CHALMERS
UNIVERSITY OF TECHNOLOGY

Youths as Passengers in Cars

A behavioural study on user experience and safety

Mio Gereben & Maia Swenson

Master's Thesis in Industrial Design Engineering and Product Development

DEPARTMENT OF INDUSTRIAL AND MATERIALS SCIENCE
Division Design & Human Factors

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020
www.chalmers.se

Master of Science Thesis (IMSX30)

Youths as Passengers in Cars – a behavioural study on user experience and safety

In collaboration with Volvo Cars Cooperation

Cover Illustration: Behavioural Archetypes from project

Cover made by Mio Gereben & Maia Swenson

Chalmers University of Technology

SE-412 96 Gothenburg, Sweden

Print: Repro Service Chalmers

Gothenburg, 2020

Master of Science Thesis

Youths as Passengers in Cars

A study on user experience and safety

MIO GEREBEN • MAIA SWENSON

Supervisor Company: **Samuel Palm**
Supervisor/Examiner Chalmers: **Anna-Lisa Osvalder**

Department of Industrial and Material Science - Division of Design & Human Factors
CHALMERS UNIVERSITY OF TECHNOLOGY - Gothenburg Sweden 2020

Acknowledgements

This is a Chalmers Master Thesis at the Department of Industrial and Materials Science under the programs Industrial Design Engineering and Product Development.

The project would not have been possible to perform without the help and support of the people and company involved in our project.

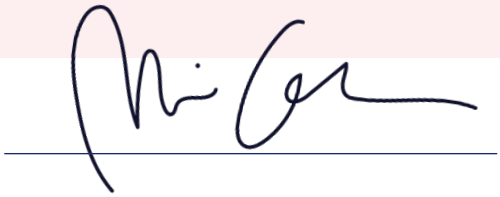
First of all, we want to thank Samuel Palm for his immense support, patience and time in being the main supervisor of this project at Volvo Cars. Without your challenging questions and input, the project would not have become what it is today. Also, we want to thank Anna-Lisa Osvalder for her academic support and professional guidance throughout the project as the supervisor and examiner at Chalmers University of Technology.

Also, a big thanks to Volvo Cars for taking in this project and for supporting us with venues, computers, materials, cars, time, and endless expertise.

Besides, we want to thank the support group from the research project 'Assessment of Passenger Safety in Future Vehicles'. Especially to Katarina Bohman for your expertise and knowledge within safety and biomechanics, to Pernilla Nurbo for your expertise and knowledge within ergonomics, and Lotta Jakobsson for your professional input and for arranging the valuable presentations.

We would also want to thank other experts for contributing with their input and support to the project. Thanks to Sara Renström for contributing with your expertise within user studies, Sara Alpsten for contributing with your expertise within ergonomics, Daniel Jungegård for contributing with your expertise within technical implementation, Christoffer Kopp for contributing with your expertise within user experience, and Fjollë Novakazi for contributing with your academic expertise.

Last but not least, we want to show our enormous gratitude to all children and families who participated in our different user studies. Thanks for your engagement, input, and spirit. Your input was invaluable!



Mio Gereben

Maia Swenson

Abstract

When youths travel in cars, they are not just sitting still and looking straight forward. Cars are today designed and constructed based on the needs from a wide range of users, and previously there has not been a project exploring the needs and activities of youths explicitly.

The purpose of this Master's Thesis Project is to investigate how youths between the ages of 10-17 years behave in cars and what activities they do. And by doing so, understand how this affects their experience, comfort and safety.

The aim is fulfilled by the research of four main areas. Firstly, a methodology for the user studies of the target group is developed and evaluated. Secondly, the needs of youths are explored and mapped through the implementation of the methods. Thirdly, what activities this target group performs and would like to perform when travelling in cars, and how the activities affect the youths' sitting postures and safety in the car is studied. Fourth and last, a design concept, intended to increase safety and enhance the user experience, is proposed. The result is also divided into the four main areas, presented below.

The methods developed and used in the study are *Parent Interviews*, *Instagram Diaries* and *Family Home Sessions.* The evaluation of the methods and the number of insights they generated, indicates high suitability for the target group and the aim of the study.

The result of the mapping of the needs is communicated and prioritised through an Impact Map including the seven Behavioural Archetypes 'The Fun Seeker', 'The Solo Rider', 'The Social Butterfly', 'The Time Killer', 'The Set-Upper', 'The Pilot', and 'The Harmony Seeker'.

The analysis of the sitting postures results in the finding of critical and desirable sitting postures for different activities. Some of the most critical activities found are: different types of phone activities, talking to a person in the front, sleeping, watching a movie together in the back seat, and looking at a phone showed by another person in the car.

The result of the design concept development is a back-seat entertainment system, including an adjustable touch screen, a safe wireless phone charging place, a suggestion for the content of the interface, and enabling using a phone as a control. The design concept is likely to fulfil the highest-ranked needs of the behavioural archetypes. Evaluations indicate that the design concept improves most of the critical sitting postures, and thereby also the safety of the target group.

Lastly, areas of further development for the methods and the design concept are suggested. The three most important recommendations are to perform conventional user study methods and compare them to the methods developed in this project, perform a sitting posture study with participants from the target group for the found activities, and validate the concept with users in the actual context, both regarding user experience and safety.

Keywords*: youths, cars, activities, behaviour, user experience, safety, design, sitting posture, user studies, impact map.*

Table of Contents

1. INTRODUCTION

In this chapter, an introduction of the thesis is presented. This includes the background, information of both the company and the research project, the purpose, the aim, and the limitations.

01

1.1 BACKGROUND

When youths are travelling in cars, they are not just sitting still, looking straight forward, and buckled up in an optimal sitting posture. Youths are doing several different activities. Today, cars are developed based on a wide range of users, and previously there has not been a project exploring the needs and activities of youths explicitly. The car might not be adjusted to the activities they are performing today or other ones they would like to perform.

Also, according to Simpson et al. (2019) the mobility of today will go through a transformation in next couple of years, mainly within the three different areas: electric vehicles instead of combustion engines, connected and autonomous vehicles, and mobility-as-a-service. Due to this transformation, the role and context of a car will most likely change. Therefore, it is interesting to research and gain insights on desirable activities of young people. What activities the target group wants to perform and would be able to perform in future cars might be very different from what is seen today, which will affect their behaviours and needs. Because of this, there are opportunities in studying and improving the experience, comfort, and safety of young car passengers, both today and in the future.

Regarding activities and safety in cars, there seems to be a research gap between children above ten years and adults. It is possible to find extensive research conducted about younger children in cars, who need different types of car seats, but when looking at the ones that no longer need car seats but are not yet allowed to have driver's license, the amount of research is significantly lower. This research gap for the user group can also be found for other areas, and it is, therefore, hard to find well-tried methods for gathering data about this group.

1.1.1 Assessment of Passenger Safety in Future Vehicles

This thesis is initiated by a research collaboration between Volvo Cars Cooperation, Chalmers University of Technology, and Autoliv. The research project is called 'Assessment of Passenger Safety in Future Vehicles'. The aim of that project is to understand how to assess the protection of the heterogeneous population of passengers in future car crashes (SAFER, 2019). The purpose of this is to develop personalised restraints for all passengers whom today are using the seatbelt as a primary restraint. During the research project, it was understood that there is a research gap regarding safety specifically between younger children using different types of car seats and adults. This regards children between the ages of 10-17 years. Based on this understanding, the subject of this thesis was developed.

1.1.2 Volvo Cars

This thesis is done with Volvo Cars, at the department Customer Experience Centre. Stakeholders within Volvo Cars for this thesis are mainly the departments of safety, ergonomics, and user experience.

Volvo Cars have been producing cars for almost 100 years. An important part of their business concept is that the user and their safety come first. Therefore, user experience is a central part of the research and development of their cars.

For the company, Volvo Cars, this study is interesting since more extensive knowledge about the specific target group would be a new valuable asset in the development of future cars. Especially since the cars of the future will enable different behaviours of the passengers. In addition, there is a hypothesis that the sitting postures for youths are affected by the different activities they perform in cars and, when gaining an understanding of this, the cars can be designed to improve youths' experience, comfort, and safety.

In addition, it is of interest for the company to understand what methods are suitable when researching the needs of youths. Because of this, the methods used in this project and how well they achieved finding the needs of youths, is valuable knowledge for the company. This knowledge could support choosing methods in future projects within research and development related to youths.

