
6. Certain actions require recall rather than recognition
7. Interface needs visual refinement.

Results presented by findings:

| Problem | Severity ranking | Heuristic violated |
|---|---|---|
| Lack of feedback for user's actions and unclear states of interface elements | 3 | #1 |
| Actions and interface elements give unexpected results | 3/4 | #2 |
| Exit options are not prominent enough | 2 | #3 |
| Inconsistent actions create friction in the experience | 3 | #4 |
| App tends to create error-prone conditions without offering help | 2 | #5, #9 |
| Certain actions require recognition rather than recall | 2 | #6 |
| Interface needs visual refinement | 3 | #7, #10 |

Table 1. Findings from Heuristic evaluation

### 6.5.5. Problem one: Lack of feedback for users' actions and unclear states of interface element

While interacting with the app and trying out features evaluators noticed that some of the functions don't provide feedback after action, so the user can be confused if the action is executed or there is a bug. Moreover, some actions resulted in visual change of interface, but only barely noticeable. Also, the response time was not always appropriate to the action. This can be frustrating since the user does not know the status of controls when he isn't near the car and even  if his actions are successfully accepted and executed by the vehicle.

Another setback is that the state of the different interface elements isn't always clear, therefore it is misleading if the interaction with the element is possible or not.

Mentioned problems violate the heuristic “Visibility of the system status” which states that the design should always keep users informed about what is going on, through appropriate feedback within a reasonable amount of time. Most of the problems were ranked with a severity of 3, which indicates they are bigger usability problems important to be fixed.

Problem can be confirmed on screens and elements mentioned below:

On My car screen the Cravat lights command doesn’t provide any feedback. After pressing the button it is not sure if something has happened and what should happen because there is no visual feedback on the car visual like on other commands (e.g. Lock/Unlock, Blink & Horn, Trunk). By clicking the “Blink & Horn” command for example the user can see lights and lines animation on the car visual stating that the command is executed.

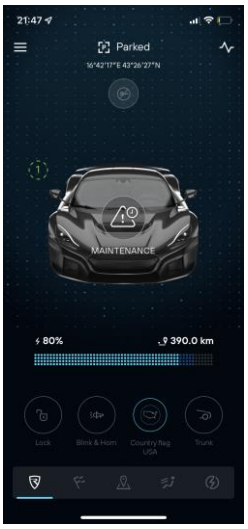


Image 29: No visual response on the car image (1) while executing Country flag command on My car screen

When the user press and holds the "Keyless Driving” button, for example, there are three competing areas of feedback and thus user attention (Image 30):

1) Keyless Driving button

2) Car visualisation

3) Disabled controls (Lock, Blink & Horn, etc.)

This is confusing for the user and indicates that multiple things are occurring when in reality it's just one.

Another issue is that the feedback for some of the commands on the My car screen is presented on the car visual, which is the center of the screen, then follows a bar that shows the current state of charge and available range for it and afterwards commands. This bar, which is just informational, creates friction between the command and the feedback because the user has to press a command at the bottom of the screen and then pass the bar to come to the top of the screen to see if something is happening.

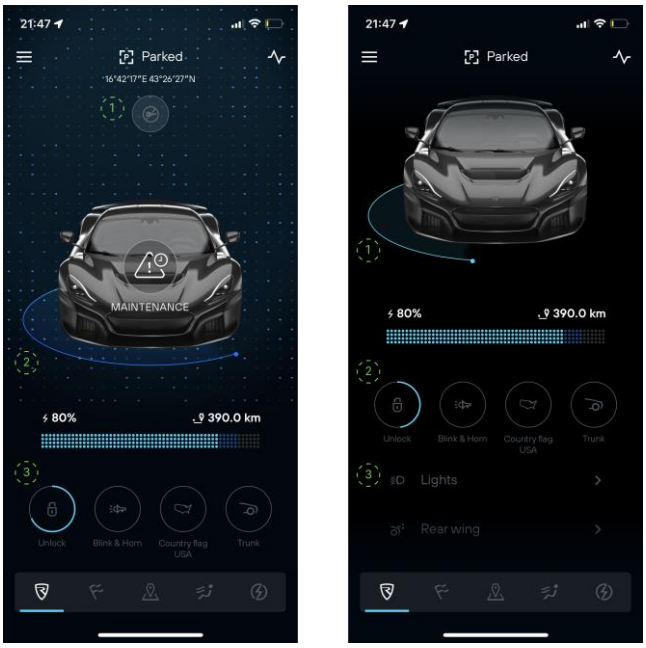


Image 30: Three areas of feedback for Unlock command on My car screen: Keyless driving (1), press & hold indicator (2) and disabled controls (3) on left; press & hold indicator (1), disabled controls (2) (3) on right

To execute the command, it is required to long press the button, which in the beginning when the users are still excited is maybe fun, but after using it for some time they can be annoyed because the goal is to do the desired action quickly.

States of the mentioned buttons are inconsistent (Image 31) and therefore give users the feeling of uncertainty. For the Lock button, the icon changes from Default to Active and

the label changes from "Lock" to "Unlock" depending on the state. On the other side, on the Trunk button, the icon colour also changes depending on the state of the trunk, but the label does not change. There shouldn’t be these types of inconsistencies on buttons which appear to afford the same type of function.

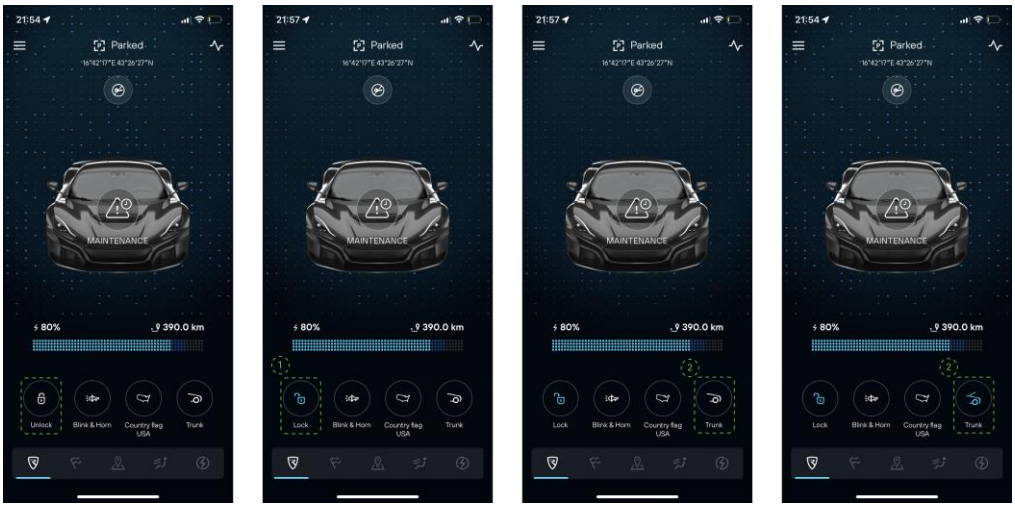


Image 31: Active state of “Lock” button (1) doesn’t follow the same logic as for “Trunk” button (2)

When the user has turned on the Lights or raised the Rear wing and exits from detailed page to the My car screen, the icon changes from Default to Active colour to indicate that they have selected an option, and the car visual accordingly changes. However, from the list item the user is not informed about what selection has been made.

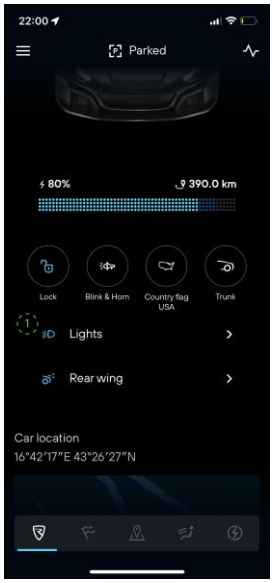


Image 32: No information of selected state in this view

Inside the Garage screen, after pressing the "Update software" button there is no feedback if the action has proceeded. Also, by clicking on a 3-dot menu (Image 33) and copying the car's VIN number there is no feedback if the number is copied. After pressing multiple times on different spots inside the vehicle card, the evaluators noticed that the user can enter the app only by clicking on the car visual element.

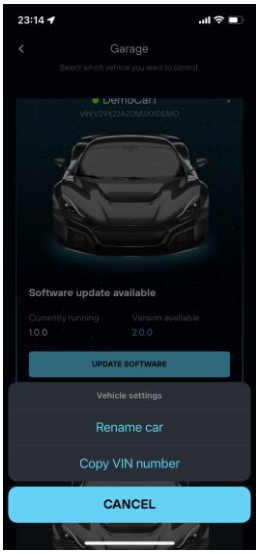


Image 33: Action sheet in Garages vehicle card

On the Map screen, there is an “i” button that should provide additional information about the map, but it doesn’t give any information after pressing it. Also, by pressing on the vehicle icon (Image 34) that is intended to track the car, zooming in to the car’s location takes too long and it is a bit frustrating. On the other side, while clicking on track the user function, the zooming animation is quick, and fluid as expected. Another issue is that there is no selected state of the pin on the map. After pressing on it, the bottom sheet opens but the icon style remains the same.

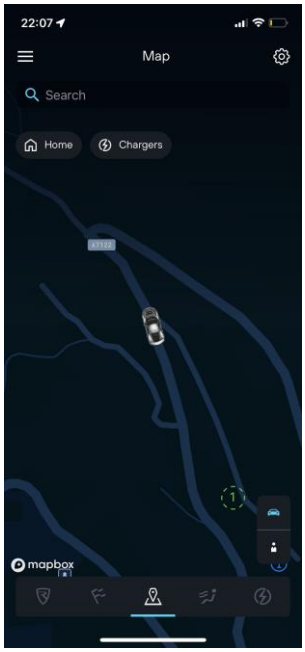


Image 34: Tracking the vehicle activated (1)

On the Climate screen, after updating the climate scheduler there is no response if the changes have been made.
Also, if the user turns on the demist, he cannot change the climate temperature inside the car. The message stating that isn’t noticeable since it’s not connected with the button (Image 35).

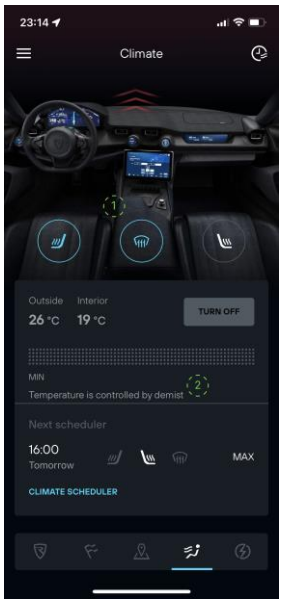


Image 35: Active demist (1) and related message (2)

Selected states of the climate commands have the blue stroke on the circular button and on the My car screen it doesn't, even though the buttons look the same. Also, after pressing the Seat heating command, the states are not clear, because it looks like it goes from on to off and then on.

While changing the country inside the Country flag tab on the Lights page, it is not clear which item is selected, because the play icon is confusing (Image 36). It looks like a chevron, and it is unclear if the user can make a selection or preview the animation. The outcome of the action is not clear. Regarding the consistency, the icon next to the country label doesn't change colour like on the rest of the commands on the My car screen.

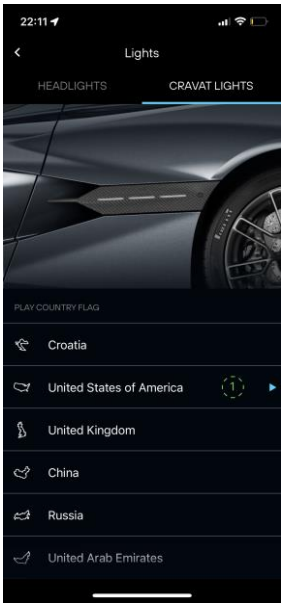


Image 36: Selected state of a Country flag list item (1)

On the Charging screen, some evaluators lacked an animation which would confirm that the car is in the state of charging. A piece of information stating that car is charging is somewhere in the card among a lot of other information.

Another issue found is that after pressing the “Unlock charging port” button there is no feedback.

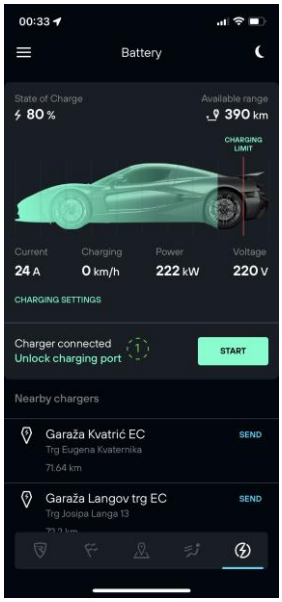


Image 37: Charging card with charging state and “Unlock charging port” button (1)

Evaluators suggested making bottom tabular navigation bigger. Multiple navigation options tend to confuse since the user has bottom tabular navigation, hamburger menu and shortcut options on the My car screen.
The app is usable, however, certain navigational elements (hamburger menu, settings button, etc.) are easy to overlook because of their visual style. There is not enough distinction between navigation elements and page contents.

Evaluators recommended the following:
Solution to these problems is to troubleshoot mentioned issues with the developers and the vehicles to see where the app is not working as expected and design assistance is needed. There should always be some kind of feedback after the user's action, so he doesn't feel like tapping in the dark. The interaction patterns/feedback on the buttons should be reconsidered (e.g. Lock, Blink & Horn, etc.). Also, action and its result should be clear without having any doubts or obstacles.
The long press gesture could be used for critical actions or to override the previous state. Another suggestion is to animate the car visual so the car turns when the trunk is opened.

Moreover, it should be evident in which state the button is, so the user is aware of the action it can do. Chosen style and logic of button states should be consistent throughout the app and with enough prominence that the user can't misinterpret them.

On the Garage screen for example, if the VIN number is copied, the snackbar should be displayed in the app saying, "Copied to clipboard".

Labels on the graph can have the same colour, some will be static and some dynamic, but the same colour style should be used through the app.

On the Climate screen, while clicking on the seat heating icon bottom sheet can be opened as it is the iOS pattern.

### 6.5.6. Problem two: Actions and interface elements give unexpected results

People expect that system work naturally, as the things behave in everyday life. A lot of assumptions also come from the devices and apps used in the past and patterns that are common to the users and therefore seem effortless. Besides from the actions, visual elements like shapes and icons should have clear meaning to the users. Evaluators noticed that expectations they had toward some interface elements are not met because of the misleading visual cues used in the app and some platform standards that aren't followed. Inconsistency is also a problem that confuses and makes the wrong impression towards the interface.

This relates to the heuristic "Match between a system and the real world", saying the design should be familiar and understandable to users. Issues found in this section are ranked with severity of 3 and 4, which means there are bigger issues and usability blockers that need to be fixed. Evaluators ranked problems found on the map as usability blockers that need to be fixed.

Problem can be confirmed on screens and elements mentioned below:
After opening options menu on the vehicle card in the Garage screen (Image 33), evaluators expected to close the action sheet by clicking on the background overlay which wasn't the possibility.

In the top bar of My car screen beneath the car's state, is the information of the current car's location (Image 38). Evaluators tried to click on it and expected to be navigated to the Map section. While clicking on the Car location card, evaluators expected to be redirected to the car's location on the map with some additional information. The same behaviour was expected by clicking on the Driving activity card.

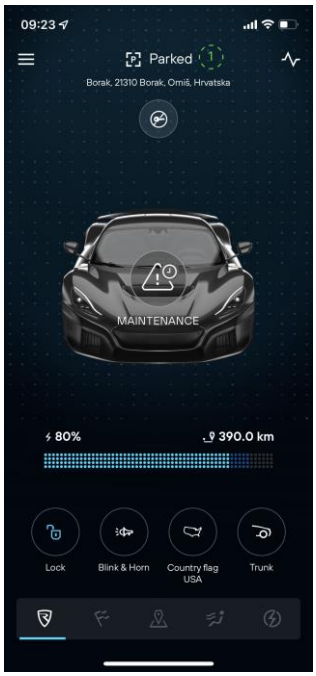


Image 38: Current car state and location on My car screen (1)

Before interacting with the “Keyless driving” button, evaluators had the impression it looks like a status indicator and not a function.

On My car screen is a row of commands in the following order: Unlock/Lock, Blink & Horn, Country flag and Trunk. Country flag command which plays an animation on the vehicle cravat lights is an entertainment function placed between functional ones. Evaluators would reposition the Keyless command to the other functional ones and put the Country flag as a separate function.
Cravat light options in the Lights section have a list of available countries to choose from as the desired animation (Image 36). “Play country flag” label and blue icon on the selected list item gave the evaluators the impression that there is only a preview of the animation and not also the selection of it.

Inside a particular session, there are two maps- one in the Summary and one in the Data tab (Image 39). Evaluators clicked on the map but there was no feedback. Evaluators wanted to see a bigger view of the map and to be able to interact with it.