1.2 PURPOSE

The purpose of this Master's Thesis Project is to investigate how youths between the ages of 10-17 years behave in cars and what activities they do. Based on the findings, a solution should be designed to enhance their experience and increase safety. In addition, the chosen methods should be evaluated based on their suitability on the target group and how well the method support finding the target groups' needs.

1.3 AIM

By creating a rich picture of youths (10-17 years old) through user studies, a broad and deep understanding can be developed. To understand this completely, it is of importance to understand youths' interests and hobbies, when they travel and why, and their perception of travelling in a car. Also, it is of relevance to investigate what probable needs youths might have in the context of a future car.

This Master's Thesis Project aims to find out how youths behave and what activities they want to perform when travelling in cars, today and in the future. And by doing so, understand how this affects their experience, comfort and safety.

From these findings, the aim is to propose one or several design concepts for future cars. Another part of the aim is to evaluate appropriate methods based on their ability to support in finding the needs of the target group.

1.3.1 Specification of the Issue Under Investigation

Based on the aim of this Master Thesis, the project work focuses on four main areas:

1. What are the *needs* of youths between 10-17 years when travelling in cars *today* and what could be the needs of youths when travelling in cars *in the near future?*
2. How will the *activities* in cars affect the *sitting posture*?
3. Based on the needs of youths, what is a possible *design* to support their activities in cars while at the same time offer a *satisfactory* and *safe experience*?
4. What *methods* are suitable to use when investigating the behaviours and needs of youths in cars?

1.3.2 Deliverables

Relating to the four main areas, the intended outcome and deliverables of the project were:

1. Mapping of the needs of youths between 10-17 years when travelling in cars, today and in the near future.
2. Analysis of how the activities of youths in cars affect their sitting posture.
3. A visualised design concept(s) meeting the found needs and requirements of the target group.
4. An evaluation of the used methods and their usefulness for finding the needs and behaviour of the target group.

1.4 LIMITATIONS

To perform this project, several limitations were applied and are listed below.

- The project is limited to two people performing the project full-time for 20 weeks ending in mid-June 2020.
- The study is limited to research children and families living in Sweden.
- Only context where cars are privately owned are included in the study.
- There was no consideration regarding functional or cognitive variations when recruiting participants to the study.
- For safety reasons, all studies and testing inside cars are static.
- The design concept should be implementable in the near future, in 5-10 years.
- The concept should be implementable in the back seat of the car.
- The cost of the concept is not considered.

2. THEORY

In this chapter, theory related to the project and the subject is presented. This includes factors to consider when designing for youths, the phone usage of youths, previous performed sitting posture studies, and lastly a section regarding the future of mobility.

02

2.1 DESIGNING FOR YOUTHS

The target group for this study are children and youths between the ages of 10-17 years. When studying children and youths there are mainly two factors that are important to consider. Firstly, it is of the essence to understand in what ways children and youths differ from adults. Secondly, the way user studies are performed must be carefully chosen and modified to suit the target group (Börjesson, 2019). These two aspects, and the phone usage of youths, are further reviewed below.

2.1.1 Cognitive and Physical Development of Children

There are different definitions of what a child is. A conventional definition is stated in the UN Convention on the Rights of the Child; "a child means every human being below the age of eighteen years unless under the law applicable to the child, majority is attained earlier" (1989). The differences between children and adults are mainly due to five factors. These are physical development, cognitive development, social development, concentration, and experience (Börjesson, 2019). These include stages of development for children. This applies for the target group of this study as well, the children and youths between the ages of 10-17 differs and should thus be divided into subgroups. A commonly used way of dividing children into subgroups is Piaget's Theory of Cognitive Development, which is based on the four aspects maturation, experience, social aspects and emotions. Another way of dividing the target group into subgroups is based on the different stages of schools, which also is based on development. In Sweden, this would be middle school including ages 10-12, junior school including ages 13-15, and high school including ages 16-17. This approach might be even more appropriate for this study since the study is performed in Sweden, and that type of division of children is commonly used and accepted.

2.1.2 Phone Usage of Youths in Sweden

In a report from the Swedish State Media Council, it is shown that the majority Swedish youths between 9-18 years old use their phone every day, the usage in the age range is above 95% (Ungar & medier 2019, 2019). Looking into the usage of the internet during their spare time 78% of 9-12 years old, 96 % of 13-16 years old, and 97% of 17-18 years old, claim that they use the internet every day. Another part of the report explains the social media usage, such as Instagram, Facebook, Twitter and Snapchat. 59% of 9-12 years old, 95 % of 13-6 years old and 97% of 17-18 years old use social media.

When looking into what social media is the most popular in the different age ranges it differs slightly, see Figure 1.

Figure 1 - Top five social medias 9-18 years old in Sweden

9-12 years	13-16 years	17-18 years
Snapchat 52 %	Snapchat 88 %	Instagram 82 %
Instagram 34 %	Instagram 84 %	Snapchat 81 %
TikTok 9 %	Facebook 23 %	Facebook 51 %
Facebook 6 %	Twitter 11 %	Twitter 11 %
YouTube 4 %	YouTube 8 %	YouTube 5 %

Furthermore, in the report, it is possible to conclude that the usage of phones has increased while the usage of other media such as computers, tablets, and hand-held controls decrease. This is argued to be an effect of the smartphone converging functions, including both games-, tv- and computer alike functionality (Ungar & medier 2019, 2019).

2.1.3 Engaging Youths in Design Practise

When designing for youths there are many benefits of engaging them directly in different phases of the design process. According to Hagen et al. (2012), it can give the researches new valuable insights, could be a way to find the source of different problems, gives the project more credibility, and can be a way of creating acceptance among the target group since it assures that their motivations and attitudes are taken into account. It is a fast-changing world and engaging young people while at the same time being able to get a rich picture of their lives is essential for understanding their different needs. It is, as mentioned, important to choose and modify methods to be applicable to children and youths because of, comparing to adults, the differences in cognitive abilities, motivations, desires etc. Engaging youths and children in the design process comes with both challenges and opportunities. Children can have difficulties understanding abstraction and conceptual problem solving, they will often try to tell the user study leader what they think they wish to hear and family members might need to be present which could influence the result (Börjesson, 2019). Since conventional methods often are based on the cognitive level of adults, they might need to be adjusted in order to generate insightful results when used for younger people.

There are numerous methods that can be used for engaging youths in design, and Börjesson (2019) claims that "Particular behaviours can only be understood in the everyday context in which they occur". By this, he means that a successful approach is to meet them in their context where they are comfortable and can show and explain what is important for them. He further suggests recording or taking photos during the sessions since it makes it possible for the researcher to be in the moment and not having to take notes simultaneously. Another important aspect, he claims, is to level with them e.g. by talking to them about things they find interesting and important.

As well as other things, what motivates and creates engagement among youths and children also differs from adults. It is therefore important to understand what excites them and is meaningful to them. One way is to look at what they consume and do in their everyday lives. According to Bowen et al. (2013), engaging them in activities that refer to 'popular culture' (TV-shows, social media etc.) were successful. According to Hiran et al. (2018) cash rewards and being viewed as someone with authority could also work as a means to motivate them.

Regarding doing workshops with youths, there are several aspects to consider in order to be successful. The session should preferably be 30 minutes to 2 hours depending on age, otherwise, that could affect their ability to stay focused or motivated (Hiran, Fleming, Hetrick, & Merry, 2018). Hiran et al. (2018) further claims that the workshop should be productive, and the tasks should be clear and if possible, also held short if the motivation among the participants is low.

Another way to engage youths in design is to use digital media. As described in chapter 2.1.2, the use of social media and other smartphone-related activities is highly incorporated in the lives of youths. According to Hagen et al. (2012), social media provides opportunities to relocate the design activities to the place where a large part of the social interaction of youths takes place. Further, four positive aspects with the use of social media for these purposes were suggested; it is 'ongoing' which creates opportunities to have a continuous relationship with the participants, it is informal and accessible, it provides means of youths to give feedback in ways they are used to (commenting, liking etc.), it is possible to scale up or down a study and for people living in different locations to participate, and lastly it is possible to make it anonymous. The thought of using digital media for researching purposes is also supported by Pink et al. (2016) who claims that it is beneficial since digital media and technologies are highly incorporated in peoples' everyday lives and for that matter also highlights the importance of it having to work for both participants and researchers.

Finally, engaging youths and children in design research puts a high demand on ethical considerations. It is important that both the youths/children themselves and parents/guardians give their consent. The child or youth should always be able to drop out, and signs of distress should be monitored by the researcher in the case that the child/youth does not dare to express this. (Börjesson, 2019)

2.2 SITTING POSTURE STUDIES

So far, there are not any extensive studies done exploring the sitting posture of youths between the ages 10-17 years. However, several studies of younger children and their sitting postures can be found. Figure 2 and Figure 3 shows methods for systematically measuring and evaluating the sitting posture of a passenger in a car (Jakobsson et al., 2011). As seen in Figure 2, the scheme distinguishes between the sagittal (fore to aft) torso and head position.

The different torso positions vary from 'a' where the entire shoulder, middle and lower back is touching the seat, 'b' where the shoulders lose the contact with the seat but the rest of the back is touching it, 'c' where no part of the back touches the backseat, 'd' the entire torso leans forward and, 'e' where the upper back is touching the backseat but the lower back is "slouched" forward. The head positions are represented as 'a' where the head touches the neck rest/backseat, 'b' when the head is straight up following the line of the back, and 'c' where the head is tilted forward. The lateral sitting posture has three classifications according to Figure 3. Starting from the left 'A' is straight, 'B' slightly tilted but within the lines, and 'C' heavily tilted and shoulders outside the lines.

2.3 LOOSE OBJECTS IN CARS

It has been shown that loose objects inside car cabins have caused several serious injuries or even deaths in the case of car crashes or emergency braking. This is not only heavy and large objects but can also be smaller objects, that turn into projectiles based on the speed of the vehicle. The impact of a loose object "will have a relative force equal to the object's weight multiplied by the speed in which it travels" (Avrahami et al., 2011). According to the study by Avrahami et al. (2011), where the number of loose objects brought into a car by 25 participants, 17% were phones, laptops, GPS, music players, and cameras. They further claim that these objects can result in fatal accidents during, for instance, side collisions if placed next to the driver.

2.4 FUTURE OF MOBILITY

The mobility of today is currently going through a transformation. The transformation is mainly based on three different factors: electric vehicles instead of combustion engines, connected and autonomous vehicles, and mobility-as-a-service (Simpson et al., 2019). This transformation creates a shift within the industry as well, with new businesses emerging, converging, and disappearing. Therefore, existing businesses must be alert for change if striving to maintain a share of the market in mobility. When looking into mobility-as-service there are four main categories: personal use, shared personal mobility, public transport, and commercial use. This change will affect the way people travel and the ownership of cars, which will change the needs and demands of the users.

When looking into opportunities with autonomous drive, it is possible to find several concept cars released by existing mobility providers. One of these is the Volvo concept car 360C, where no human driver is needed (Volvo Cars, n.d.), see Figure 4. This concept car has SAE (Society of Automotive Engineer) level 4 or above of autonomous drive (SAE International, 2018). The 360C presents the opportunity for the interior with different seating constellations and even an option with a bed-like seat. This opens for other types of activities than what is possible in the cars of today.

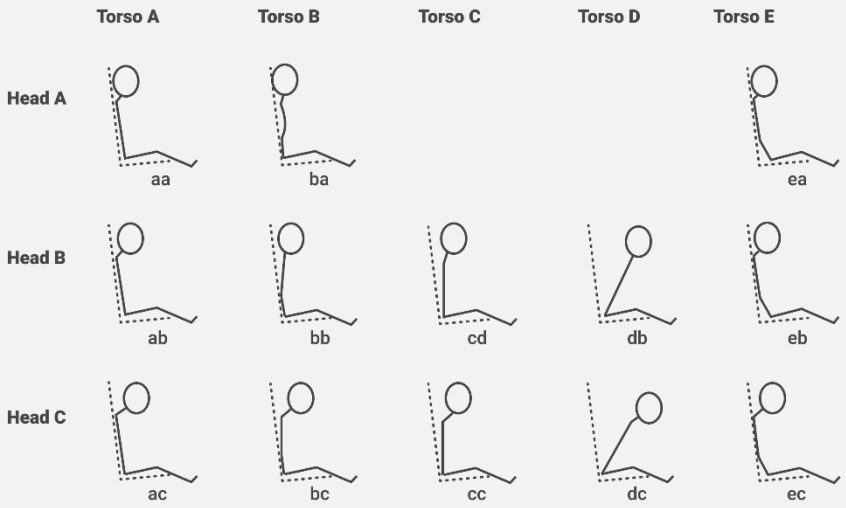


Figure 2 - Sagittal sitting postures (Jakobsson et al., 2011)

Figure 3 - Lateral sitting postures (Jakobsson et al., 2011)

Figure 4 - Volvo 360C interior office (Volvo Cars, n.d.)

3. METHODOLOGY

In this chapter, the theory of methods that were used in the project is presented. This includes both general design methodology theory, but also the theory of specific methods.

03

3.1 CONVERGENCE AND DIVERGENCE IN DESIGN

According to experiences Nilsson Wikberg et al. (2015), a design process contains multiple phases of divergence and convergence, see Figure 5. The divergence phases mean that the solution space is broadened, i.e. more solutions are sought and defined. The convergence phases are the opposite to the divergence phases, in which the amount of solutions is decreased either by discarding the ones that do not e.g. meet requirements, or by combining different ideas. In the end of such a process, many different ideas have been explored and evaluated.

3.2 PYRAMID OF KNOWLEDGE

There are four different types of knowledge that researchers can gain insights from, see Figure 6. The first is the *explicit level* which people often verbally can share. Therefore, interviews, see chapter 3.3, or questionnaires are suitable to use when wanting to access this type of knowledge. The second one is *the observable level*, which is about what people do and how they use things. This is harder for people to express and different kinds of observations are needed for understanding these types of behaviours. The third level, *the tacit*, are things that people know, but they do not know that they know. They can act according to this type of knowledge but cannot explain why easily. The fourth level contains *latent needs* which are needs that people are not yet aware of, i.e. future needs. The third and the fourth level can be reached through generative techniques, further described in chapter 3.5 (Sanders & Stappers, 2018).

3.3 INTERVIEWS

Interviewing is a qualitative method which is based on asking users questions with the purpose of understanding them by gaining knowledge about their experiences, attitudes, motivations, knowledge, etc. It can be useful in several different phases of the design process. In the early phases it can be used as an exploratory method to gain knowledge about the user while in the latter phases it can be used to gain feedback on a concept (Nilsson Wikberg et al., 2015).

There are three types of interviews: structured, unstructured and semi-structured. Structured is pre-determined questions which is asked from the top to the bottom, in a structured way. Unstructured is without preparation asking sporadic questions, often creating a sense of a natural type of conversation. Semi-structured is somewhere in between the two, when questions are pre-determined, but the interviewer can probe and ask other questions related to the answers of the interviewee (Nilsson Wikberg et al., 2015).

It can be useful to use mediating tools to help the interviewee relate or remember, which can allow more depth and enhance a discussion. A mediating tool is some type of stimulus to support creating reflection and focus (Wallgren, 2016).