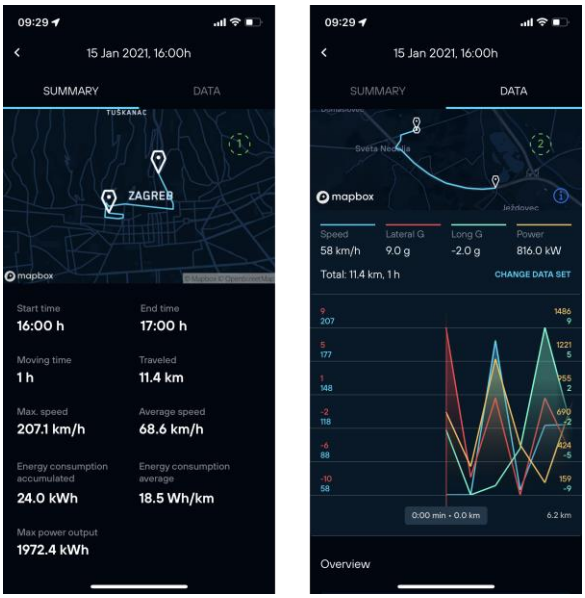


Image 39: Map view in Summary tab (1) and Data tab (2)

On the Map sections, there are UI elements (chips) that give the user an option to set/view a home address or see a list of nearby chargers. Each charger list item has a textual “Add” button (Image 40). This button adds the location on the list which can be a journey plan sent to the vehicle from which the navigation will start.

Evaluators were expecting a quick action of sending a particular location to the vehicle and not putting it on the list to get an option to send it. The list feature had not been clear before exploring the app. It had not been understandable and intuitive at all. Even if the intention is to send multiple locations to the vehicle it is cumbersome. After adding a location to the list, the user needs to first find it on the map, because he is not redirected to the added location. The user only gets a non-clickable notification that the location is added to the list. There is no change on the map, only the Add button switches to remove which is also confusing because the intention was to add the location.

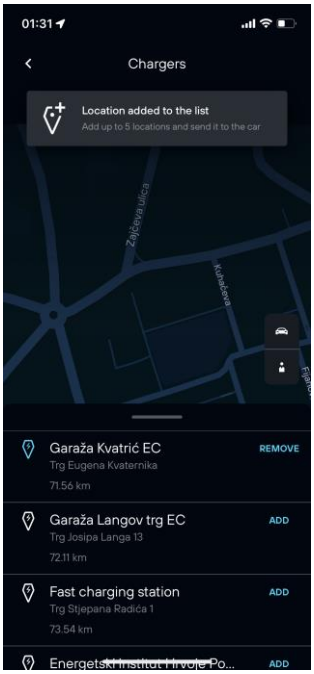


Image 40: List of chargers with “Add/Remove” buttons

The user cannot preview the location before adding it because the element is not clickable, he can only search for it on the map. Elements added to the list can be seen on it while returning to the main map view. Horizontal cards are clickable and the user is zoomed to the location on the map. On the map, pins have numbers which corresponded to the order the user has added the locations but user cannot see the same information on the horizontal cards. To see all added pins on the Map, evaluators were zooming in and out on the map. The “Details” button opens the list of added locations with the option to delete them, change their order and send locations to the vehicle.

A list of climate schedulers can be seen in the Climate section. The created scheduler can be updated and deleted by a swipe to reveal action. There is no option to delete the scheduler inside the Scheduler Details page which was expected (Image 41). The user can save or cancel the update. It isn’t clear if the user clicks on the back button if he will go back or cancel the update.

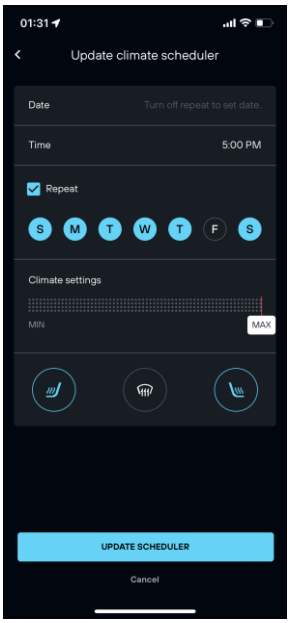


Image 41: Details of created climate scheduler

Modals consist of the body text and actions. It is desired that the ones that have two actions show the desired one on the last place and not the first one (Image 42). This is more intuitive for the users since they initially look for the last action and expect to finish the action quickly.

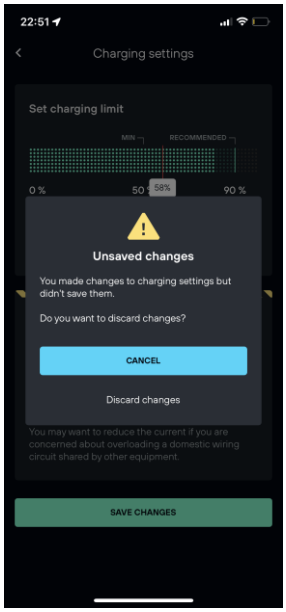


Image 42: Charging settings modal to accept or deny made changes on charging limit and/or charging current

“Unlock charging port” button is placed on the Charging screen underneath a “Charger state” label (Image 37). Button differs by style and positioning from other buttons so it doesn’t give a feeling it’s clickable.

The iconography is sometimes really difficult to process (e.g. rear wing, country flag, keyless driving etc.) especially if the icon is small or not accompanied by a label (Image 43). Some of the icons are not informative and clear enough so they is a possibility of misinterpreting the meaning and consequently available actions behind it.

Image 43: Rear wing icon (Left) and country flag icon (Right)

On the My car screen, there is an icon with crossed key (Image 44). It represents Keyless driving. Most of the evaluators, didn’t understand what this action does because the icon gave them the wrong impression. It looked like the keys are forbidden or the car is locked.

Image 44: Keyless driving icon

While the maintenance of the car is available there is a “Maintenance” button on the car visual (Image 45). The icon with the maintenance label as well as the explanatory text did not give enough clearance if this is the notification for the maintenance of the car or app.


Image 45: Maintenance button

Valet mode and Launch controls are indicators (Image 46) shown on the session card and inside the session's information. Evaluators didn't understand the meaning of these icons and due to the fact there was no label or tooltip they couldn't find their meaning.


Image 46: Session card with Launch control and Keyless driving indicators (1)

Seat heating icons on the Climate screens confused the evaluators if they stand for heating or cooling/ventilation of the vehicle. After clicking on the command, icon turns blue, meaning that the seat heating is active regardless of the blue colour (Image 47).

Image 47: Active state of Driver seat heating (Left) and off state of passenger seat heating (Right)

Evaluators recommended the following:

For the design to be intuitive it needs to be clear to users. Words, icons, and concepts need to be familiar and logical to users. Using the app needs to feel natural and flawless. That can be achieved by following real-world conventions, and platform standards and corresponding to desired outcomes (called natural mapping). Design is a connection between a user and a product. The relationship the user is building with the design greatly determines his level of satisfaction with the product. If the results of user actions are expected and quickly discoverable users will always return to the product and will use it with excitement because the interactions feel effortless. To achieve that, as mentioned above, design should use logical patterns and cues that people are familiar with from real life experiences. The user shouldn't adapt to the app but vice versa.

Natural mapping is a concept that refers to a design in which the system controls represent or correspond to the desired outcome. It helps users to understand how a system can be used and what actions are required to accomplish their goal. Designers can create natural mappings in several ways, including the three common patterns: spatial, conceptual, and behavioral similarity.

The icons mentioned above should be redesigned, and clarity needs to be prioritized over "style". Icons are important cues that convey a message of possible actions. The shape and position of standalone icons and the ones that are part of the button determine the meaning and context of possible action. By only changing the active colour of the seat heating icon from blue to red, the users are more confident they have turned on the heating and not the cooling or ventilation. For cravat icons, it would be more useful for users to get a hint of the outcome of the command. The icon can contain, for example, colours of animation that will play rather than the country's shape.

The maintenance icon, for example, needs to be inside a different context to convey a clearer message that the maintenance of the vehicle, not the app is requested.

Most used and useful commands on the My car screen should be positioned on the most optimal position and have enough prominence because those are the commands that the

user will see first when entering the app. The actions must be completed as quickly and effortlessly as possible. Putting the Keyless command among Unlock/Lock, Blink & Horn, and Trunk can create a more logical flow for users.
Separating the Country flag command can be an option so the fun option gets different treatment. Selecting the desired Country flag inside the Lights option needs to have a preview option before selecting so the user understands what the outcome is. One interesting and exciting solution would be to use the car visual as an entry point for different functions like turning the lights, opening the trunk, and unlocking it.

Interface elements should behave expectedly, according to the platform standards and commonly used design patterns. Users do not always perform actions step-by-step but rather want to just quickly come to the desired outcome. Users expect to exit the process by clicking on the and not necessarily the “x” button because it requires more effort. For the same reason, the primary buttons/actions on the modal are situated on the last position because the users expect them to be there as it is the most intuitive place for users to click it.

Google maps is the most used platform for map controls and most of the user's expectations are based on the behaviour learned there. To make app map controls easy to use they should follow or be inspired by the (behaviour) patterns of the Google maps application. The user wants to see a location on the map and according to that determine which action to take. It is expected to manipulate specific locations or multiple ones if preferred. While planning a journey it is natural to select or know the starting, ending points and stops in between in order they will happen. Common gestures should be offered on the map to enhance and ease the experience of the map.

### 6.5.7. Problem three: Exit options are not prominent enough

Users often perform actions by mistake, so it is important that they can leave the unwanted action quickly and return to the preview state without a lot of effort. When it's easy for people to back out of a process or undo an action, it fosters a sense of freedom

and confidence. Exits allow users to remain in control of the system and avoid getting stuck and feeling frustrated.

Evaluators noticed that close and cancel buttons or generally exit actions are visually too small and tappable area should be bigger. Exit options are sometimes placed on the top corners of the interface which can be hard to reach. Another issue is that they are displayed on the interface in different styles and degree of importance which can be confusing or misinterpreted by the user.

This relates to the heuristic “User control and freedom”, saying the design needs marked "emergency exits" to leave the unwanted action without having to go through an extended process. Issues found in this section are ranked with a severity of 3 which means there are some minor, but also bigger issues that need to be fixed.

Problem can be confirmed on screens and elements mentioned below:
The close button on the Maintenance screen is hard to reach, the icon itself and the tap area are small so it can be frustrating on bigger screens (Image 48). Back buttons are also very small and hard to reach, but this is partially resolved with the ability to swipe right to go to the previous screen.

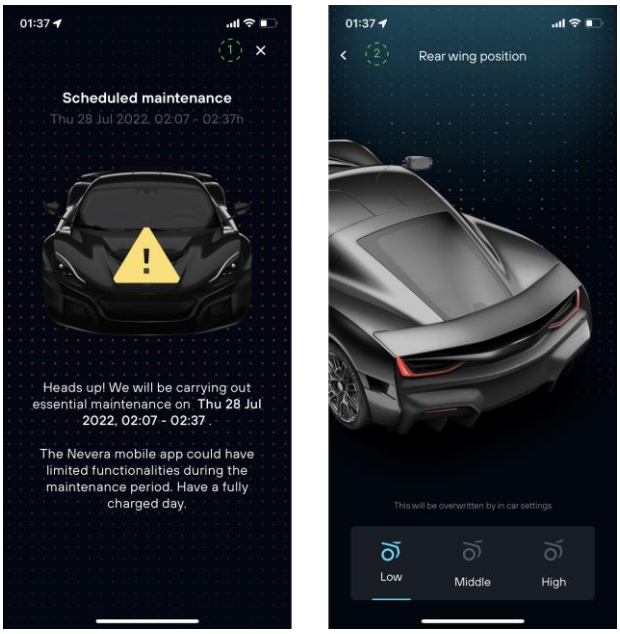


Image 48: Close button on Maintenance page (1) and back button on Rear wing position page (2)

The cancel button in the Garage bottom sheet is too prominent, and it has the same importance as the “Update software button” (Image 33). It is hard to understand that the primary action is to select a desired vehicle to enter in the app.
The button’s label on the Charging screen should be checked because it is initially unclear what are the proposed actions after quitting the process of setting the charging limit and/or current.

<u>Evaluators recommended the following:</u>
Following the thumb zones on the screen, the easiest for the user is to reach the bottom middle of the screen to perform the exit action. Buttons should be clear and have the same style and logic that is appropriate to their intention.

### 6.5.8. Problem four: Inconsistent actions create friction in the experience

The apps should use consistent actions, styles and patterns so the user doesn’t have to make his/her own conclusions which actions are connected and which not. Consistency creates clarity and harmony, so the elements and actions look and feel natural. Besides, it is important to follow platform and industry conventions. Jakob's Law states that people spend most of their time using digital products of their rivals. User's experiences gained through the usage of the products of their rivals determine their expectations (from the similar products that they will use).
While interacting with the app evaluators came a lot of inconsistencies both in visual language and actions. This increases users' cognitive load by forcing them to doubt and learn something new repeatedly. Consequently, the app can appear complex and unpleasant to use.

Moreover, it is good to follow platform and industry standards because that is what the users expect. They assure the user can recognize the specific element or actions and based on that they know how to interact with it. An example that the evaluators have pointed out is the map inside the app. They started interacting with it as they do with Google maps but got unexpected results. Experience for them was unnatural, weird and frustrating. Users learned how to do very similar actions in one, very logical way but the app’s interface doesn’t allow them to reuse their knowledge. Another issue was that similar buttons do not require the same approach and have the same results.

Visually, evaluators thought font sizes are too small with a lack of visual hierarchy. The spacings, colours, and interface elements do not follow the same logic and style and therefore create inconsistency. This relates to the heuristic “Consistency and standards” saying the users should not have to wonder whether different words, situations, or actions mean the same thing. Issues found in this section are ranked with a severity of 3, which means there are some minor, but also bigger issues that need to be fixed.

Problem can be confirmed on screens and elements mentioned below:

Inconsistency in placement and visual style is the first issue. Call-to-action buttons are placed differently throughout the app, sometimes they are in the center like “View all driving activities” on the My car screen, sometimes right like on Climate “Turn on” or left like “Navigate” on the Map (Image 49). They also have different styles. All call-to-action buttons are blue except on the Charging screen.

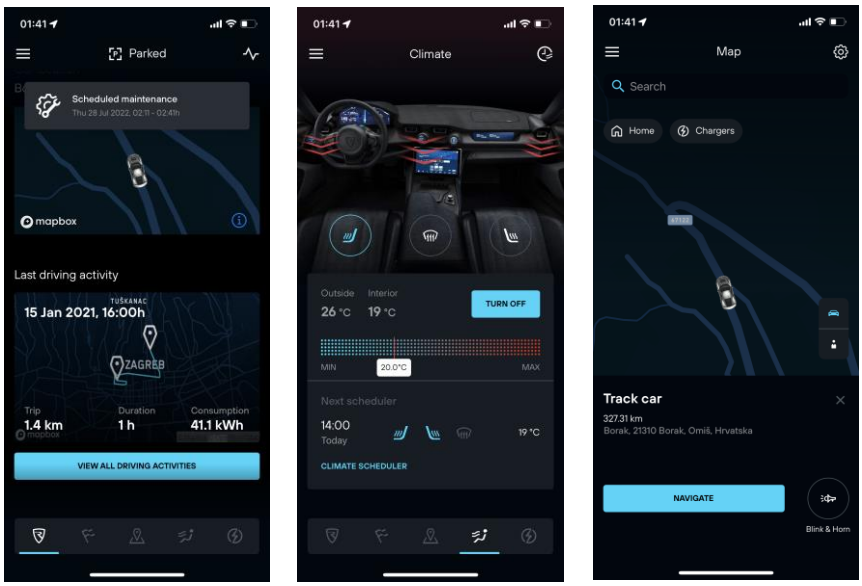


Image 49: Inconsistent buttons and font styles on My car, Climate, and Map screens

The number of font sizes should be reduced and the same font style for the labels in one section is not used in another. For example, labels in Sessions screen have different weight, and size from the ones on the Climate screen. Some text buttons are uppercase, and some title case, in different weights, colours and sizes (Image 50). The “Charging settings” button is green, normal weight and upper case. The button underneath “Unlock charging port” is green, bold, and in different sizes and title cases. Another text button on the same page, but a bit lower, is upper case, blue, bold and in a smaller size.

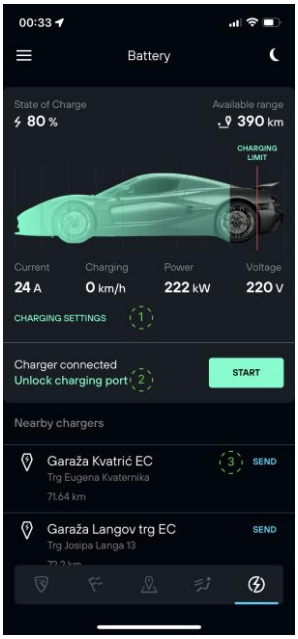


Image 50: Different styles of buttons of the same prominence on Charging screens “Charging settings” button (1), “Unlock charging port” button (2) and “Send” button (3)

On the Driving activity screen font style of the section is smaller than the one used for a name of a particular activity inside the card. This is an example of a lack of information hierarchy by choosing the wrong font sizes.

Evaluators noticed that card interface elements that are used as a container for section’s information and actions on the Climate and Battery screen show different margins sizes used in the app. They also illustrate inconsistent spacings between elements.

Inconsistency in actions is the second issue. On My car screens, the user is introduced with circular command buttons like unlocking the vehicle, blinking, horning and opening the trunk. To send the request for execution of those commands, the user needs to long-press the buttons. On the Climate screen user can see the same button style, but to be able to turn on or change the seat heating he can just press the button, or even press it multiple times in a row.

On the Driving activity page, inside the particular activity user can interact with two graph types. First is the main, overall graph with 4 values and below is a single graph for each value. On the overall graph, the user can move on the graph by swiping left and

right. There is also an option to zoom in and out. To move on the graph below the user can click and swipe left and right.

Inside the Vehicle specification screen user can move between the tabs by clicking on the tab or swiping left or right. On the Lights screen, the user can move between the tabs just by clicking on them (Image 51).

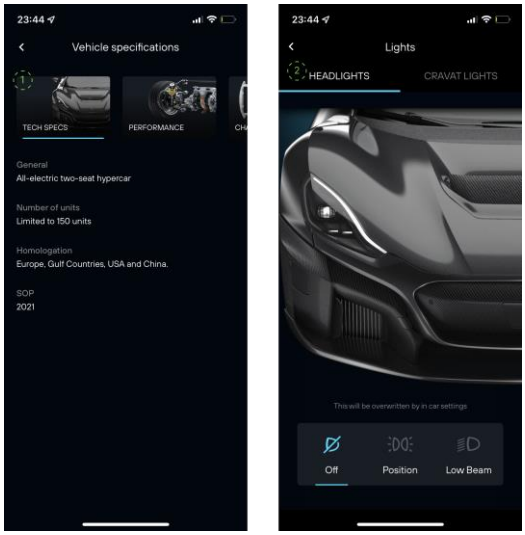


Image 51: Tabs on Vehicle specification screen (1) and on the Lights screen (2)

List items on the Scheduler screen can be deleted only by swiping to reveal, and on the Map screen, there is a trash icon and no possibility of using gestures.

Inside the Climate and Charging sections, users can interact with the red needle to change for example the climate temperature, charging limit or charging current. A needle with the same red stem and green label is available on the car visual of the charging section but is not interactable (Image 52).

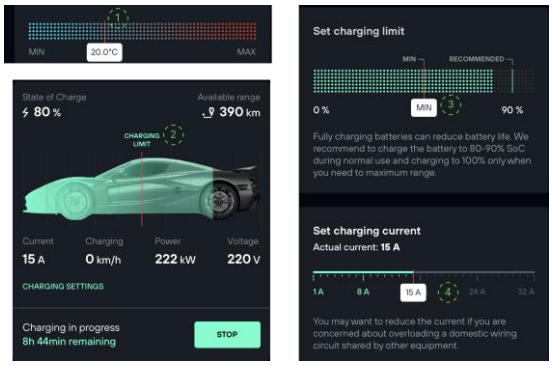


Image 52: Temperature needle on Climate bar (1), Charging Limit needle (2) (3) and Charging current needle (4)

In the Charging section, the user can click on the list item and be redirected to the location on the map. In the Map section, list elements are not clickable, and the user is zoomed to a location either by manually doing it or by adding the location inside the list and then by clicking on the horizontal location card. Users can quickly send the location of the charger to the vehicle by clicking on the “Send” button. The same option is not available on the Map section. User can only add it to the list and send it from there. Generally, behaviors mentioned in the previous sections weren’t expected from the evaluators and didn’t follow standards.

<u>Evaluators recommended the following:</u>

The designer should first do an audit of the app to uncover all inconsistencies to be able to correct them. A standard ensures that users can understand the individual interface elements in the design and know where to look for specific features.

There needs to be both internal and external consistency. Internal consistency means the elements and functions need to be consistent within the app and then within the same family of products, in this case the car. External consistency means following established industry conventions which are familiar among users.

Jakob's Law of the Web User Experience says that users spend most of their time on other sites. Thus, the users will already be familiar with anything that is a convention

and used on most other sites and it can only be deviated from if there are major usability issues.

Regarding the visual part, the typography and colour style guide need to be chosen or refined and be used consistently throughout the app. Also, Accessibility Standards for text sizes and contrast need to be checked. Visually identical elements and actions need to be used in the same way to provide the same results.

Evaluators stated that map flow needs to be changed to follow behaviors from Google maps which also recommends Jakob's law.

### 6.5.9. Problem five: App tends to create error-prone conditions without offering help

Evaluators noticed some places that could lead users to make mistakes because of the lack of information and contextual help. There are two types of errors: slips and mistakes. Slips are unconscious errors caused by inattention. Mistakes are conscious errors based on a mismatch between the user's mental model and the design.

The design does not give enough information which leads the user to guess and make assumptions based on available information. There is no additional information, hints, context help or question and answer section where users could be informed. The user can only ask for help by sending an email which he can find on the Support page. The user is left either to continue the action and see if the result is wanted or even not try to perform the action. This can be a frustrating experience for the user.
Touchable areas need to be bigger, so the user doesn't have to be very precise while trying to click on the button. Even if the icon size or container size is smaller touchable areas should be big enough so the user doesn't have a feeling that control is not working or gets frustrated that he cannot hit the specific position. Another problem is when interactive elements are crowded next to each other. The user has could have difficulty interacting with it because of the possibility of misclicking elements.

This relates to the heuristic “Error prevention and Help and documentation”.
Issues found in this section are ranked with the severity of 2 and 3, which means there are some minor, but also bigger issues that need to be fixed.

Problem can be confirmed on screens and elements mentioned below:
On the Driving activities page, particularly on a particular activity, are shown two indicators in case of a launch control or valet event (Image 45). If the user can’t recognize the icons or figure out after the drive what actions he did there is no way to find that information in the app. Indicators are not clickable and don’t provide any additional explanations.

On the Climate screen, it feels like the current temperature in the car is unknown before selecting desired climate temperature (Image 53). There are only small grey labels next to the control giving the impression they are static rather than variable data. The user has to turn on the climate first to see what the last set temperature in the car was.

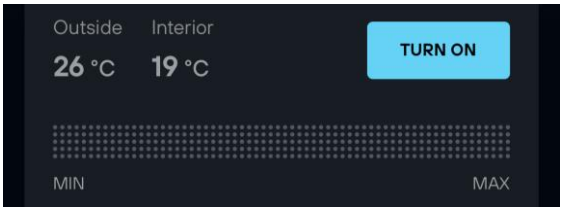


Image 53: Climate bar while the climate is turned off

The keyless driving button on the My car screen allows the user to start the car without the key. Evaluators stated that before pressing the button they haven’t had enough clues that this action could be done with the button. It was unclear what action if any could be done with it. There is also no tooltip or help text stating what keyless driving is.

Help text which is shown while changing the charging limit or current is not understandable (Image 54). It is unclear what will happen if the user sets the value above the recommended. The app warns the user and allows him to perform the action with unclear result.

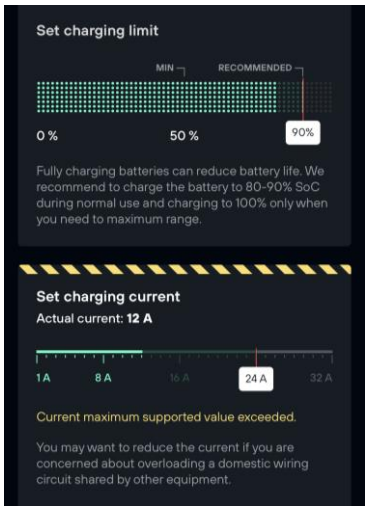


Image 54: Contextual text in Charging settings screen while setting a charging limit higher than actual

While creating a repeating climate scheduler the user can mark the days on which he wants that the chosen conditions to be met. Besides from that option, there is no information when the starting and ending date of the scheduler is.

While scrubbing the graph inside the session, the whole page starts scrolling, so it is hard to find a desired information if the screen is slightly moving up and down while searching for the information.

Tap areas are too small, for example, the whole list of elements on the Map is not clickable, only the buttons on the edges are. The search area on the Map is also small and the user needs to specifically click on the container to search for a location. Generally, the back buttons are very small, placed in the top left corner and the user needs to be precise to return to the previous page.

Evaluators recommended the following:

It is recommended to either eliminate error-prone conditions or check for them and present users with a confirmation option before committing to the action. In the mentioned causes the confusion would be solved by providing help text or additional information and by showing the current state of the system before acting so the user feels confident about his actions.

Human interface guidelines recommend a minimum target size of 44 px wide and 44 px high. Considering different thumb sizes and positions of the buttons, they surely need to be reliable and forgiving enough for users to have a flawless interaction.

A good practice is to show interactions and data while onboarding, so that the user gets familiar with that and knows what to expect. Another good idea is contextual help while opening the app, so the user can clearly see how each control can be used or what it means.

### 6.5.10. Problem six: Certain actions require recall rather than recognition

People have limited memory and interface should help users recognize the information and not have to remember it from one part of the interface to another. Information required to use the design should be visible or easily retrievable when needed. This relates to the heuristic “Recognition rather than recall”. Issues found in this section are ranked with a severity of 3, which means the mentioned issues should be fixed.

Evaluators noticed that visual elements in some cases put a cognitive load on users rather than minimizing it. Visual elements don’t guide users through an interface with different areas of attention. It can look like all elements have the same importance. Some controls give a wrong impression which actions can be done with them.

Problem can be confirmed on screens and elements mentioned below:

The keyless driving button on the My car screen initially doesn't tell the user he can unlock the car by pressing on it. Icon shows crossed keys which can be misinterpreted. The button doesn't have a label and it is smaller than then the rest of the buttons on the screen.

On Climate and Charging screens users can change the temperature or charging limit by moving the needle across the bar. While having the finger on the needle user cannot see the current value he's selecting because the label is covered by the finger. The user needs to remember the starting value and move the finger below or release from the needle to see the newly set value.

While creating a list of locations to be sent to the vehicle, locations in the horizontal list do not have a numeration saying in which order the user has added them (Image 55). The user needs to try to remember in what order he has added them to the list. If the locations are familiar to the user, this won't create a big problem, but if he travels to new places, this could be a frustrating experience.

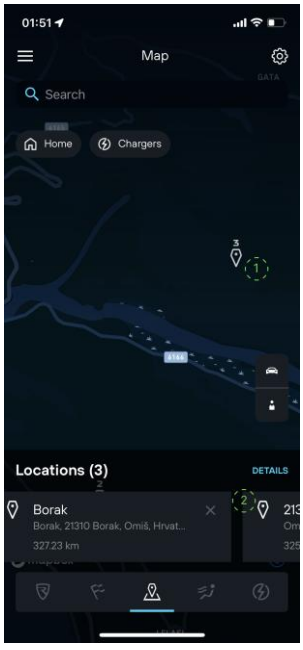


Image 55: Location number on the map pin (1) but not on the horizontal card (2)

It feels like no colour system or typography scale is being followed in the app. Headers are not distinctive enough from subsequent content. Also, inconsistent spacing is used inside the app. Sometimes the elements are too close like in the driving activity list, so the user can barely see where one card ends and another starts. Other times the spacings are too big and create doubt if the elements are connected like on the climate scheduler.

Evaluators recommended the following:

Interface needs to guide the user, give the essential information, and remind the users if needed in particular context. Commands, like Keyless driving, need to have enough information to be clear. Adding a label to the keyless button, making it bigger and in style with other commands and having a tooltip or onboarding tutorial would make it clearer. Also on the Climate screen, the interior and exterior temperature labels need to be more prominent, so the user is confident that they show current temperature. Adding a bigger label and change the position on the needle can reduce mistakes.

Interface needs to have a unified style that is visually pleasing, readable and understandable by the users. Same colors should be used in a same way and convey a logical message to the users. Text should be big enough to be legible and the same time allow users to quickly differ the most important information from the rest of them. This way interface will reduce memory load and the experience of the app can be improved.

### 6.5.11. Problem seven: Interface needs visual refinement

It needs to be ensured that the visual elements of the interface support the user's primary goals. The user's interactions with the system should enhance the quality of hers/his life. This relates to the heuristic "Aesthetic and minimalist design" and "Pleasurable and respectful interaction with the user". Interfaces should not contain information that is irrelevant or rarely needed. Every extra information in an interface competes with the relevant units of information and diminishes their relative visibility. Issues found in this section are ranked with the severity of 2 and 3, which means there are some minor, but also bigger issues that need to be fixed.

The problem the evaluators noticed is that the layout of some screens was noisy with a lot of elements and information and not all of them were informative enough. The balance between conveying important information to the users and having visually pleasing elements like images is sometimes off. Images are very attractive but tend to take a lot of space and are placed in the most obvious positions in the interface while some important actions feel secondary and less important. This can be seen by the size of some buttons, small label size, choice of colours which tends to blend with the background. Also, the elements and typography don't always show the hierarchy. The user can't only by briefly looking at a piece of information see which is the most important one and which is for example a help text. This can be very discouraging for the user because he needs to actively search for his information on the interface rather than being guided by it. Visual cues need to assure that the user can find the information quickly and accurately and do the task he intended to while entering the app. Generally, the interface needs to be intuitive that the user can have pleasurable interaction with it.

<u>Problem can be confirmed on screens and elements mentioned below:</u>
Some labels are tiny, hard to read and even hard to understand. For example, command labels on the My car screen are small. Moreover, while logging in error text displayed to the user is hardly readable. Also, profile subtext in the menu, car location in the header, graph legend values and the information on the needle are very small (Image 56). Currently selected value on the needle is small and while interacting with the needle to

put a desired climate temperature user is covering it with his finger. Besides the fact the text sizes are too small, interface colours tend to blend in with the black background.

“This will be overwritten by in-car settings” shown on the Lights and Rear wing page is redundant because this is expected car behavior and creates confusion (Image 47 2).

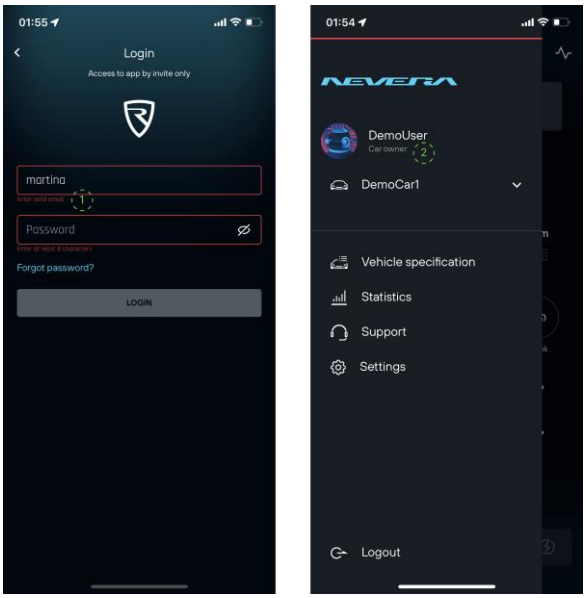


Image 56: Error text in the input field during the Login process (1) and users profile text (2)


Image 57: Overview label on the Data section of a Driving session (1)

The “Overview” label on the graph section should be changed to “Details” because each graph is shown separately, and the overview gives a feeling that they are all placed in one view (Image 57).

The “Next scheduler” label and icon in the header showing the climate scheduler are not connected (Image 58).

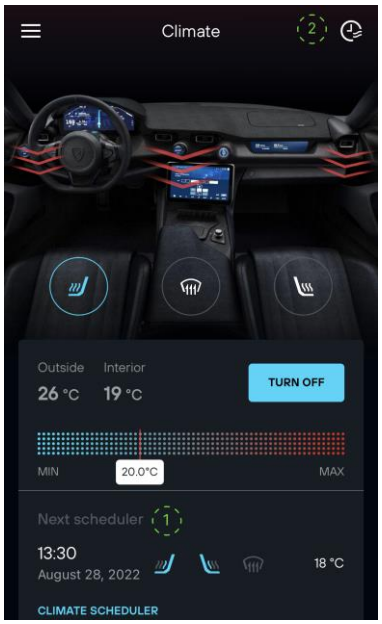


Image 58: Scheduler icon (1) and “Next scheduler” label (2) disconnected

The layout is at some places designed to add visual noise and not to reduce it. The Driving activity screen, precisely list of driving activities looks very cluttery (Image 59). A long list of cards with map backgrounds and information on them creates noise. Another example would be a charging card. Only the car visual stands out and other information look as if they were of the same importance. Even the “Unlock charging port” button looks like text. There is no hierarchy and users' eyes are constantly searching for cues.
On the My car screen, functional control like keyless driving could be placed among other commands and not above to make it more prominent and in context.