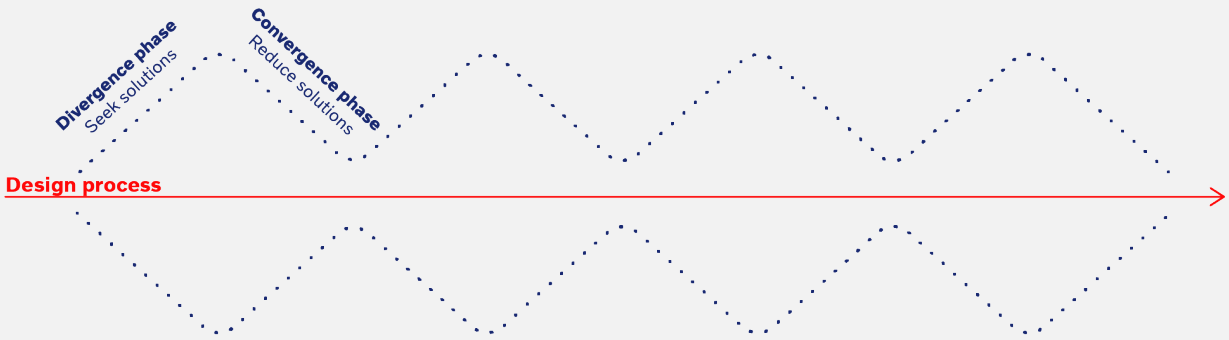


Figure 5 - Divergence and convergence in a design process

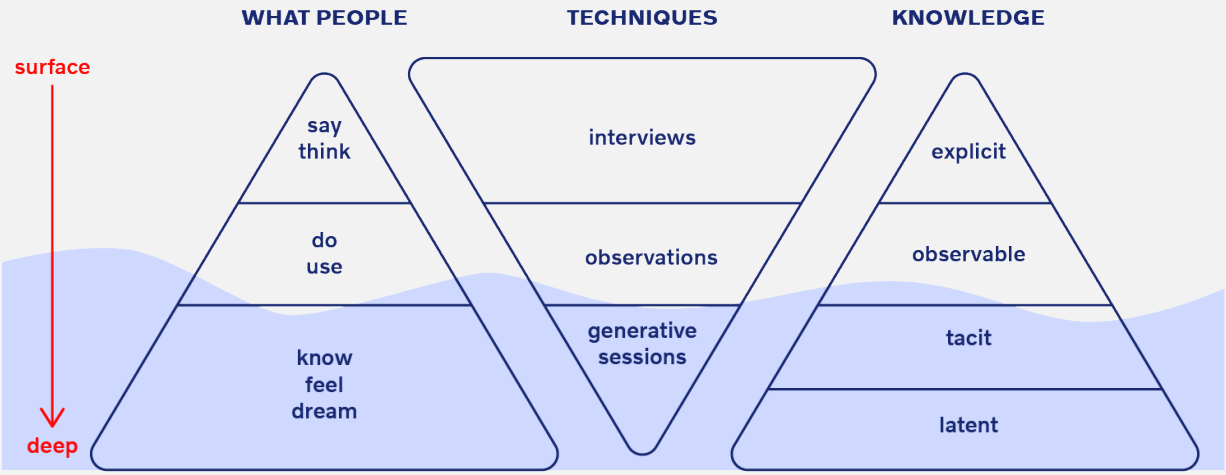


Figure 6 - Pyramid of Knowledge, inspired by Sanders & Stappers (2018)

3.4 PROBES

Understanding the behaviour of someone in their everyday life can be challenging. Both because it is difficult for a user to recall what they did in a specific situation but also since they might not be aware of their own behaviour (Renström, 2019). As seen in chapter 3.2, different types of methods can be used to reach different depths of knowledge. Probes is a group of methods where the users explore and document their own needs and experiences (Nilsson Wikberg et al., 2015).

Something that the probe methods have in common is that they benefit from sending packages to the participants. A package should include material for the participants to be able to perform the method, an instruction, or any other pre-requisite experiences (Nilsson Wikberg et al., 2015). The package should be experienced as playful yet professional, since it should be fun to participate but at the same time the participants should know that they are taken seriously (Sleeswijk Visser et al., 2005). It can also be motivating to include a picture of the organiser of the study to make it more personal, and some type of small gift as a first incentive, such as candy or similar (Renström, 2019).

3.4.1 Experience Sampling Method

One type of probe method is called Experience Sampling. The Experience Sampling Method is based on snapshots from the user which can include behaviours, interactions, thoughts, moods or feelings. These snapshots are self-reported in real time when signalled and often includes both photo and text. It can be both digital or analogue (e.g. paper and pen), random or set intervals. How the users are signalled can be based on e.g. location, messages, calls, or notifications (Renström, 2019).

3.4.2 Diary Studies

Another type of probe method is Diary Studies. These are self-reporting by the user and include personal details. It can be more or less guided, if guided it includes some type of questionnaire and if less guided it is more dependent of each participant. It can be performed both digitally or analogously, and event-based or not (Renström, 2019).

3.4.3 Sensitisation

The purpose of sensitising is to prepare participants for a generative session. It is used to trigger, encourage, and motivate the participants to start thinking, reflecting, wondering, and exploring their own personal experience related to a product, context, or similar. The participants perform the sensitising on their own, close in advance to the generative session. The material and instructions to be able to perform the sensitising can be sent home and be performed typically for one or more weeks. It is based on exercises for the participants to think about past experience and reflect about their present experience (Sleeswijk Visser et al., 2005). The material created during the sensitisation can also be used for analysis (Renström, 2019).

3.5 GENERATIVE TECHNIQUES

The generative design research is a part of the participatory design research field, as can be seen in Figure 7 (Stappers & Sanders, 2008). Unlike other research methods, the tools developed within the generative research field focus on gaining insights on experiences from the participants on a tacit and latent knowledge level. The participants can more easily share understandings about what they know, feel, and dream which creates a deeper understanding of their experiences (Sanders & Stappers, 2002).

The methods and tools that are used in generative design research are often seen as different types of *co-creation*, which according to Sanders & Stappers (2008) refers to "any act of collective creativity, i.e., creativity that is shared by two or more people.". The principles behind this is that people, through the creative process, more easily can access and express their experiences. This is often done by letting participants hands-on create some sort of artefact and then let them explain their thoughts behind their creation. These artefacts can be everything from collages, drawings, scenarios, enactments, or other things that allow the participants to create something. It is often done in small steps in order to guide the participant and to reach the goal of the activity.

One way of structuring a co-creative session, is to use the model of *Experience Domain* which can be seen in Figure 8. By first processing their present situation and then go into past experiences, people can also reflect on and express their future desires and needs. (Sanders & Stappers, 2018)

3.6 CONTEXTUAL INQUIRY

A contextual inquiry is an interview in the specific context of an interaction between a product/service and the user of it (Renström, 2019). It was originally used for gaining insights about work environments and structure. This is done through simply going to a person's work and asking questions about the things they do. By spending time in the actual context, the researcher can immerse themselves with the user and get in-depth insights about things in the environment that otherwise might have been missed if e.g. the interview had been held in the office of the researcher. This could be completed with enactments such as a walk-through of a specific task. A method like this could allow for reaching observable knowledge levels by taking part of what people actually do in the correct context (Renström, 2019).

3.7 KJ ANALYSIS

When collecting data, it is of high importance to not interpret the data directly since this can lead to misinterpretations, but to perform an analysis before interpreting data. One method for qualitative analysis is KJ Analysis, also known as Affinity Diagram. It is used to structure great amounts of qualitative data into groups. These groups can be named to different categories based on its content, which then can be analysed and be used for extracting needs. For instance, quotes from interviews can be grouped into categories based on what the interviewees have referred to. (Wallgren, 2016)

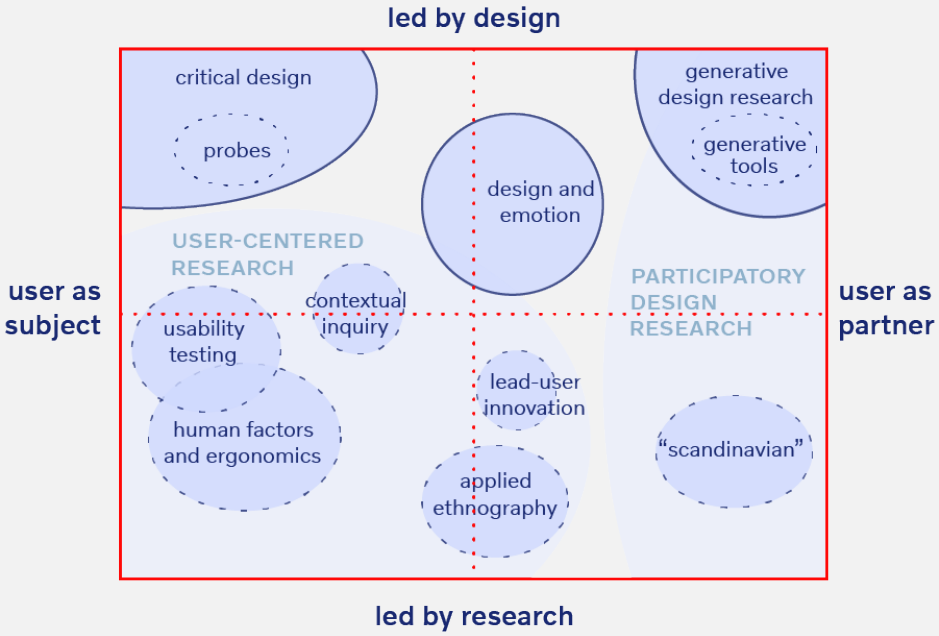


Figure 7 - Landscape of human-centred design research, inspired by Stappers & Sanders (2008)