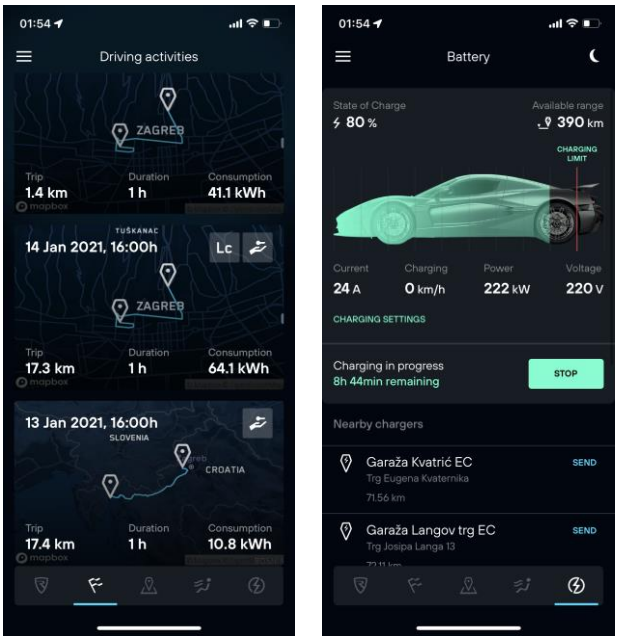


Image 59: Driving activity screen (Left) and Battery screen (Right) have visual noise

Images and multimedia content in the app are realistic and attractive but sometimes do not add much value. On the My car screen it feels like car visual (Image 30) does not add much value and it pushes the essential controls and information far down the screen. The same issue is with the car visual on the charging card. It gives information about the current state of charge, but it is hardly readable from the image itself because of the colour choices and small contrast. Another example is the image in the Rear wing section (Image 60) showing the change of the position of the rear wing based on the users' activities. Because of the image angle, there is barely a visual difference between the high and low rear wing position.

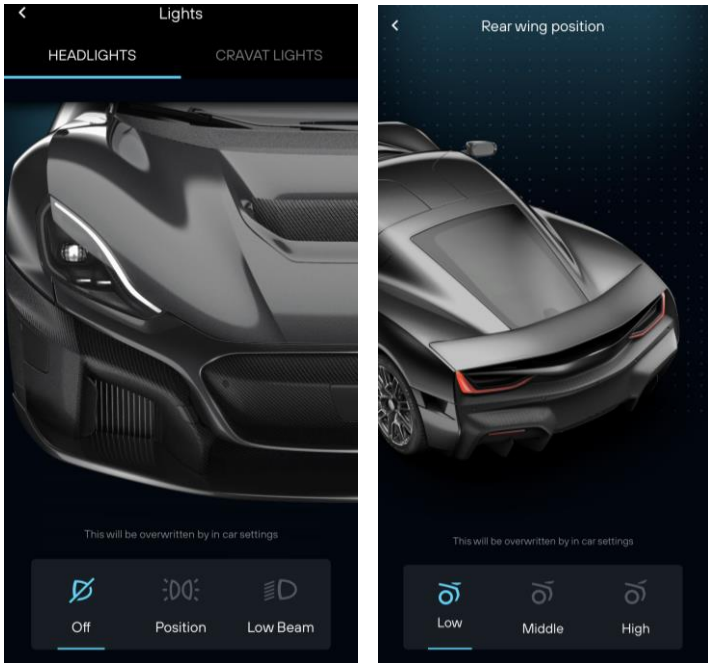


Image 60: Car visuals on Lights screen (Left) and Rear wing position screen (Right)

The brightness contrast between the interface elements and background colours is too small. The app is available only in dark mode and elements tend to blend in with the background, like on Driving activity cards or in the Garage and on My car screen.

Another example are toast notifications which show system status based on user input or the general status of the app or vehicle (Image 61). This information is particularly important for the users but can sometimes be overlooked. The reasoning behind is the grey background colour of the notification that gets lost in the dark, black background. The contrast is not big enough to attract the user's immediate attention.

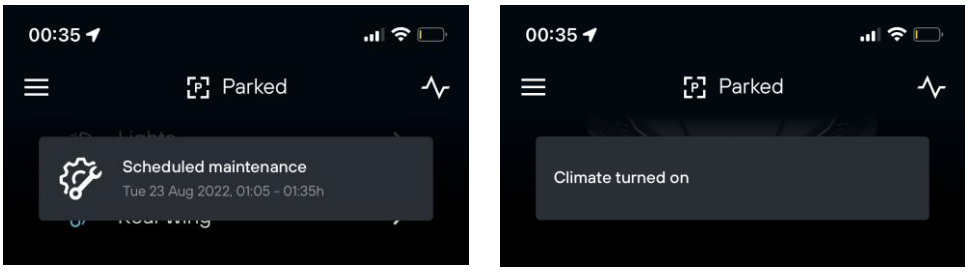


Image 61. Toast notification (Left) and Snackbar (Right)

App gestures are mostly intuitive except for map interactions and buttons on the main screen (e.g. Lock), but need to be unified. The hamburger menu should be opened by swiping the left corner of the screen which is the iOS pattern.

Evaluators recommended the following:

Only essential information with a visual hierarchy should be displayed on the screen to help the users in achieving their goals. All icons, labels and images should be informative, understandable and have the level of prominence according to their importance. The balance between positive and negative spaces helps guide the user, lower memory load and gives a feeling of harmony and hierarchy. Both micro and macro space is important to show the relationship between the elements and sections. With smartly chosen font sizes and colours, users can discover data more easily. Interface elements should all be placed inside the grid and with good spacings, it would be more harmonious.

It is also important that the contrast between the elements and the background is big enough and can be easily checked with online tools or the Figma plugin “Color checker”. Interactions should also be obvious, intuitive and according to the device guidelines, so the user feels in control. Another design standard is that the notifications are in colour opposite of the background, so this could easily resolve the issue in the app.

To improve the contrast on the My car screen, the background glow can be wider and more prominent. Users expect the Garage screen to be brighter because while entering it in real life people turn on the lights.

The layout can be also improved by placing the controls on the most prominent and reachable positions in the app and using visuals to enhance the functionalities and not to take too many distractions.

## 6.6. Usability testing methodology

The moderated usability test was conducted using the testing version of the Nevera mobile app on the iPhone 12 Pro. The location of the test was a meeting room inside the Bugatti Rimac office. A laptop was used to record audio and measure time. With the phone was captured screen recording. The test facilitator was guiding participants and captured data.

Participants who shared similar traits to target users were recruited from company departments. E-mails were sent to attendees requesting their availability and participation in the usability test. Participants responded with an appropriate date and time.

Each session lasted approximately an hour. During the session, the test facilitator explained the session and reassured participants that their competence was not being tested, but rather the design's efficacy.

The test administrator moderated the session by giving the participant task scenarios to complete. The participants 'actions were observed by asking questions to understand their thought process and behaviour better. Participants were also asked how they expected certain features to function, or how they preferred to perform certain tasks in digital interfaces.

The session captured each participant's navigational choices, task completion rates, time on the task, comments, questions, and feedback. It was a hybrid test because it collected both qualitative and quantitative data. Time needed for the participant to complete a task was measured and completion rate was determined. After gathering this quantitative data, participants were asked a series of questions to understand their point of view and get their subjective opinion of the interaction or element presented to them. Also, after the test study had ended, SUS survey was given to participants to fill it according to the experience they had with the mobile app.

Five participants were scheduled over five testing dates. Of the five participants, four were male (80%) and one was female (20%). The pool of testers was comprised of young adults, age 25-35. The job roles of the participants were as follows:

- 2 Software engineers (40% of testers)
- 1 Battery system engineer (20% of testers)
- 1 Embedded hardware engineer (20% of testers)
- 1 System test engineer in Electrical department (20% of testers)

### 6.6.1. Metrics

The results of the usability testing are presented in the following format:

- Successful Task Completion
- Non-critical errors: deviations which do not prevent task completion, but rather reduce the efficiency
- Critical errors: deviations which prevent the user from completing the task
- Time on the task: the time to complete each scenario, not including subjective evaluation durations, was recorded.
- Comments: valuable remarks from users expressing their likes, dislikes, thought processes, and recommendations
- Subjective evaluations: regarding ease of use and satisfaction was collected via the SUS questionnaire

### 6.6.2. Evaluation Tasks/Scenarios

Participants attempted completing 12 task scenarios. Each task had follow-up questions to better understand the user's perspective and observations which helped determine task success. Tasks were formed based on findings from heuristic analysis and functionalities that the internal design department felt like a potential drawback for the users.

The following task, observations and follow-up questions were used:

1. You are in the parking lot, standing next to your car but cannot find your car key. Unlock the vehicle using the mobile app

- Observation:
    - Does the user understand he needs to long-press the button to send the command to the vehicle?
    - Can the user tell the current state the vehicle is in (locked/unlocked)?
    - Does the user notice visual feedback on the car visual during the process of unlocking?
- Follow-up:
    - Did you understand the state car is in before unlocking the car?
    - What did you expect when you wanted to click on the button?
    - Are you familiar with long-press action? Have you used it in other apps? If so, where?
    - What do you think about visual feedback presented on the vehicle?
    - How do you feel about visuals and information presented on this page?

2. After unlocking the car, you are ready to begin your drive, but you still cannot find your car key. Start the car using the mobile app.

- Observation
    - Can the user recognize the command?
    - Does the user understand he needs to long-press the button to send the command to the vehicle?
- Follow-up:
    - Are you familiar with this command? Would you prefer to have an explanation of keyless driving with the command?
    - Do you understand the purpose of 2-minute timer?

3. It is already dark outside. So before starting your journey, turn on the low beam headlights.

- Observation
    - Can the user easily navigate through tabs to the light command?

- Does the user understand that he needs to press the bottom tab to change the light setting?
- Did the user notice that the icon of the list and the car visual on My car screen changed?
- Did the user try to interact with the car visual?

- Follow-up:
  - Would you change anything regarding this action?
  - How do you feel about the car visual?

4. On January 7th, you lent your car to a friend. Now, you want to check if he drove according to the speed limit. Find the detailed view of the Speed Graph for his driving session on January 7th.

- Observation
  - How does the user navigate to the sessions page? (From My car screen or bottom sessions tab)?
  - Can the user easily navigate to the sessions section and find mentioned session?
  - Does the user distinguish graph preview of sessions data vs individual graphs?
  - Can the user move through the speed graph?
  - Does the user understand how to change the chart values?
  - Does the user try to zoom in the graph?
  - Did the user try to turn off one of the graph values?
  - Did the user notice the information on the needle?
  - Can the user say that that movement on the graph is connected with the one on the map route?
  - Did the user try to interact with the map either in “Summary” or “Data” tab?
- Follow-up:
  - How do you feel about the session list? Could you easily find the desired session?

- Would you like to find the session more easily (filter)?
- Did you expect the information presented on the session card or would you change something? (Start/end time, event icon)
- Do you understand what these icons represent? (referring to Valet mode and Launch control indicators)
- Can you understand the graph and its legend?
- How would you view different data value on graphs?
- Was it easy for you to move on the graph?
- What do you think about the map view and the graph? Is there some connection?
- Can you describe the graph and information that it displays?
- What do you think red line on the map represent?
- Did you expect that you could interact with the map?
- Do these graph labels look clickable to you?

5. Today is a hot summer day. You are almost finished with work and would like to pre-cool your vehicle before you start driving home. Set in this moment the climate temperature to 18°C.

- Observation
    - Can the user navigate to the climate section?
    - Did the user turn the climate on?
    - Did the user interact with the temperature bar?
    - Did the user notice visual feedback after setting desired temperature?
- Follow-up:
    - Can you tell me what is the current exterior temperature?
    - Did you have any obstacles while setting the temperature?

6. While checking the news in the morning you remembered you need to pick up your friend on the way to work. She is always cold, so now turn on the passenger seat heating to level 2 to be prepared.

- Observation
    - Can the user recognize the command?
    - What gesture does the user use to change the heating level? (e.g. click, long-press)
    - Can the user notice he can click multiple times at once to change the heating levels?
- Follow-up:
    - Did you expect this kind of behaviour?
    - Would you change this interaction?

7. You have planned a journey for the 18th of July of 2022. According to the weather forecast it will be chilly in the morning. To be prepared, make a climate scheduler that occurs on July 18th, 2022, at 9 am, set the temperature to 20°C and turn the driver seat heating to level 1.

- Observation
    - How did the user navigate to the climate scheduler? (Climate scheduler button or icon in the header)
    - Does user try to click the whole section regarding the scheduler or just the button?
    - Does the user understand how to change different preferences?
    - Does the user notice he needs to uncheck the repeat box to be able to choose a specific date?
    - Can the user easily change the climate settings in the scheduler?
    - Can the user spot the scheduler he just made among other ones?
    - Which gesture does the user use to delete a scheduler?

- Follow-up:
    - Was it easy to you to navigate through screens?
    - Does the “Climate scheduler” button look clickable to you?
    - Did you expect this kind of a date picker?
    - Would you like to have more information while setting the climate scheduler?
    - Is it obvious where is the climate scheduler you just created?
    - How would you delete a climate scheduler?

8. Before arriving at lunch, your car’s battery level was pretty low. There is a good charging station at Garaža Kvatrić. Send the location of the Garaža Kvatrić charger to the vehicle.

- Observation
    - Does the user search for chargers on the Map or Charging section?
    - Does the user try to tap the Chargers chip on the map?
    - Does the user click the “Add” button on the charger item?
    - Does the user try to click on the location item in the list?
    - Does the user understand the toast notification displayed to him?
    - Does the user try to tap the toast notification?
    - How does user manipulate the map? (Click, long-press, pinch)
    - Does the user understand he needs to return to the map and click on the “Details” button to send the location to the vehicle?
    - Does the user notice the “Send location” button?
    - Did the user click on a horizontal card?
- Follow-up:
    - Did you understand what this list represents?

- Was this action intuitive to you or would you change something?
- Could you easily navigate through pages?
- Did you have enough time to read the notification? Did you understand it?
- Can you click on the pin on the map. Did you expect that? What do you think about this page?

9. You are temporarily living in Zagreb and don't want to search for your apartment location every time. Set "Nehajska 24" as your home address.

- Observation
  - Does the user click on the home chip on the map?
  - How does the user interact with the map? Does the user pinch to zoom in?
  - Does the user click on the map or on the box above?
  - Does the user know how to add a pin?
- Follow-up:
  - Did you expect this behaviour?
  - What interactions do you expect with the map?
  - Was it easy for you to choose the desired address?

10. You are planning a journey and want to send locations to the vehicle. The first stop should be "Vukovarska" street to pick up a friend. Second stop "Maksimirska cesta", then "Buzin" and final one "Ilica". Because of the lack of time delete the last stop.

- Observation
  - Does the user understand how to add a location?
  - Can the user use the search?
  - Does the search behave as user expected?
  - Can user manipulate different list views?

- Does the user try to click on the pin on the map?
- Does user try to click on the pin? Is the response expected?
- Does the user try to click on the location item in the list?
- Does the user understand how to switch between pages?
- Does the user understand what is the list of locations?
- Does the user click the “Details” button to send the locations to the vehicle?
- Which gesture does the user use to delete a location from the list?
- Which gesture does the user use to reorder the locations?

- Follow-up:
  - Was this interaction intuitive to you?
  - Are you familiar with this deleting pattern?
  - How would you reorder elements in the list?
  - Try to click on the horizontal card. Did you expect this behaviour or you thought you will be redirected to a location with automatically opened location details?
  - Did you expect that you will be able to add location from Location details page?

11. Before the meeting, you started charging your car. Since the meeting got extended, you decide to charge the car to 100% and increase the charging current to 16A so you are ready for a longer journey afterwards.

- Observation
  - What interaction did the user do to change the charge limit?
  - Did the user click on the “Charging settings” button?
  - Did the user try to interact with the needle?

- How did the user interact with the bars?
- Is the warning information noticeable to the user?
- How does the user feel when he sees warning indicators?

- Follow-up:
  - Would you change something regarding this action?
  - Does the needle look interactable to you?
  - Did you understand the warning information that was presented to you during the setup of values?

12. You are at the charging station and have plugged in the charger. Start the charge with the app and describe to me the information displayed on the charging card.

- Observation
  - Did the user click the “Start charging button”
- Follow-up:
  - Is information displayed to you understandable?
  - Would you say that some of this information is more important than other?
  - What do you think about the charging visual? Is the information displayed pleasing/beneficial?