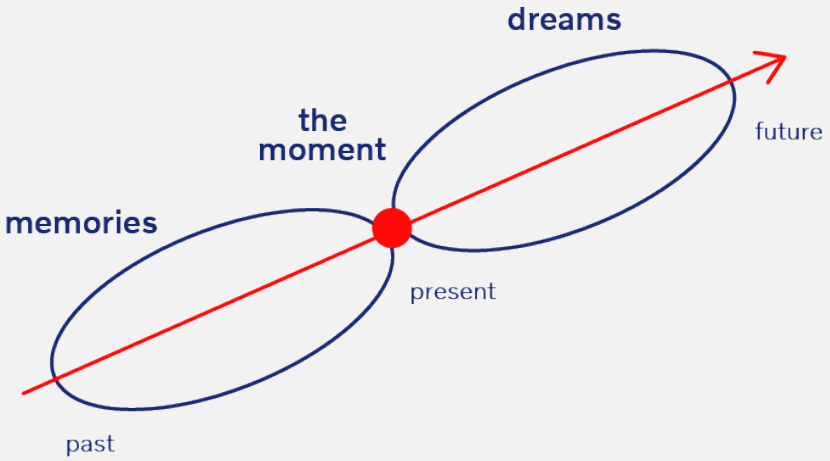


Figure 8 - The experience domain, inspired by Sanders & Stappers (2018)

3.8 PERSONAS VS. BEHAVIOURAL ARCHETYPES

Personas is a commonly used method in user-centred design, originated by Alan Cooper (1998). A persona is a hypothetical archetype, of a real user. Based on what is learned regarding the users, personas are discovered and to some extent also made up. It is a description of a user based on the users' goals and is thus a tool for designing and meeting the goals of that specific hypothetical archetype (Cooper, 1998). Some are criticising the value and purpose of personas. Cabrero et al. (2016) claims that personas can lead to misinterpretations based on the misrepresentation of fictive users. Also, personas can be interpreted differently by different cultures. Doneva (2017) mention that the usage of a persona refers to an individual which brings a subjective interpretation.

An alternative to personas is the use of behavioural archetypes, where the characteristic behaviours of groups of users are described based on their motivation, general attitudes and traits. It is based on who (does what), how (they do it), and why (they do it) (Doneva, 2017). Young (2016) suggest ditching demographics and preferences from the descriptions of personas since these can become "distracting barriers". An option mentioned is to create a representation of a group with so called thinking styles, also known as behavioural audience segment, to keep away from names and photos which are not necessary for design (Young, 2016). This resembles the behavioural archetypes described by Doneva (2017). In addition, by creating behavioural archetypes it is possible to connect this to the business impact and thus prioritize what behaviours to design for (Domingues, 2018). This can be done in combination with a so-called Impact Map.

3.9 IMPACT MAPPING

Impact Mapping is a method for strategic planning and visualization. It is based on connecting behaviours of users to their needs, capabilities and functions to meet those needs. This is done to be able to prioritize among functions based on what can make the greatest business impact (Berndtsson et al., 2014). The method is based on three levels: why, how and what, which is shown in Figure 9 (Domingues, 2017). After visualising the three levels, the needs should be evaluated based on their impact to each user behaviour. The result is an indication on which needs will give the most impact when solving it.

3.10 REQUIREMENT SPECIFICATION

Requirements describe what should be addressed when developing something and how a solution should be like. It can also be seen as a carrier of knowledge throughout a project. A Requirements Specification is a collection of the requirements and desires, still distinguishing the two. A Requirements Specification is even more useful when including underlying intent of each requirement as well as specifying how the requirement should be verified. (Almefelt, 2019)

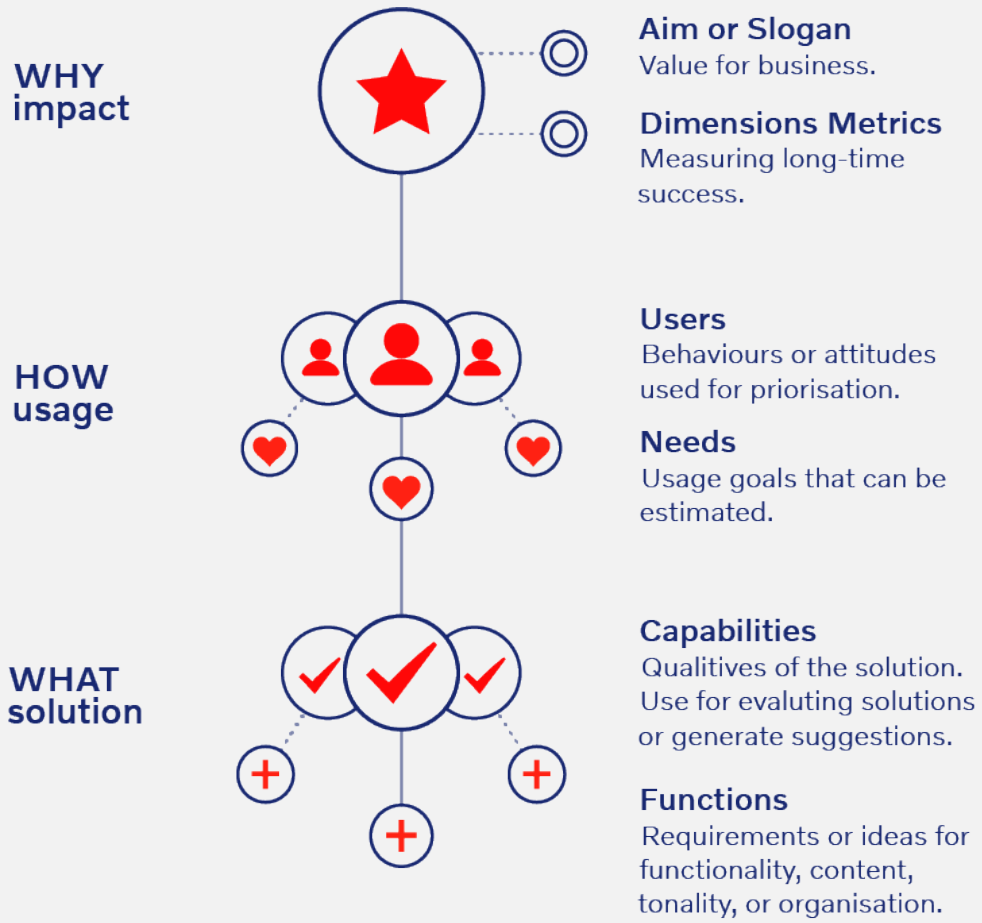


Figure 9 - Model of Impact Mapping, inspired by Domingues (2017)

3.11 DESIGN GOAL AND INTERACTION VISION

Vision in Product Design is a context-driven design approach that results in products that create meaning for people that also reflects the designer behind them. This is done by creating a strong vision for the product that focus on the interaction between the user, product, and context. By defining the type of affect you wish to achieve with the design before deciding on *how* it will do this is essential for this approach. There is a distinction between a preparation phase and the design phase. During the preparation phase, the old interaction with the existing context/solution is deconstructed and in the design phase, future context, interactions and designs are constructed. (van Boeijen et al., 2013)

An important building block of this approach is the creation of a "statement" (van Boeijen et al., 2013), from here on called *Design Goal*, which is a short statement including the user, the context, and the wanted effect of the design. To make this statement stronger, something called an *Interaction Vision* is created to complete the Design Goal. This is done by conceptualizing the interaction, by for instance, comparing it to an unrelated action/interaction/experience and then finding qualitative characteristics that defines this interaction. This could be visualised with a picture that represents the wanted feeling of the interaction which can then work as a guidance during the design phase.

3.12 IDEATION METHODS

There are several different methods that can be used to support creativity and innovation. In this chapter, the ideation methods used in this project are described.

3.12.1 Brainstorming

Brainstorming is a method to find new ideas to solve problems. It is used to share all types of ideas, with a focus on quantity instead of quality. It can be performed both in groups and individually. If performed in group, it is of importance that no criticism is shared during the session since this can constrain creativity. Usually it is done using paper and pen. (Nilsson Wikberg et al., 2015). Brainwriting 6-3-5

Brainwriting 6-3-5 is a type of brainstorming method, where the participants brainstorm individually during a fixed time and then passes on the result to another person. The next person then builds upon and can be inspired by the previous result. (Nilsson Wikberg et al., 2015).

3.12.2 Braindrawing

Braindrawing is based on the same principles as brainwriting, the difference is that the participants draw instead of write text. These two can be combined. When having a big group of participants, it is recommended to have a facilitator to control the practicalities, such as controlling that rules are followed and the time. (Nilsson Wikberg et al., 2015).

3.13 PUGH MATRIX

A method for concept screening and enhancement is PUGH matrix. It is based on the desires and sometimes also the requirements from the specification. Each concept is evaluated in relation to a reference concept based on if it accomplishes a criterion better (+), worse (-) or at the same level (0). This evaluation together with the weighting of each criterion creates a sum which indicates what concept fulfils the criteria the best, in total. The result can be used to screen concepts and/or combine good (+) values into new solutions. Changing the reference concept can create different results. (Almefelt, 2019)

4. IMPLEMENTATION

In this chapter the implementation of the project is explained, including the process flow and how the methods used were implemented. Further, how the methods developed during this project were designed and why is explained. On the following page, the process of the project is presented, see Figure 10.

04

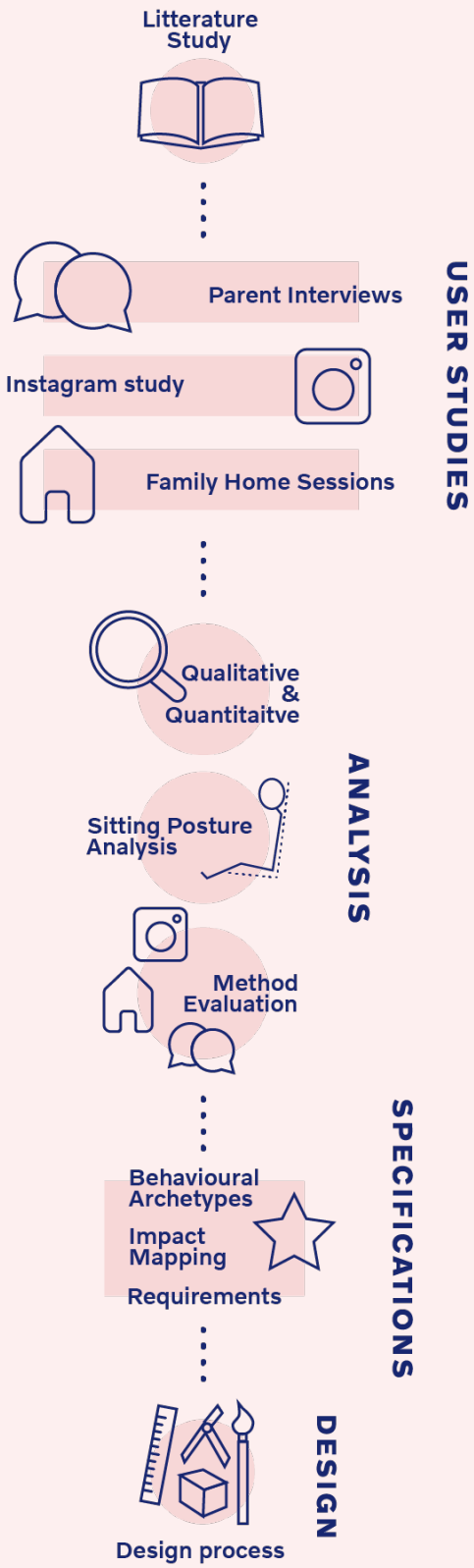


Figure 10 – The project process

4.1 LITERATURE STUDY

Starting the project, a literature study was made through searching databases to find relevant articles and books. But also, by going design course material related to the subject. This was used to gain knowledge about the subject and to develop the methods used in the project. The main areas researched were about design studies with children and youths, youths in general, previous sitting posture studies in cars, the future of mobility, and user studies' methodology.

4.2 USER STUDIES

Following the literature study, several user studies were performed to find the behaviours, needs and desires of the target group. The methods were chosen to complete each other to be able to find both explicit, observable, tacit, and latent knowledge, see chapter 3.2. The chosen methods were developed based on knowledge about previously performed methods, knowledge about youths, and theories regarding what can engage youths in user studies, see chapter 2.1. Based on this, different methods and elements were combined with the intention to suit the target group. Also, the methods were designed to generate the knowledge needed to answer the first two questions of the project: (1) to find the target group's needs and (2) find what activities the target group perform in cars and how this affect their sitting postures. The chosen methods were *Parent Interviews*, *Instagram Diaries*, *Family Home Sessions*, and *Sitting Posture Studies*.

Parent Interviews was a pre-study and the results worked as input to the design of the other user studies. *Instagram Diaries* was chosen to collect information and gain knowledge about the target groups' everyday behaviour and desires. The material from the *Instagram Diaries* was then used during the *Family Home Sessions*, to be able to generate a deeper understanding of the target group. Lastly, a *Sitting Posture Study* was planned with the purpose of understanding how the found activities and behaviours would affect the sitting postures and thus also the safety of the target group.

Due to the extraordinary circumstances because of COVID-19, the *Sitting Posture Study* was not possible to execute as planned. Instead, a sitting posture study was performed without the participation of actual users.

4.2.1 Parent Interviews

The first method of the user studies was semi-structured interviews, see chapter 3.3, with parents. The intended purpose with interviewing parents was to create an initial understanding of the target group to be able to design the upcoming user studies, as a type of pre-study. This included understanding what different types of families there are and what youths' lives look like in general. But also, to understand more about youths' car riding habits with a focus on when and what they do when riding cars.

There were two reasons for interviewing parents. Firstly, since the purpose was to get a first insight, no deep understanding of youths' behaviour was needed. Because of this, parents instead of the youths themselves could be interviewed to gain that first, less biased perspective of the target group. Secondly, interviewing youths instead of parents would have required more preparation both regarding the design of the study but also regarding consent arrangements, see chapter 2.1.3. Thus, it was assessed as suitable to perform interviews with parents.

Method Design

The interviews were semi-structured and approximately 45 minutes. The interviews focused on the parents' children and family, especially with a focus on the children's hobbies and their car riding habits (when they ride the car, how long trips are, what they bring, and what they do).

As a mediating tool, see chapter 3.3, different scenarios were read out loud by the interviewer. The scenarios were based on what the interviewees had previously shared and were designed to trigger the interviewees to reflect upon a specific trip. By making the interviewee think about a

specific moment it is possible to avoid generalising, which can lead to non-accuracy of the answers.

The interviews were performed using video or phone calls if the interviewees could not access the video call software. This, since the design of the interview did not require to meet in person and because the participants were not located nearby the interviewers.

Participants
In total six different parent interviews were performed, see Figure 11. All participants owned one or more cars. All ages of the target group but 15-year olds were represented. There was a spread in single or partnered parents, in number of children living at home, and in gender of the parents.

Figure 11 - Parent Interview participants

Participant	Gender	No. of children	No. of children living at home	Age(s) of child(ren)	Single/Partner
P1	Male	3	3	11, 14, 16	Partner
P2	Female	2	2	13, 17	Partner
P3	Female	2	2	10, 11	Partner
P4	Female	2	2	9, 12	Single
P5	Male	3	1	12 (25, 32)	Partner
P6	Female	2	1	13 (25)	Single

4.2.2 Instagram Diaries
The intended purpose with the *Instagram Diaries* was to catch the everyday behaviour of youths, with a focus on their car riding habits. The intention was to gain an understanding of how often they ride the car, in what situations, what they do in the car, what their interests are, and what they rather would like to do. Another purpose of the method was to prepare the participants for the *Family Home Sessions*.

Method Design
The *Instagram Diaries* is a method inspired by the different probe methods Experience Sampling, Diary Studies and Sensitising. The method was developed to suit the target group, to make it fun and easy to participate, and to fulfil the purpose of gaining an understanding of youths' car riding. Using social media as the tool for reminders, communication, and reports was assessed as suitable for the target group. This, since youths in general use their phone and social media every day, see chapter 2.1.2, and because using social media in design research is engaging, as described in chapter 2.1.3.

In the *Instagram Studies*, all children (who were within in the ages 10-17 years) in a family should follow an Instagram account, created by the researchers. To this account they should send a picture or video and answer four questions each time they went by car. The language used in the study was Swedish since only Swedish children and families participated. An example of what a reporting of a car ride could look like can be seen in Figure 12.