### 6.6.3. Executive summary

After completing the usability testing of the Nevera application, it has been identified several problems and pattern:

My car

- None of the testers expected that circular commands on My car screen require a long-press gesture
- Keyless driving and unlock icon are too similar
- The keyless driving button is not clear and recognizable enough
- 80% of testers would like the car visuals in the app to match the actual car colour
- The country flag command gives no feedback to the user

Driving activity

- Valet mode and launch control icons are not accessible
- All testers tried to click on the valet mode and launch control indicators
- 60% of testers tried to click on the map and expected a full-screen preview of it
- While setting the climate temperature, current value is barely noticeable because it is covered by the finger - All testers had trouble with it
- The blue colour of the heating icon created doubt if the command is heating or cooling the seats
- 60% of testers were confused about the behaviour of the seat heating function, going from on to off and on again
- 80% of testers didn’t use the multiple click option (because they can’t see the feedback while holding their finger on the button)
- The newly created climate scheduler lacks prominence - 80% of testers couldn’t spot it
- While repeating a climate setting it isn’t clear what is starting and ending point
- 60% of testers tried to delete the climate scheduler with long-press

Map

- All testers expected behaviour on the app's map to be the same as on Google maps

- None of the testers could initially understand the meaning of the list and 20% still after exploring the app
- All the testers expected to be automatically redirected to the list after adding a point to it
- None of the testers could quickly send a charger’s locations to the vehicle
- 60% of testers tried to put the car’s location as a starting point for the app's navigation
- All testers expected to see the pin on the map after pressing the “Add” button
- All testers expected the whole charger (list) item to be clickable, and be visible after opening the location details on the map
- 80% of testers tried to swipe up a horizontal locations card to see more info
- 80% of testers thought “Details” doesn’t indicate the action of sending locations to the vehicle
- 80% of testers expected to see all locations from the horizontal list shown connected on the map
- All testers expected to be able to add the locations from the Location details page
- 80% of testers expected to see all locations from the horizontal list connected on the map
- All testers wanted to add the locations from the Location details page
- All testers tried to click on the text field on the map and wanted to edit entered home address
- 80% of testers would prefer to automatically have a pin on the map and just move it around the map to set the home address
- 80% of testers expected to automatically see the home screen on the map after adding it

Charging

- 40% of testers thought “Unlock charging port” is not a button
- 60% of testers expected to see an animation on a car visual as a confirmation that the car is charging
- 60% of testers had difficulty seeing the value of the charging needle

- 60% of testers were unsure about the meaning of warning messages while setting charge limit and current
- 80% of testers tried to interact with the needle on the car visual to change the limit
- 60% of testers wanted to see if they are connected to an AC or DC charger

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| 1. Unlock the vehicle using the mobile app | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 2. Start the car using the app | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 3. Turn on the low beam headlights | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 4. Find the detailed view of the Speed Graph for friends driving session on January 7th. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 5. Set in this moment the climate temperature to 18°C. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 6. Turn on the passenger seat heating to level 2 | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 7. Make a climate scheduler that occurs on July 18th 2022 at 9 am, set the temperature to 20°C and turn the driver seat heating to level 1. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 8. Send the location of the “Garaža Kvatrić” charger to the vehicle | 🟢 | ❌ | ❌ | 🟢 | 🟢 | 3 | 60% |
| 9. Send locations to the vehicle. The first stop should be “Vukovarska 32” street to pick up a friend. Second stop “Maksimirska 2 cesta”, then “Buzin 6” and final one “Ilica”. Because of the lack of time delete the last stop. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 10.Set “Nehajska 24” as your home address | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 11. Charge the car to 100% and increase the charging current to 16A. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| 12. Start the charge with the app | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |

Table 2: Successful Task Completion Rates of the conducted usability test

The System Usability Scale (SUS) is a reliable tool for measuring usability. It consists of a 10-item questionnaire with five response options for respondents; from Strongly agree to Strongly disagree. Most participants scored the app between 70-80 which corresponds to good, but one participant scored less than 68 which is less than average. Scores below 68 points had issues with the design that need to be researched and

resolved, while scores higher than 68 indicate the need for minor improvements to the design.

SUS score by participants:

- P1: 62.5 score
- P2: 82.5score
- P3: 70 score
- P4: 75 score
- P5: 82.5 score


Image 62: System usability score rates

### 6.6.4. Results: User task one

**Non-critical errors** found in the first user tasks are that:

- 5 testers (100%) initially didn't long-press the command, but only after visual feedback was present on the car's visual
- 2 testers (40%) briefly thought the top, keyless driving icon was something that could
- potentially be related with unlocking

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Unlock the vehicle using the mobile app | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 12.3s | 9.8s | 11.2s | 6.7s | 11.5s | | |

Table 3: Success and time results of the first task

**User comments** related to first task are:

P1: "I was expecting, probably some type of unlocking animations, like press and swipe. Or something more immediate, like just press and see some special animation with timeout or like one, two seconds just to specify I'm unlocking the car."

P1: "...this image of the car… I see that it is so realistic render of the image of the car that I would just try to swipe around the car to see if it moves or something like that."

P3: "It doesn't make sense that I need to long-press the button to lock it, maybe unlocking it's okay"

P4: "I didn't expect the long-press but there are a lot of visual cues that I need to continue pressing it, and besides if I just click nothing happens."

P5: "... what I'm thinking to do is like to rotate this car like a 360 view..."

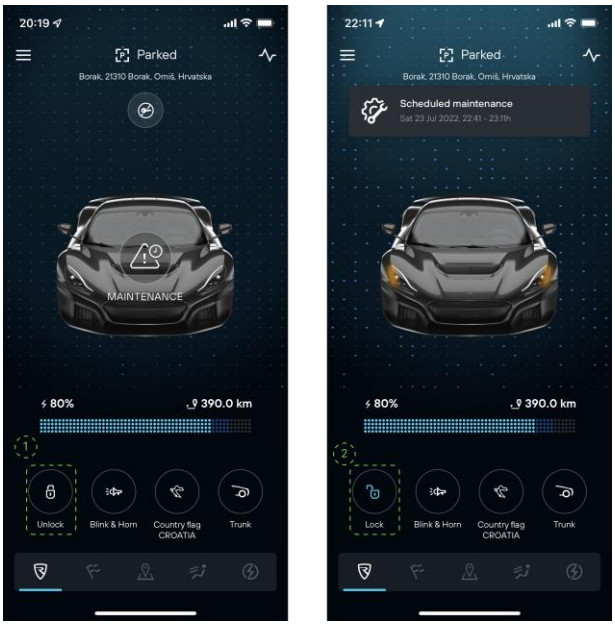


Image 63: Expected actions to complete first task; Click on “Unlock” button (1) unlocks the car (2)

### 6.6.5. Results: User task two

**Non-critical errors** found in the second user tasks are that:

- 5 testers (100%) didn’t understand the keyless driving icon
- 5 testers (100%) didn’t initially consider pressing the button; it was either a guess or the only considerable option after exploring the rest of the app’s functions
- 3 testers (60%) thought the keyless driving button is a status indicator showing if the car is locked or unlocked

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Start the car using the mobile app | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 1min 13s | 15.8s | 12.2s | 46.5s | 14.6s | | |

Table 4: Success and time results of the second task

**User comments** related to second task are:

P1: “It didn't give me any clue that it was a button or if it was just like a visual representation of the state of the car… I thought it was the same functionality *(lock/unlock)*, but just different placement.”

P1: “For me, it would be better than the application tells me that. I recognize the car; keyless driver is on or off.”

P2: “I thought it’s connected with unlocking the car... it looks like a status indicator if the car is locked or unlocked.”

P3:” it looks like something is locked.. it would make sense for me that it is at the bottom with the rest of the commands.”

P3: “I need more information because it’s not clear… I would like to be guided after I unlock the car because that is the next logical step if you don’t have the key.”

P4: “It wasn’t intuitive but the keyless button was the only option left... I would put it at the bottom next to unlock command.”


Image 64: Expected actions to complete second task; Press (1) and hold (2) on “Keyless driving” starts the command (3)

### 6.6.6. Results: User task three

**Non-critical errors** found in the third user task are that:

- 1 tester (20%) was looking for a command in the Climate section
- 1 tester (20%) clicked on the car visual on the My car screen

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Turn on the low beam headlights | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 32.1s | 15.2s | 5.1s | 12.3 | 4.8s | | |

Table 5: Success and time results of the third task

**User comments** related to third task are:

P1: “ I tried to click on the lights on the car.. that would be cool”

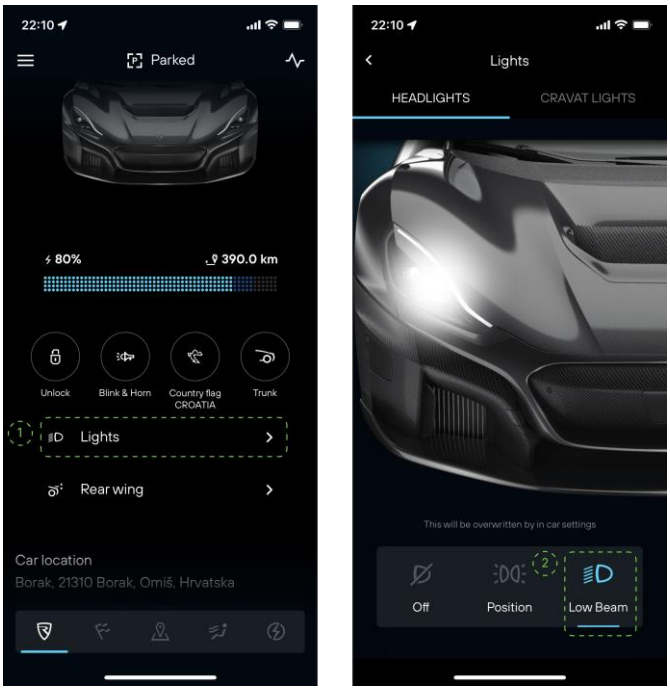


Image 65: Expected actions to complete third task; Click on the “Lights” item on My car screen and “Low Beam” option on Lights screen (2)

### 6.6.7. Results: General observations for My car screen

**Non-critical errors** found on My car screen are that:

- 4 testers (80%) stated they want the car visuals in the app to match the actual car colour
- 2 testers (40%) misclicked the commands while swiping
- 4 testers (80%) weren't sure if the county flag command works and what is the result because of the lack of the feedback
- 2 testers (40%) tried to click on the state of charge bar

**User comments** related to general observations of My car screen are:

P1: "This button or label for the maintenance, I'm guessing it's giving me feedback for something to be done to the car so I would, immediately gravitate towards that button, as soon as I open the app."

P2: "I would make the maintenance button more prominent, maybe in some colour like yellow or red."

P2: "I thought I would be able to see a detailed view of charging with more options where I can set something."

P3: "Since I don't have any indicator on the car, I'm not sure if this function *(country flag)* will turn on/off or something will happen for a few seconds… It confused me because there is no response after my press."

P4: "I cannot see the feedback *(of keyless driving)* because the car can't rotate so I don't know if it works or not."

P5: " I'm scrolling and just misclicked the country flag button.. it shouldn't be like this because I can accidentally turn something on."

P5: "…SOC bar looks like a slider to me."

### 6.6.8. Results: User task four

**Non-critical errors** found in the fourth user task are that:

- 2 testers (40%) didn't understand the meaning of the "Change data set" button
- 1 tester (20%) thought the graph legend labels weren't clickable
- 1 tester (20%) stated the "Change data set" button doesn't look clickable

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Find the detailed view of the Speed Graph for friends driving session on January 7th. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 40.4s | 45.8s | 1m 32s | 59.8s | 1m 27s | | |

Table 6: Success and time results of the fourth task

**User comments** related to fourth task are:

P1:" I was expecting to be able to filter or disabled/enable back the different features, like the speed lateral G… This is cool."

P1: "Change data set"… I don't know exactly what this is. I would probably suggest changing the wording, instead of changing dataset, probably select data or view available data points."

P2: "I don't know what "Change data set" means. I was expecting to change the measuring unit and not different values."

P2: "I like it when I turn off one of the values on the graph, it is still visible but only disabled, and even the numbers change when I move through the graph."

P3: " It is too much information for me, I can compare only 2 graphs at the time. It requires too much mental capacity. I don't need that much data at once. It looks nice but from a usability point of view too much."

P5: "Change data set doesn't look like a button to me. I wasn't sure if I can click on this label. I would be clearer if it had a background."

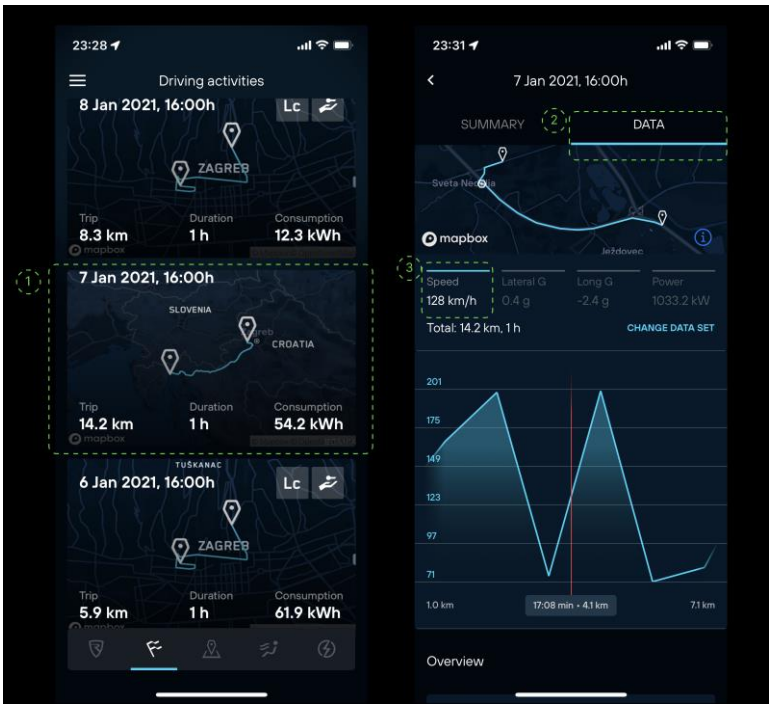


Image 66: Expected actions to complete forth task; Click on Session card (1), Data tab (2) and then on graph labels to turn off all values except Speed (3)

### 6.6.9. Results: General observations for Driving activities screen

**Non-critical errors** found in the graph section are that:

- 2 testers (40%) didn't try to use the zoom option without prompting
- 2 testers didn't understand the difference between the overview and individual graphs
- 2 testers would like to see the average speed value on the graph

**User comments** related to graph section are:

P1: "Yeah, it is smooth.. it's responsive and no objections here." *(The graph movement)*

P1: "I'm trying to find the average speed, because I saw it on the Summary page. I was just thinking that probably I would be able to find it somewhere in these graphs."

P3: " I would like to hold my finger on the label and send it to the trash*." (To move a value from the graph)*

P3: “ I expect identical interaction on the graphs. Interaction on the top graph is great, but it doesn’t exist on the bottom one anymore…I just want it to be persistent because now it is weird for me.”

**Non-critical errors** regarding icons on activity card are:

- 5 testers (100%) couldn’t identify the meaning of the valet mode icon
- 4 testers (80%) couldn’t identify the meaning of the keyless driving icon
- 5 testers (100%) tried to click on the valet mode or keyless driving indicators

**User comments** related to icons on activity card are:

P1: “ I'm guessing that's like lending the car to somebody. The first thing that I would try is just trying to tap on top of the icons to see if it’s giving me something else.

P2: “I would like to have some kind of info.”

P3: “I expected that it is connected with the map. (on the Summary page) ... If I have a button on the image, I expect I can see the route in detail or to redirect me to the Google maps.”

P4: “I would like that they are clickable and that a small window opens so I don’t have to think a lot about it.”

**Non-critical errors** found in the map view above the graph (Data tab) are:

- 3 testers (60%) tried to click on the map and expected a full-screen preview of it
- 2 testers (40%) didn’t see the connection between the graph and the map

**User comments** related to Data tab on map are:

P1:“ I find it interesting that, for example, even if I scroll *(top graph),* this timeframe is not locked into these *(bottom graph).* So, I would have to go manually into each graph and try to find this specific timeframe. “

P1: “I think it's quite nice. *(relationship between the map and graph)* … I would expect at this point if I just tap on the map that I would be able to put it like a full screen or something like that.”

P4: “I would freeze the top map, so she is always on top while I scroll, so I can see, okay this number is related to...”

P4: “I would like to be snapped to the graphs *(while scrolling)*, so I don’t have to manually have to pinpoint and have two half ones.”

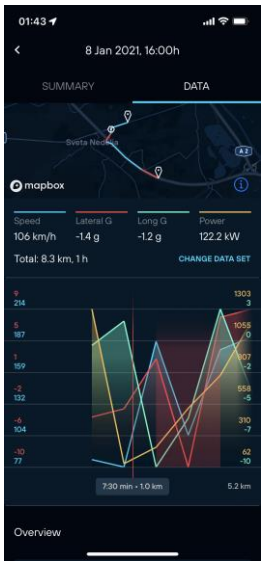


Image 67: Relationship between the graph movement on the map

**User comments** related to Driving activity cards are:

P1: “I think it would be useful also to be given the option to create labels for it. So let's say, a trip to Split or lent the car to X and Y. It would be at least useful also to have this information here. I would be beneficial to see two months from now, going into the log and trying just finding the specific spot. So, I don't have to remember the exact date on when I did whatever. “

P1: “I would like to have like a quicker search.”

P3: “Consumption label is misleading for the energy… I would remove the year from the card so the clutter reduces.”

P4: “I would like to see a different icon for the start and ending of the activity.”

P5: “I would like to search the activities and type the date, filtering maybe like in an iPhone gallery. When you stitch your fingers, you can squeeze the timeline. ..I also like a quick scrolling.”

### 6.6.10. Results: User task five

**Non-critical errors** found in the fifth user task are that:

- 2 testers (40%) wanted to first set the temperature and then turn on the climate
- 5 testers (100%) had trouble seeing the value on the needle while setting the temperature
- 1 tester (20%) clicked on demist button because it looked like it related to turning the climate
- 2 testers (40%) tried to find the control on the Home screen
- 2 testers (40%) tried to swipe up to change the temperature

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Set in this moment the climate temperature to 18°C. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 32.5s | 25.1s | 22.4s | 18.4s | 20.1s | | |

Table 7: Success and time results of the fifth task

**User comments** related to fifth task are:

P2: “I thought I can set a temperature and then turn on the climate…When I click on the turn-on button, I don’t know at which temperature I’m setting the climate. What if turns on 30°C... I would like to have some indicator on which value it will turn on.”

P2: “While I’m holding my finger on the needle, I can’t see the value I’m setting. I can see it if I slide the finger a bit lower. I can still set the value but would like to have a better view.”

P3: “It’s one step too much... It’s logical for me that I set the temperature and climate automatically turns on because if I change the temperature, it is obvious that you want to turn on the climate.”

P3: “If I put the seat heating to the max I would like also the climate automatically turn on because I want to heat the car.”

P3: ”The number on the bar is small…while I hold my finger on it I can’t even see the value I’m selecting... the number should be big so I can immediately see on which value it is set.”

P4: “I can see the outside and interior temperature so I will probably turn on the climate here, but besides from that I don’t know that this is the climate because it only says turn on. I would like a better visual cue”

P4: ”It says only min and max so I have to move to figure out what is the actual temperature.”

P5: “So my thought was okay, first I must adjust the temperature, then turn it on. But after I couldn't find the way, I turned it on and now I can see that I can set the temperature.”

P5: ”I like that I can slide to the bottom and still change the value because my finger is always covering the temperature... I've tried to swipe to check if there is something more.”

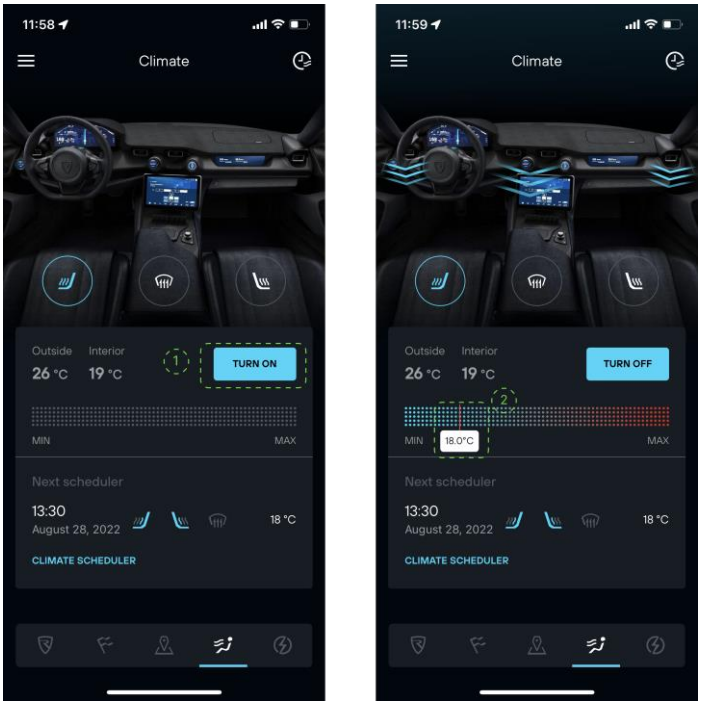


Image 68: Expected actions to complete fifth task; Click on “Turn on” button (1) and setting a temperature with needle (2) on the temperature bar

### 6.6.11. Results: User task six

**Non-critical errors** found in the sixth user task are that:

- 3 testers (60%) were confused by the blue seat heating icon, if it was for heating or the cooling
- 3 testers (60%) were confused about why the command was briefly disabled after clicking on it
- 4 testers (80%) didn't use the multiple click option (because they can't see the feedback while holding their finger on the button)

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Turn on the passenger seat heating to level 2 | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 3.5s | 2.4s | 2.8s | 1.6s | 2.3s | | |

Table 8: Success and time results of the sixth task

**User comments** related to sixth task are:

P1: "It's blue. *(the heating icon)* So I'm not, I don't know if this is heating or cooling... From the usual standard, you would think this is heating, but I don't know if, the seats are able also to cool down."

P1: "I see that it has like an animation of putting the button grey, which usually means like disabling. Uh, I don't think I would prefer that one."

P2: "You can't see what is happening under the finger... Sometimes people just do this and do not lift-off, the finger very much. So are not, able to see the full feedback. I'm guessing probably it would be also useful just to have the animation here and probably get like a pop up on the main screen just to signal you that something's happening."

P3: "It reminds me of the ventilation of seats, and its heating."

P4: "I don't understand the second step, this greyed out and blue circles... I don't want the perception that something is delayed in the car because I don't know how long it

takes that the signal comes to the car nor do I care... I just want a notification if the command hasn't been executed… If I click a button, a get an instant response in the app. I don't care if the car turns that in 2,3,5 seconds and not right away. When I come to the car the outcome is the same, and there is a chance I get upset if I didn't get an immediate feeling it works."

P5: "While tapping fast it's hard to see what's going under the finger. It's quite not intuitive for me… maybe it would be better when you tap and still push up to show me over these options, like turn to the third level, second and first. It is more intuitive, or I would be more confident."

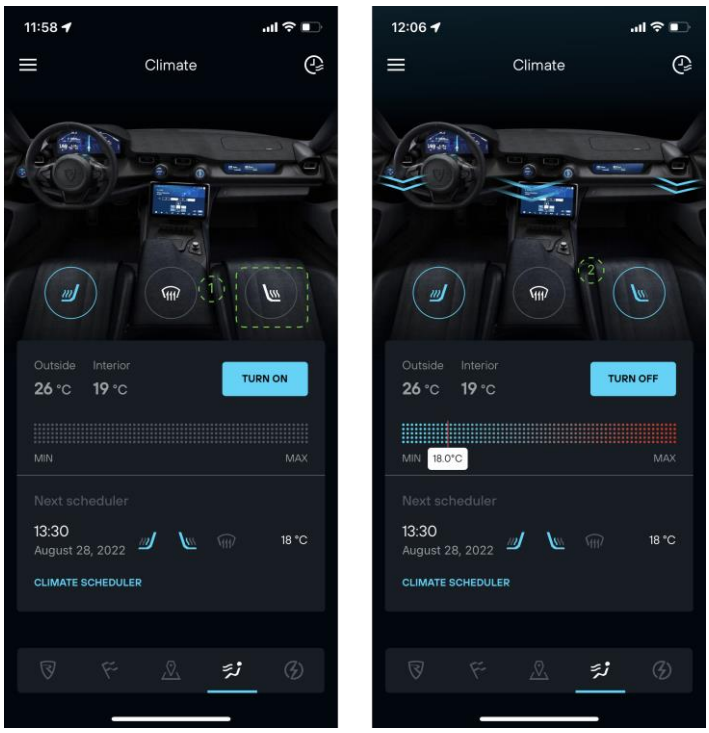


Image 69: Expected actions to complete sixth task; Double click on the Passenger seat heating button (1) turns the heating to level 2 (2)

### 6.6.12. Results: User task seven

**Non-critical errors** found in the seventh user task are that:

- 4 testers (80%) had trouble finding newly created scheduler among other ones
- 3 testers (60%) used long-press to delete the climate scheduler
- 2 testers (40%) thought they can't create a scheduler via the scheduler header icon
- 3 testers (60%) weren't sure what is the starting and ending point of the repeat option
- 2 testers (40%) would like to see weekly schedulers

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Make a climate scheduler that occurs on July 18th 2022 at 9 am, set the temperature to 20°C and turn the driver seat heating to level 1. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 36.5s | 34.7s | 42.1s | 29.5s | 31.2s | | |

Table 9: Success and time results of the seventh task

**User comments** related to seventh task are:

P1: "I see some settings here, like an alarm application style...This layout is nice. It's very descriptive."

P1: "While long-pressing nothing happens, it just opens the new page… it says cancel, but I don't know if it will cancel the action or go back."

P1: "I wasn't sure that these two were connected *(demist and temperature slider)*. Similar to when I enable repeat here… I see that this gives me a reason why it is disabled. For me makes sense, but you would like more information."

P2: "I thought that it would probably be something else (header climate icon). The icon looks like a preview. If the task was to preview a scheduler, I would then press it."

P4: "I don't have any icon for the delete, anything. I would just long press and it would give me the option to select more and an additional menu for seeing additional actions like move copy, share, delete…"

P4: ”I expect that my scheduler is first, but there is no visual feedback…like a small flashing animation.”
P3: “If I press on the repeat, I’m not sure what is the starting and ending date... I’m missing this info... I’m not sure if it starts from today and last until I turn it off.”
P5: ”Maybe to add also the label for the seat heating of passenger and driver, just to make me more confident.“

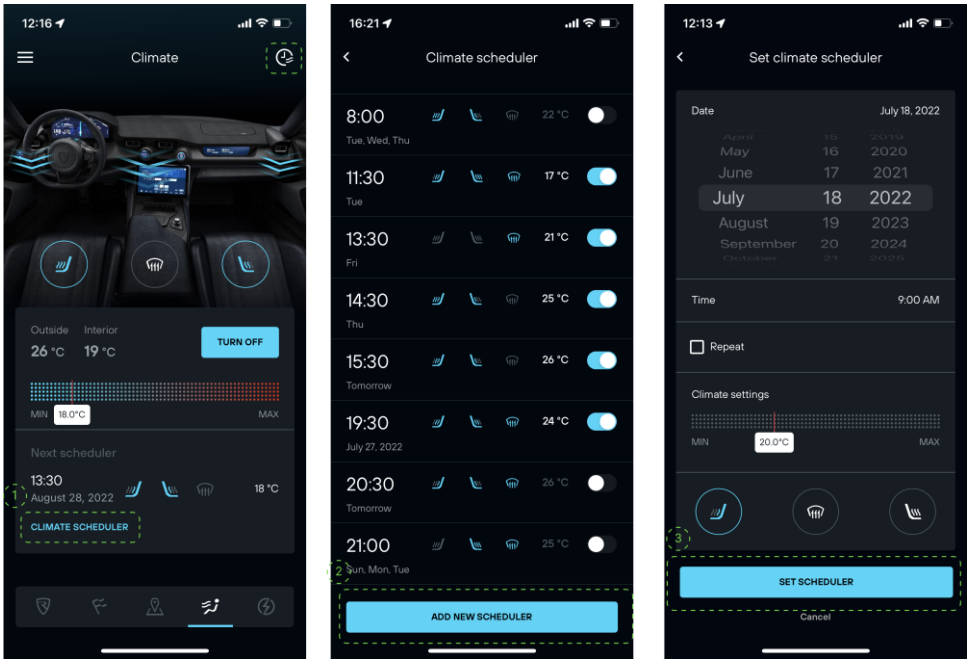


Image 70: Expected actions to complete seventh task; Click on either “Climate scheduler” button or icon in top bar (1), next click on “Add new scheduler” and after choosing all options click on “Set scheduler”

### 6.6.13. Results: User task eight

**Critical errors** found in the eighth user task are that:

- 2 testers (40%) couldn’t send the location to the vehicle without help
- 2 testers (40%) couldn’t find the “Send locations” button
- 2 testers didn’t understand the relationship between the list and the car without an explanation

**Non-critical errors** found in the eighth user task are that:

- 5 testers (100%) didn't try to send charger's location using the charging section
- 5 testers (100%) didn't find an option to quickly send charger's location to the vehicle
- 1 tester (20%) clicked on the My car screen to send the location
- 5 testers (100%) initially didn't understand the meaning of the list and 1 user (20%) still after exploring the app
- 3 testers (60%) tried to put the car's location as a starting point for the navigation

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Send the location of the Garaža Kvatrić charger to the vehicle | 🟢 | ❌ | ❌ | 🟢 | 🟢 | 3 | 60% |
| **Time on the task (ToT)** | 1m 8s | / | / | 1m 15s | 1m 32s | | |

Table 10: Success and time results of the eighth task

**User comments** related to eighth task are:

P1: *(Describes location list )* "So if I go back, I would expect that this is like a frequent locations suggestions, added by me. "

P2: "What is the list? What do you do with it? It is not intuitive... I would rename it into route or plan route... Where is the list now? I have to search for it."

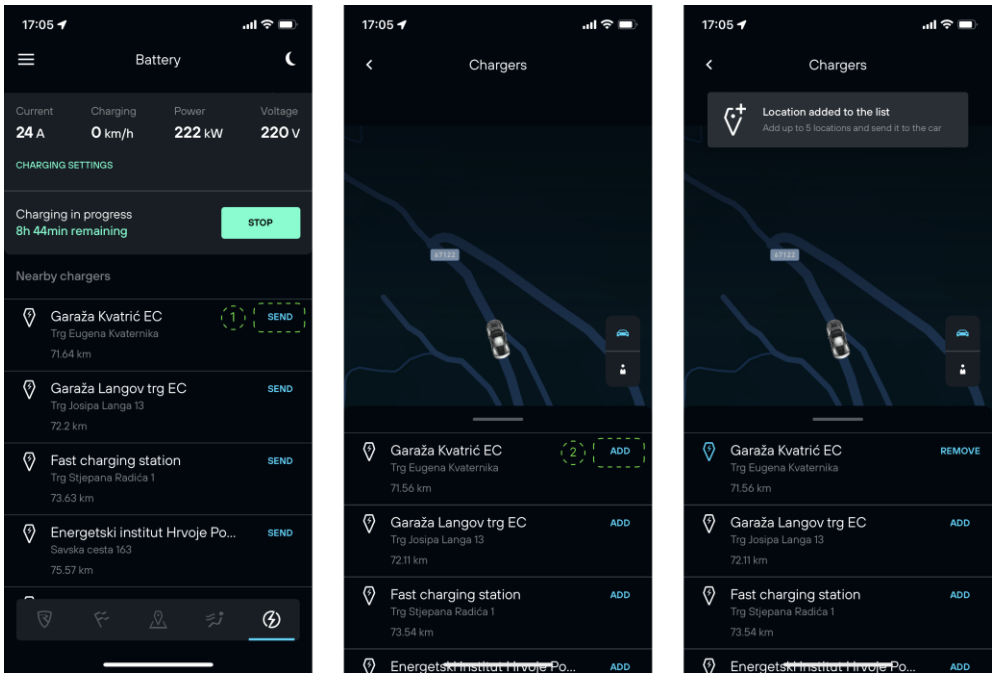


Image 71: Expected actions to complete eighth task; User can on Battery screen press on “Send” button next to chosen charger (1) or on Map screen under chargers add it to the list and send from there to the car (2)

### 6.6.14. Results: General observations for Charging screen

**Non-critical errors** found in the Charger’s section are that:

- 5 testers (100%) initially didn’t understand the meaning of the “Add” button
- 3 testers (60%) expected the “Add” button to trigger navigation to the location
- 5 testers (100%) were confused about the position of the list after pressing the "Add" button
- 5 testers (100%) expected to see the pin on the map after pressing the “add” button
- 5 testers (100%) expected the whole charger (list) item to be clickable, and to be visible on the map after pressing the location details

**User comments** related to Charger's section are:
P2: "Are these all chargers? Can I search for chargers?" *(in chargers list)* I want to see all chargers on the Map with the car or at least the first one."
P2: "I would like to have besides "add" button in the list, also a send button… I expect to be able to send just one location quickly to the car because now I'm constantly adding them to the list. I can't click on the notification to be redirected to the list but have to go back from this page *(chargers list)* and enter the Details page to send it."
P3: "I would divide the chargers by speed. Fast ones should have three bolts, medium two and slow one bolt sign... It is dangerous to show chargers that are not compatible with our car. I have too little info about the charger. I want to know if it is in function, availability of charging units, reviews…"
P5: "Instead of the add button, I would expect share button… Share to the car or the person… I would like to share the location maybe with the person responsible for this car."