First, a private Instagram account was created with the name "vi_aker_bil" which means "we are riding cars", see Figure 13. The Instagram included a biography describing the purpose of the account and that it was only used for the study. Before the study had started three posts were made. One post included a presentation of the researchers, the second included the instructions of how to report a car trip, and the last showed an example of how a trip could be sent to the account. These were created to make the information easily accessible for the participants, but also to make the Instagram profile personal.

When deciding what social media to use, several aspects were considered. According to the Swedish State Media Council (2019) as shown in chapter 2.1.2, Snapchat and Instagram are the two most popular social medias for youths between 9-18 years in Sweden. Since the messages and images sent in Snapchat are only temporarily available, it was assessed as unsuitable for the study. In comparison, Instagram offers several different sources of communication, both permanent and temporary, while at the same time being frequently used by the target group. Instagram was thus assessed as the most suitable social media for the study. The prime issue using social medias for the target group is the fact that the age limit is in fact 13 years. Even though this is the age limit communicated by the social media providers, it is possible to see that in the age range of 9-12 years, 52% uses Snapchat and 34% uses Instagram (Ungar & medier 2019, 2019).

After the Instagram account was set-up, a package was prepared to each family, see Figure 14, the content of the package can be found in Appendix A. The package contained:

- a contract – for the parents to sign content and agree to the terms of the study.
- an instruction – written with the intended purpose of being personal, professional and informative while at the same time being fun, simple and motivating. See chapter 3.4.
- Signs with straps to hang in the car – as a means to remind the participants to send pictures while riding the car. Explained with a hand-written post-it with instructions, to make it even more personal.
- a bag of candy – as a small incentive and motivation for the start, as motivated in chapter 3.4.
- a weekly schedule and check list – as another reminder for the family to remember reporting all the trips.

One day in advance to the start of the study, one parent in each family participated in a short pre-interview. This was both to get an insight about the family, but also as a way of walking them through the study and ensuring that they knew what to do. During the meeting, the parents were asked to confirm whether the children accepted using Instagram or not. The ones who did not have Instagram or did not want to use Instagram were asked to use text messages instead. Three out of 17 participants, see Figure 16, decided to use text messages instead of Instagram. All the others confirmed and accepted using their private Instagram accounts in the study. The parents were also allowed to follow the account, to get an insight in the study and understand what their children did.

The main part of the study consisted of the participants sending a photo or video of what they did, accompanied with a message with answers to four questions, each time they went by car. This was done for one week. The photos/videos were used as a way of understanding the context for the different car trips, but also for making it possible using those as a mediating object in the next method, the *Family Home Sessions.* The four questions were:

1. Where are you going?
2. Who else is with you in the car?
3. What are you doing in the car?
4. What would you like to do if you could choose freely?

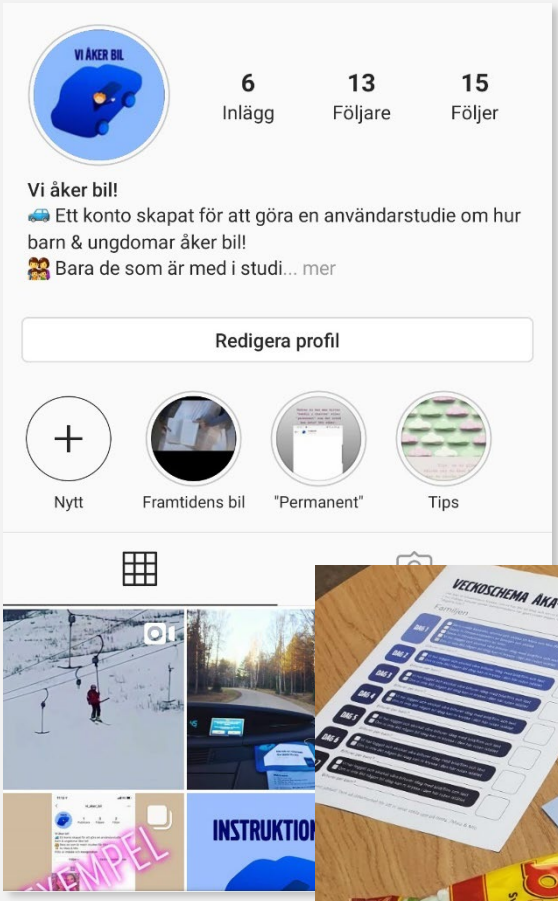


Figure 13 - Instagram account profile

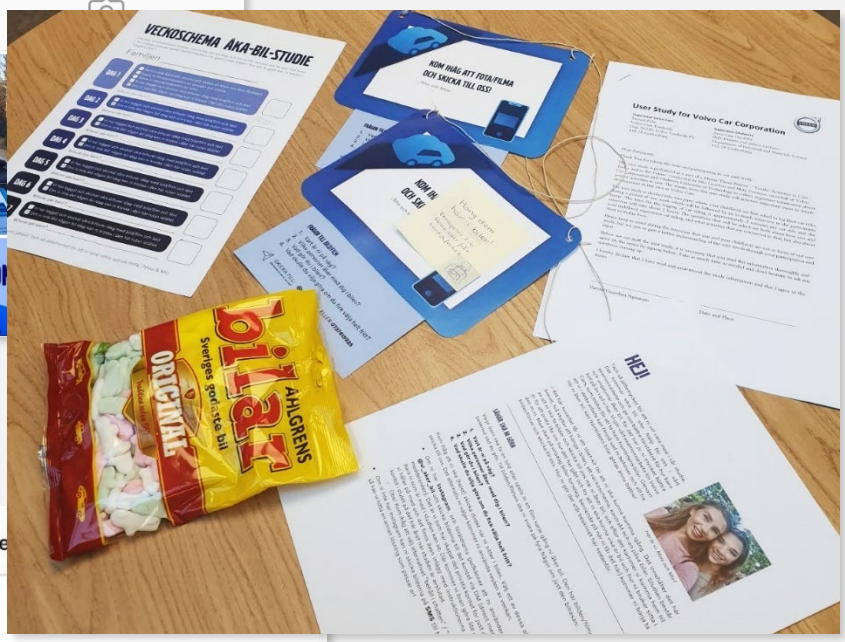


Figure 14 - The start package Instagram Diaries

Figure 12 - Example of Instagram reporting

The first question was chosen to understand what type of trip it was, but also to get an understanding of when the youths ride the car. The second question was chosen to know how many people rode with the participant, but also to understand how that affected what they did. The third question was the most central, to find out what youths are usually doing when riding the car. The fourth and last question was chosen to create an understanding of the participants dreams and desires. It was intendedly formulated as an open question to make it possible to include all types of wishes.

The questions were assessed as simple to answer and not time consuming, to make participating less demanding. It was assessed to take approximately two minutes to complete the reporting of each car trip.

Each family was also asked to send an introductory video of their car and of their family. This, for the researchers to get a better insight of the participants and "get to know them" better. In addition, they were asked to send a photo, or include it in the video, that they had put up the signs inside the car. This, since the signs were assessed as an important reminder and by making the participants send a picture of it, it could be assured that the signs were used.

The main difference between Instagram and text messages was how the participants received reminders. One of the main concerns with the method was how to make the participants remember to send in reports for each trip. This was one of the main reasons that the application chosen was Instagram. Using Instagram allowed three different types of reminders: uploading posts to the feed, stories, and private messages. A detailed schedule was made to spread out and differentiate the reminders, see Figure 15. The schedule was designed with pictures and messages to suit the target group. The participants using text messages only got the reminders labelled "Personal message". The reminders were scheduled to be experienced as random, for the participants to not get used to the messages and thus ignoring them. How these messages were formulated was intended to support levelling with the target group, by using a similar way of communicating and writing as them, as motivated in chapter 2.1.3.

In addition to the reminders, each message the participants sent was "liked" to confirm it was received and some of the messages were also replied to. This, in order to make the participants feel like their participation mattered and make the communication personal.

When the method was designed, it was briefed to an expert researcher within the field of these types of studies to get feedback. The method design was motivated and discussed. The input led to some changes of the study. The expert confirmed that the design of the method could create interesting results and that it was probable to find the needs of the youths. In addition, the expert stressed the importance of a pilot study and adjusting the method based on the result.

Before starting the study, a pilot study was thus made. This included sending the instructions to a family with a 12-year-old to give feedback, but also performing the study with a 17-year-old. The pilot study resulted in some small adjustments. Mostly, the pilot study confirmed that what was intended with the study could be achieved.

The study was performed in two phases, since the first round did not include enough participants. Therefore, the study was repeated almost exactly, but with a new Instagram account called "vi.aker.bil" and new participants within the target group.