**User comments** after pressing the "Add" button on Charger's page are:
P1: "I don't see any feedback from this map, so I'm not sure what I'm doing. I just go back and try to see the list of things... I expect that it would show me the location on the map to at least get an overall idea of the surroundings of the place. If I don't remember the place by name, I will try to figure out the location surroundings to see if there is something specific near it."
P2: "I don't know specifically what I did when I added this location to the list. Is it added to the car's navigation or some list on the phone? I'm guessing this is like the expected way or trip to go to. I wasn't expecting to create a list of like, let's say hops during a specific trip. I was just expecting to go directly into location… like on Google maps, to go to that location."
P3: "Did it add to the list or send to the car? Why would I like to add it to the list and not automatically send it to the car? I don' t want to instantly add it because I'm not sure where this location is. I want to clink on this *(list item)*, be transferred to the map and confirm it."

### 6.6.15. Results: User task nine

**Non-critical errors** found in the ninth user task are that:

- 5 testers (100%) expected the same behaviour of elements and functions as on Google maps
- 4 testers (80%) tried to swipe up the horizontal location card to see more info
- 2 testers (40%) tried to rearrange the location on the horizontal list with drag and hold gesture
- 4 testers (80%) thought the “Details” button doesn’t indicate the action of sending locations to the vehicle
- 4 testers (80%) expected to see all locations from the horizontal list shown connected on the map

**Non-critical errors** found in the ninth user task related to specific location information are that:

- 1 tester (20%) thought the route point wording was unclear
- 2 testers (40%) expected that clicking on the toast notification will navigate to the list of locations
- 5 testers (100%) initially misinterpret the function of the “Navigate” button

**Non-critical errors** found in the ninth user task related to Locations details page are that:

- 1 tester (20%) couldn’t delete a location point
- 2 testers (40%) couldn’t rearrange the locations on the Details list page
- 5 testers (100%) wanted to add the locations from the Location details page

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Send locations to the vehicle. The first stop should be “Vukovarska 32” street to pick up a friend. Second stop “Maksimirska 2 cesta”, then “Buzin 6” and final one “Ilica”. Because of the lack of time delete the last stop. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 2m 3s | 2m 45s | 3 m 42 s | 3m 3s | 2 m 38s | | |

Table 11: Success and time results of the ninth task

**General user comments** related to ninth task are:

P1: ”It’s like the app is teaching me its flow.”

P5: “I would use this list feature if someone told me what it does, and not straight away because I expect the behaviour from Google maps.”

**User comments** related to horizontal cards on the map:

P1: “From the current layout *(horizontal cards)* it is easy to see that I actually can delete one point…. but to be able to change it, I'm not sure if I long press or try to swipe up and down to try to see if I can place it in front or something like that… which I can’t.”

P4: ”I'm trying to swipe to see if I get an additional option.” *(horizontal cards)*

P3: “It's not giving me the hint *(details button)* that I can do this entire flow and send it.”

P2: “I’m not sure if this details button is an explanation of the list or if it will open the list...It sounds like it shows more info and not additional options. I would change the text to see more.”

P3: “I expect to choose a starting and ending point and the app shows me chargers available near the route… and I can add a waypoint if I want.”

P4: “I expect that click on the element will send me to a location, and if I want more info I can expand this card. Since that doesn’t work, I have to click on the pin on the map… Inside the list, the icon should have the number of locations. It would be more intuitive.”

**User comments** related to specific location information:

P1: “I would also change the wording on this route point to a hop or a stop.”

P1: “I would expect to have a button somewhere when I don't have location added so the map is empty. I would like to have some specific hint that I can create a trip, like a like plan a trip…”

P2: “Is this my pin *(I just created)* or a charger? They are too similar. They are confusing me, I would change the colour on the shape… and it’s also white *(the icon)*, like it’s not active and something you lastly added to the list.”

P1: “After I do this *(click add from a chargers list)*, I would expect to be taken automatically in the last window. Since I added it, I would expect to be taken back here *(to the map).* For the first time I wouldn't know that details allow me to send this location to the car.”

P2: ”I don’t understand the difference between the navigate and add route point button. Navigate automatically navigate the location or send the location to the car and I can start the navigation from there? … Oh, no this is navigated on my phone.”

**User comments** related to Location details page (list of locations):

P1: “ I'm not giving the visual feedback that I can rearrange the stops.” *(On the location details page)*

P2: “In these location details, I would also expect to have like a plus icon to add a location.”

P1: “Since I am not inside the car or near the car, I would expect some type of feedback after sending the location. So, for example, if I sent those locations, I don't know if I'm able to cancel the action from the app. “

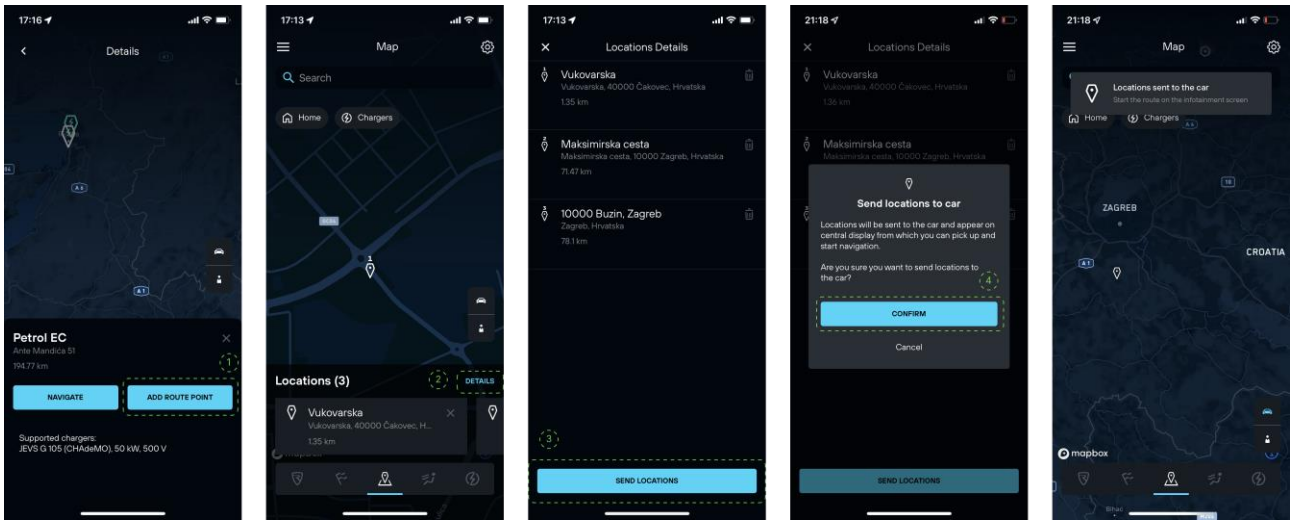


Image 72: Main actions to complete ninth task; Adding locations to the list (1), click on "Details" button on main Map screen (2), then click on "Send locations" and "Confirm" button to successfully send them to the car

### 6.6.16. Results: User task ten

**Non-critical errors** found in the tenth user task are that:

- 5 testers (100%) tried to click on the text field on the map
- 5 testers (100%) expected to change the address in the text field on the map
- 2 testers (40%) tried to click on the map to add a pin
- 4 testers (80%) would prefer to automatically have a pin on the map and just move it around
- 4 testers (80%) expected to automatically see the Home icon on the map after adding it

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Set “Nehajska 24” as your home address | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 1 m 49s | 1m 58s | 1m 30s | 1m 47s | 1 m 59s | | |

Table 12: Success and time results of the tenth task

**User comments** related to tenth task are:

P1: ”Yeah, this is my current location… Then from here, I would just expect to have like a point on the map showing me where is this place located or have the pin set up and manually move. ”

P5: ”The first thing I would try is just to click on the text here to see if this is editable... *(text field on top)* It is not.. Since I don't see the names of the streets on the map, I don't know which one is Nehajska 24, or if it even exists, so I would just definitely start moving the pin around to see if I'm able to find the specific street. It's not very straightforward for me to manually change it. “

P3: ”I expect to always see favorites on the map, like home and work address.”

P4: “I don’t know where I am currently on the map... I expected that I can add a pin just with a click or like it is on Google maps that a have a pin on the map that I can move around. It is more precise if I have a pin because when I use my finger it’s harder to hit the right spot. I have to zoom in a lot and then add.”

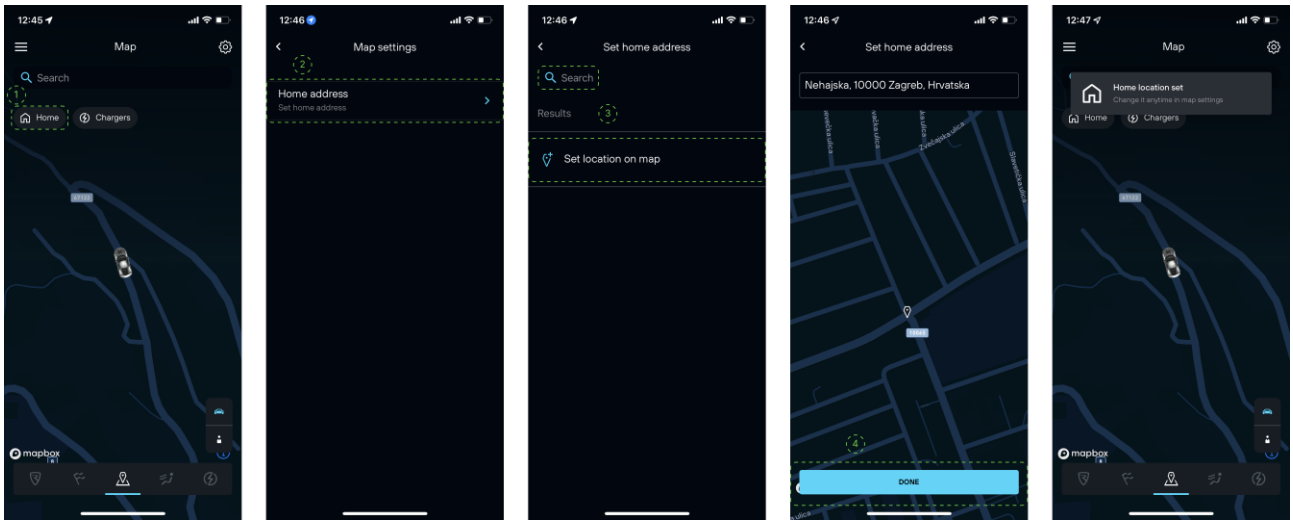


Image 73: Expected actions to complete tenth task; Click on “Home” chip (1), “Home address” item (2), either “Search” or “Set location on map” (3) and “Done” button (4)

### 6.6.17. Results: User task eleven

**Non-critical errors** found in the eleventh user task are that:

- 3 testers (60%) had difficulty seeing the value of the needle
- 3 testers (60%) were unsure about the meaning of warning messages
- 4 testers (80%) tried to interact with the needle on the car visual to change the limit
- 2 testers (40%) expected to change the limit on the SOC bar (My car screen)
- 3 testers (60%) wanted to see the corresponding charging time next to the current bar
- 3 testers (60%) expected to see if the car is connected to an AC or DC charger

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Charge the car to 100% and increase the charging current to 16A. | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 34.6s | 26.4s | 19.3s | 18.1s | 25.4s | | |

Table 13: Success and time results of the eleventh task

**User comments** related to eleventh task are:

P1: ”This is similar to what I was telling you about the icon of the seat heaters…I need to tap on top and try to move the finger down to see, and make some space… It's a little bit tricky to set the specific value… I would like to have like a small pop up here to show me the new value that I'm setting. Also it would be useful to have like the option to tap on top of the window to try to set it manually.”

P2: ”I was taught through the app that I can move the red needle... There was also one on the climate and graphs, so intuitively I wanted to move it.”

P3: ”I would automatically open the charging port like on the Tesla app because I want to change the charge limit after I plug in the charger.”

P3: ”I would like haptic feedback while selecting a charge limit value and to lock on like 50, 60, 70, or at least at recommended value… I can’t see the value I’m setting because I’m covering it with my finger.”

P1: “Yeah, because of the message, I'm just getting the hint to set it to 90% or up and that's it. I have no clue about batteries or no technical knowledge... so I’m scared to set it lower than that because I think it is bad…I question why I have the option to set it lower if I'm warned that it’s not a normal thing to do.”

P2: ”I think it would be very useful to give a hint what is the safe or common range of current to use in the chargers… It would be even useful to have expected charging time here. “

P4: ”Nice animation on charging current...I would make is timely dependent... now I need to go back to see how much time is left to a full charge and if it’s charging too fast.”

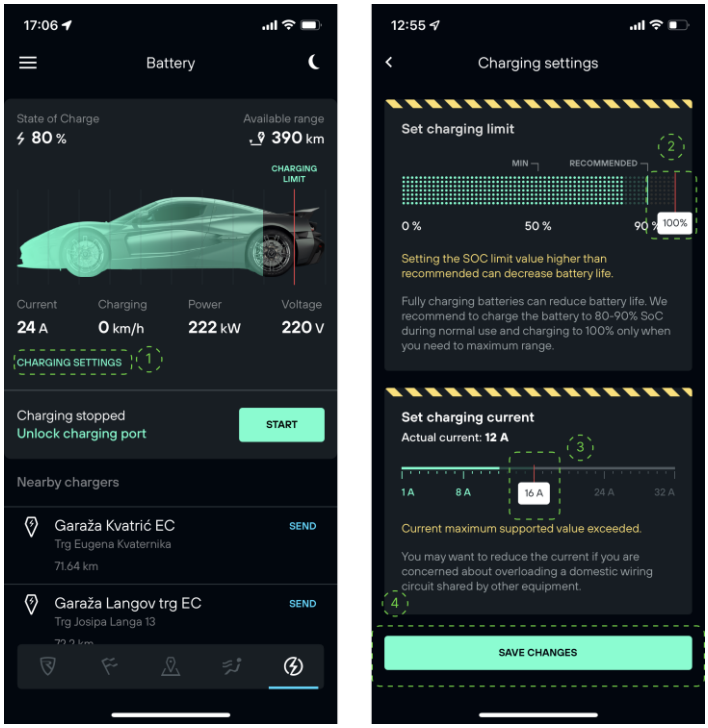


Image 74: Expected actions to complete eleventh task; Click on “Charging settings” button (1), change the charging current by moving the top needle (2) and for charging current bottom needle (3)

### 6.6.18. Results: User task twelve

**Non-critical errors** found in the twelfth user task are that:

- 2 testers (40%) stated “Unlock charging port” doesn’t look like a button/action
- 1 tester (20%) was confused by the usage of blue and green colours on the Charging page
- 3 testers (60%) expected to see an animation on a car visual as a confirmation that the car is charging
- 2 testers (40%) were confused about the km/h unit in charging speed
- 2 testers (40%) wanted to see a battery visual with the current SOC value

| Task | P1 | P2 | P3 | P4 | P5 | Success | Completion rate |
|---|---|---|---|---|---|---|---|
| Start the charge with the app | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 5 | 100% |
| **Time on the task (ToT)** | 2.3s | 1.4s | 2.4s | 1.9s | 2.1s | | |

Table 14: Success and time results of the twelfth task

**User comments** related to information and actions in twelfth task are:
P1: ”It doesn't give me the feedback that this is an action I can perform *(unlock charging port).* It looks like a tooltip that gives me further information about the action or what is this intended to do.“
P3: ”I would think that kilometers per hour are mostly for speed, so I don't know if this is actually, like kilowatts per hour. “

**User comments** related to the visual appeal of Charging card are:
P2: ”My visual interest is caught up into top portion of the screen, so I'm not seeing the message that charging in progress. It mostly cuts my attention to the images and big numbers and different colours.”
P1: ”I don't like the green colour going over the *car (for representing the percentage of the battery charged)…* I think it's messing with the image of the car. It is very bright. You’re not able to see the details of the car or anything. I would prefer to have the charging animation... like some sort of smoke around or pulsating to represent that the car is currently charging.”
P3: ”I would like to see an animation, like where the green glow is pulsating because the only difference between this screen and the one before is the start and stop.“
P2: ”This list of chargers is too much. They can be here but collapsed. There are too many things on the screen.”

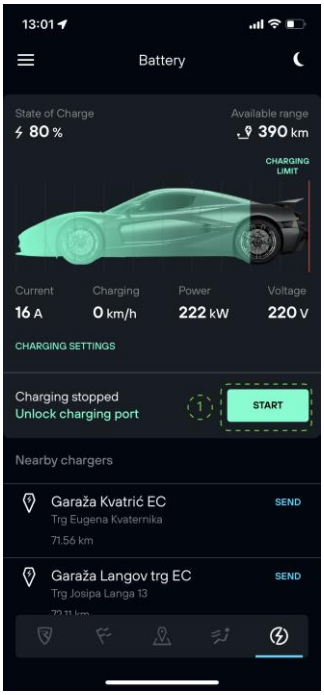


Image 75: Expected actions to complete twelfth task; Click on “Start” button on Battery screen to start charge of the car

## 6.7. Desirability testing methodology

Product reaction cards help identify users' perception of the app, and according to gathered data, it can be seen if that aligns with the values the brand wants to convey. Target users were filling out an online questionnaire where they were given screenshots from the app and afterwards needed to pick 5 adjectives which best describe the design. The list had a variety of words: negative, positive and neutral. 40% of the words were negative, 10% neutral and 60% positive. In the end the users could explain their choice and what caused these emotions.

### 6.7.1. Results

33 participants participated in the test and results were following:

- 59% described the app as **attractive**
- 50% described the app as **high-quality**
- 38% described the app as **complex**
- 32% described the app as **busy, energetic, and powerful**
- 29% described the app as **exciting, overwhelming, and impressive**

Approximately 85% of participants described the interface with at least one of the brand attributes.

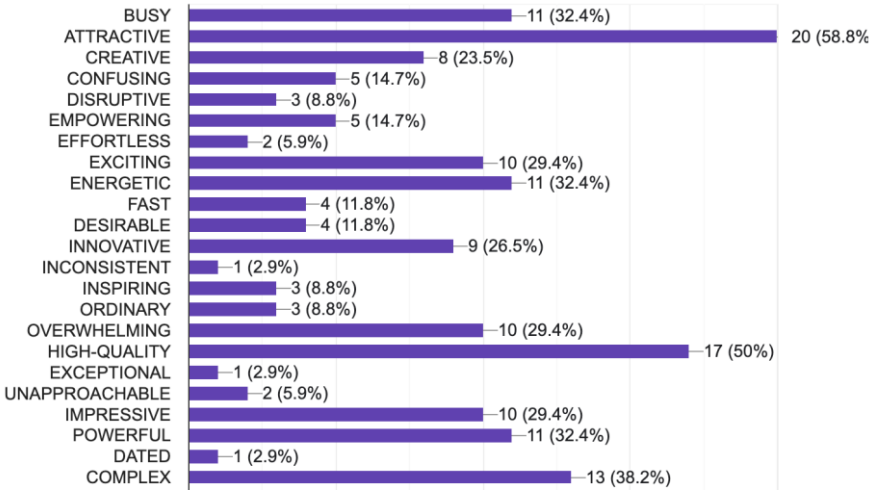


Image 76: Results of Desirability study presented in percentages

According to the questionnaire results participants had mixed feelings about the app. More than half of the participants described the app as attractive and high-quality, but almost 40% thought it looked cluttered.

The intention of the design was to convey a feeling of attractiveness, excitement, innovation, quality and energy. According to the results, some of these reactions were present while the participants were looking at the design.
Among desired results there are also unflattering ones like the ones saying the interface looks complex, cluttered and overwhelming.

The users' perception of aesthetic is important because the wrong appearance and feeling can also influence the functional perception of the app installing uncertainty and doubt in features. Visual inconsistency and crowdedness influence users' action time and decision-making. Visual inconsistency and crowdedness influence the users' action time and decision making. Users need more time to perceive elements and their connections and then decide.  At the same time they can feel confused, hesitant and even frustrated.

Participants stated following influenced in their choice of app's attributes:

- "Although the images looked high quality, I failed to find a hierarchy in info displayed and where my eyes should focus first. "
- "…a bit too much data on each screen…"
- "…Mainly the design and pictures of the car, everything looks sleek and easy to use but still with a good choice of options."
- "Design, color palette and right amount of information which are very well presented."
- "Duplicated information between first and last screen, too much information displayed at once in a single screen (reduces interaction ease depending on display size), color scheme seems to be black, blue, and red, but at the last screen is green. The theme is relatable with the Nevera, that is great."
- "There are a lot of things on the screen, not all things are relevant for the purpose the screens should display."

- “The design looks nice and powerful but it seems like I would be confused by the number of controls available on the screen at the same time.”
- “Great design, lots of information displayed which is good but it takes a second or two to figure out what you're looking at. If the navigation map will be used for real time navigation, I suggest more contrast on the road, without the shading near the edges of the screen. “
- “The nature of Nevera app is, I believe, really complexed because of the number of information it must show, but also intricacy of its calculations and accuracy they have to give to the driver. A lot of these information must be shown in the simplest way - what is complex. I think that was solved well even though some of the pages will always stay a bit busy. I think the visuals and graphs are quite exciting and inspiring, as well as its content.”

## 6.8. Overall testing results and redesign proposal

This study was conducted to present the importance of testing design solutions with real users as well as experts in the validation phase of product development cycle to get intuitive experience tailored to users. The aim was to show heuristic evaluation, usability testing and desirability testing as efficient methods for evaluation of user’s experience and gaining insights about user’s preferences information of the app’s alignment toward platform standards. Data gathered from the Heuristic evaluation have shown app’s inconsistent, confusing, and deficient elements and interactions that could potentially frustrate users and have a negative influence on the experience of using the app. These data highlighted problem areas and weak spots, which was a good starting point for usability testing with real users. Besides concerns gathered from heuristic evaluation, designers have added their own input for areas they were unsure about while designing. This information together shaped the scenario tasks users were conducting. Usability testing has shown the real problems users have while interacting with the app. Heuristic evaluation has given a full picture of the app’s positive and negative spots, but not from the user’s perspective. Usability testing has confirmed some problems discovered in heuristic evaluation as real setbacks and rejected some false assumptions.

Also, data from usability testing gave insight into user's behavior, perception, and preferences. It is discovered that users have the biggest problems with map interactions. Also, visual, and functional inconsistencies through the app have confused users. The meanings of some elements were not clear enough and available actions weren't aligned with users' expectations. Desirability testing has shown users' feelings toward visual interface and consequently revealed if the brand's attributes match with users' impressions.

Findings from usability testing that match heuristic evaluation discoveries have helped reveal real users' issues ranked by severity to be fixed and opportunities for enhancement. Issues are divided into three categories: issues to be fixed before releasing the app, problems that are going to be tackled gradually and available to users via app's updates. The last category are issues that are good to solve but will be focused on only if there is time and budget left. Troubleshooting problems with the development team and testing the app with the car is essential to achieve a good vehicle app experience. The vehicle and the app are in constant communication and therefore should be synchronized.

After finishing the redesign process, solutions are again going to be tested with users to confirm if the design is going in the right direction. In the end users will be able to use the app flawlessly and with excitement and joy. Aligning features to users' perspective and car limitations can enable to create a great product. Mobile app is addition to car experience and allows users to be constantly connected to the car. Creating an experience beyond driving is a next step to building a continuous bond with the brand and experience that lasts.

Based on the testing results the design team has decided which areas to improve and in which order by ranking them based on issues they create for understanding and usability of the app. The map section is the first one that goes into a redesign process. Special attention has been paid on the flow for creating a route plan and sending it to the car. Users' preferences and comments have been taken into consideration. Generally,

proposal is to add a button for creating a route, where user can add or delete points and see them on the map.

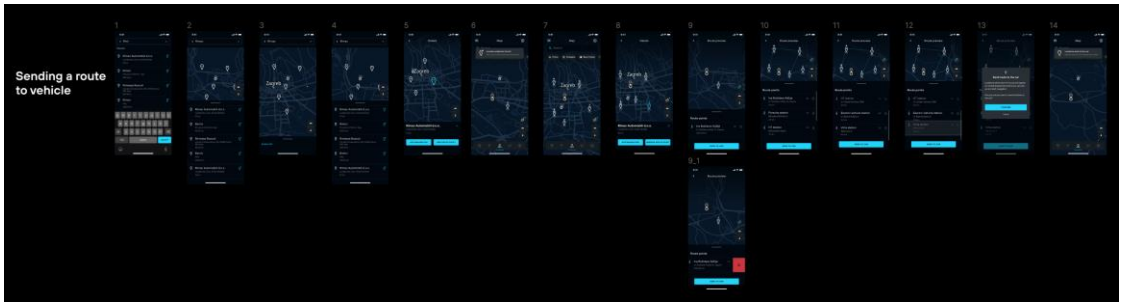


Image 77: Redesign proposal for a flow to create and send route to the vehicle

The second step has been to align the style guide and additionally define it where needed to leave no room for speculations. Testing results have indicated inconsistency in typography styles, so adjustment to the existing styles is being made. Also, buttons in all states are being analyzed to remove contradictory and improve difficult to understand states. Besides typography colour style guide has been adjusted.

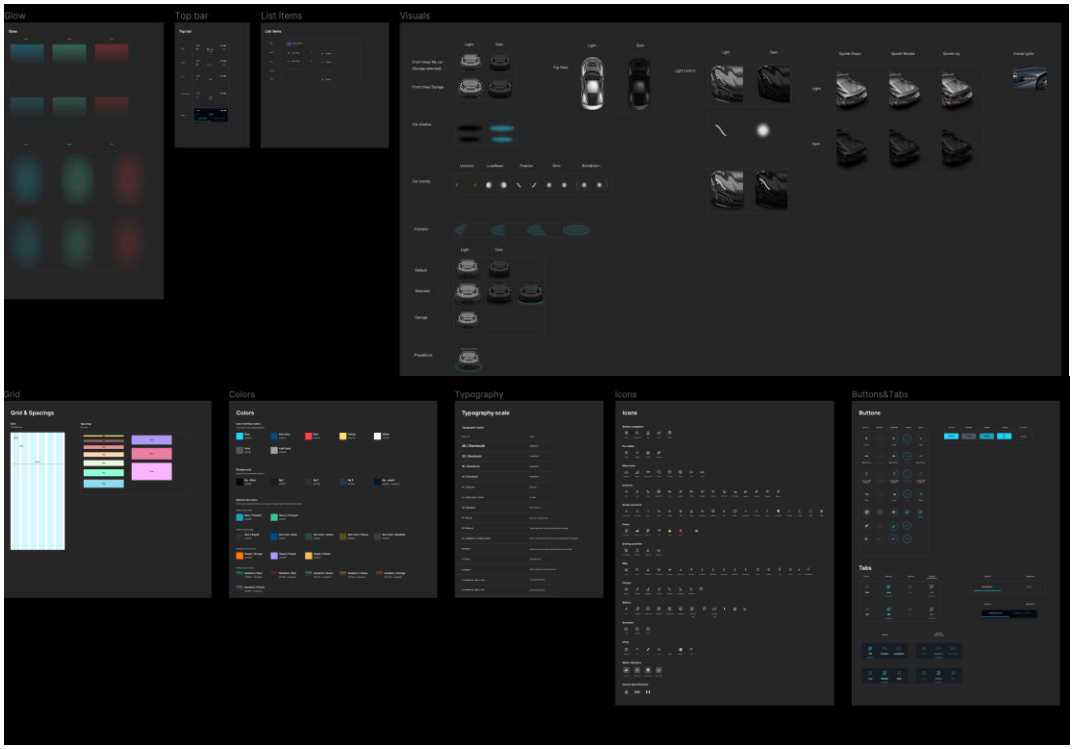


Image 78: Proposal for a style sheet

Another area of improvement is charging card with actions of changing charging limit and current on the Charging screen. In order to fulfil the user's expectations and keep the actions consistent through the app, a red pin is placed as an interactive element. By clicking the needle user can change the charging current. Information on the vehicle card has been prioritized, so the visual hierarchy can be created. "Unlock charging port" button, which looked unclickable, has been replaced with an icon. In the redesign proposal whole "Charging settings" page has been deleted and changing charging current can be done on charging card with a stepper button.

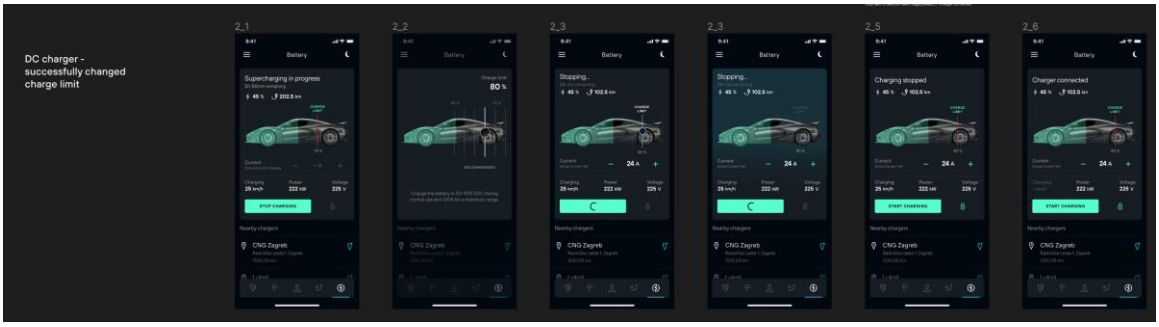


Image 79: Redesign proposal for a flow to change charging limit during DC charging

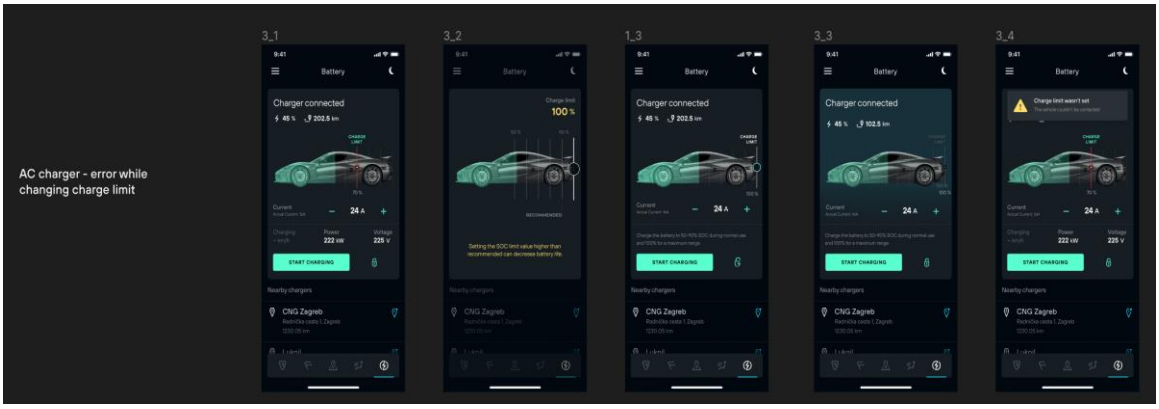


Image 80: Redesign proposal for a flow to change charging limit during AC charging

# IV. CONCLUSION

Findings from the Heuristic analysis, Usability and Desirability testing have pointed out the app's weak points and helped improve its usability. Heuristic evaluation is a good method for finding functional and visual inconsistencies and potential issues for the users. It gives a good basis for further testing with the users since it discovers which areas of the product do not follow design or platform guidelines. Usability testing is an essential research method to determine the simplicity of the product usage. Designers' assumptions about users and experts' assessments in heuristic evaluation are proved or discarded by the real users. Usability testing shows how the user uses the app, which elements and actions are intuitive and which confusing. Quantitative data like the percentage of success task completion show if the user knows how to use a specific feature. However, whether user had problems with it cannot only be seen from qualitative data, but also from the time spent on the task. Even if the user finishes the task successfully, the time spent on the task is the first indicator that shows if the user was confused or struggled. Qualitative data confirms numeric data and gives the reasoning behind the user's actions. Gathered information about user's perspective and preferences help align the interface toward the user's expectations. Moreover, the user's perception of the app shapes feelings while using the app and indirectly effects on the perception of the app's usability. Visually cluttered and complex interfaces look hard to use and convey a feeling of insecurity.

Only choosing one of the mentioned methods during the testing phase of the product development process would give partial and potentially misleading data. Considering the limited resources of the company, it is always best to choose the usability testing method. The heuristic evaluation method, if conducted separately, can give deceptive results since it is not done with real users. Usability testing has showed that target users are mostly focused on functionality and not on small details (as long they don’t affect usability). Furthermore, some data from heuristic evaluation are contrary to usability testing results because UX just assume the users’ thoughts. While assessing the user experience of the product the most accurate and valuable data are gathered from users who will eventually be consumers of the app. Nevertheless, the heuristic evaluation

method is a good pointer for designers to see what principles they need to follow in future products to be successful on specific market platform. From aesthetic point of view, visually cluttered and complex interfaces look hard to use and convey a feeling of insecurity.

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