Figure 15 - Plan for reminders to Instagram Diaries

Day	Time	Media	Picture	Message
Tuesday	16.30	Personal message		Hej! Imorgon börjar studien, hoppas du känner dig redo. Det innebär alltså att du ska ta en bild eller filma varje gång du åker bil och svara på de fyra frågorna. Det ska du skicka till oss här! Har du några frågor?
Wednesday	12.00	Instagram post	Elephant GIF	Nu åker vi! Kom ihåg att ta bilder när ni åker bil och skicka till oss :D Om det är något ni funderar på kan ni skriva och fråga här, smsa, ringa eller maila.
Wednesday	19.30	Stories	Car-related picture	Har du åkt någon bil idag? Kom ihåg att skicka till oss i DM! Vet du inte hur man gör? Kolla in Exempel-inlägget.
Thursday	14.00	Personal message (only to the ones who has not yet sent anything)		Tjena, vi tänkte bara höra om allting har gått bra med att ladda upp hittills? // Grymt jobbat, tack för att du skickade din(a) resa(or) igår!
Friday	07.30	Instagram post	Picture from participant	Här är ett exempel från en av våra studiedeltagare. Just nu är ni elva barn och ungdomar som deltar - och vi kommer ha ytterligare 5 familjer som ska delta! Så bra jobbat hittills, väldigt roligt att få se!
Friday	15.00	Stories	Boomerang of us	Nu är det helg!
Friday	15.00	Mail to parents		Hej, vi vill bara säga att det har gått jättebra hittills! Hoppas det känns bra för er.
Saturday	11.00	Instagram post	Child riding ski lift	Woop woop, sportlov! Ska bli kul att se vad ni hittar på när ni är lediga. Keep it up!
Sunday	10.00	Personal message		Meddelande anpassat efter personen
Monday	12.00	Stories	Movie of future concept car 360C	Vad hade ni tyckt om att åka med en sån här? Kolla in den här filmen om en häftig framtidsbil. https://www.youtube.com/watch?v=q7K3cjBoTf4
Tuesday	07.00	Instagram post	Picture	Nu kör vi sista dagen gänget, ni är grymma!
Wednesday	09.00	Instagram post	Applause GIF	Wow vilken bra arbete ni har gjort! Det har varit så roligt att följa. Nästa och sista steget är att vi kommer hem till er för en intervju med hela familjen. Vi ser fram emot att ses!

Participants

Nine families were included in the *Instagram Diaries*, in total including 17 children, see Figure 16. The families were from Karlstad, Gothenburg, and Lerum in Sweden. They all owned one or more cars and a majority lived in a villa. Families having one to three children participated, with the average of exactly two children living at home.

Figure 16 - Participants of the Instagram Diaries

Family nr.	Family code	Participant Children	Ages	Gender	City	Instagram or SMS
1	TH	TH1	15	Girl	Karlstad	Instagram
		TH2	13	Boy	Karlstad	Instagram
		TH3	11	Girl	Karlstad	Instagram
2	LO	LO1	14	Girl	Karlstad	Instagram
		LO2	12	Boy	Karlstad	Instagram
3	WI	WI1	15	Girl	Karlstad	Instagram
4	ST	ST1	10	Girl	Karlstad	Instagram
		ST2	13	Boy	Karlstad	SMS
5	SA	SA1	12	Boy	Karlstad	Instagram
		SA2	10	Girl	Karlstad	Instagram
6	AN	AN1	17	Girl	Gothenburg	Instagram
		AN2	15	Boy	Gothenburg	Instagram
7	SU	SU1	17	Boy	Lerum	Instagram
8	AP	AP1	13	Boy	Lerum	Instagram
		AP2	12	Boy	Lerum	Instagram
9	SV	SV1	14	Boy	Karlstad	SMS
		SV2	17	Boy	Karlstad	SMS

The age spread of the participants can be seen in Figure 17. The age of 16 was the only one not represented in the *Instagram Diaries.* The average age of the participants was 13,4 years.

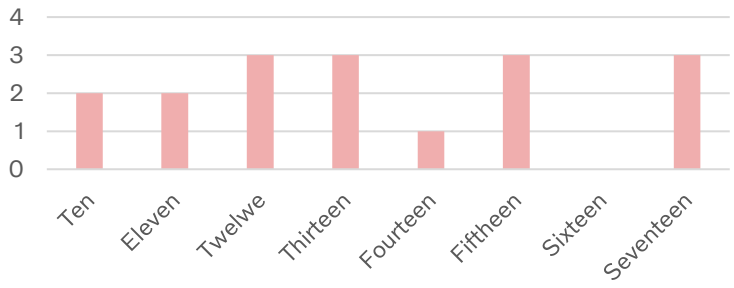


Figure 17 - Distribution of age among participants Instagram Diaries

4.2.3 Family Home Sessions

The third method for collecting data about users was *Family Home Sessions.* This was a form of generative session, see chapter 3.5, done together with families that had participated in the *Instagram Diaries*, see chapter 4.2.2. These sessions included semi-structured interviews, co-creative activities, and contextual inquires in the families' cars.

The intended purpose was to deep dive into the everyday behaviour of the participants (mainly the children of the families) and to get deeper understanding of their car experiences. This included their needs and wishes for both their present situation and for future scenarios. The sessions were held in the homes of the participants (with one exception when this was not possible). Meeting the families in their home was done to create a more personal and relaxed setting for the family and to be able to use the context as a sort of mediating object itself, see chapter 3.6. Also, the parents participated in some of the activities. They were thought to be able to help the children remember things about the trips and come with valuable input to discussions.

Before performing the study, a pilot test of the study plan was done with two persons experienced with different types of user field research. They were asked to "act" as if they were in the target group and then share valuable input. The study plan was then iterated and finalised before meeting with any families.

Method Design

Each session lasted for 1,5 hours. The structure of the session was adapted to follow the Experience Domain, see chapter 3.5, in order to make it easier for the children to not only reflect about their experiences but to also reflect upon their future desires and needs.

First, general information about the session and the project in general was presented to the family. This included the purpose of the project, what the project would result in, the aim of the session, and what was expected from them as participants. Lastly consent for recording and filming the session was asked and given before starting the session. See Appendix B for full time schedule for the *Family Home Sessions*.

To start off the session, the first activity was a presentation and storytelling around the table. This was done to create a common ground for the session and in order to prepare them for the following activities. Every person in the room told their name, interests, and a special "car memory". The memory could be positive, negative or just something they thought of that they had experienced related to a car situation. This, to make them start reflecting about the theme and to simply have a fun and relaxing start of the session. The facilitator started with an example to set the level of the self-presentation and the car memory in order take the pressure off the participants and get discussions started quickly.

For the next activity, a collage of each participants photos from the *Instagram Diaries*, which had been prepared in beforehand, was placed in the middle of the table. The pictures were glued on a big sheet marked with each day of the week. Also, the answers to the four questions related to each trip was printed and placed next to the picture on the collage. Each child had a separate week marked with their name to create the feeling that they were equally important and represented. See Figure 18 for a picture of the collage during one of the *Family Home Sessions*.

The main purpose of the collage activity was to generate more knowledge about the different trips that participants had reported during the week of the study. Each child got to explain and answer questions about their different trips. In addition, there were collective discussions about the trips that they had done together. For the most interesting trips, semi-structured interview questions including probing was asked to the child who had sent in the photo. The questions dug deeper into the aspects of what had happened before, during and after the trip, their moods, what they had brought with them, interactions with others etc.

Figure 18 - One of the collages during a Family Home Session

In order to make the activity more interactive, the children and parents were asked to write post-its and notes and add them to the collage. They were also provided with paper sheets with sets of smiley icons (also referred to as "Emojis"). The participants were asked to reflect upon the mood they had been on during the specific trip and represent this with an Emoji of their choice. Apart from getting them to reflect upon this, the Emojis were meant to create more engagement since it is something they use in their daily digital interactions with friends and family and on social media, see chapter 2.1.3.

The third activity was about other trips that were not covered in the *Instagram Diaries*. A paper sheet was placed on the table with 'Weekdays', 'Weekends', and 'Vacations' marked in different sections. The aim for this part was to gain insights about trips that were missed because of the timeframe for the *Instagram Diaries*. The family were asked to write about the trips on post-its and place them on the sheet in the right category. The same type of semi-structured interview questions was asked for these trips as for the ones in the previous collage activity.

The fourth activity was a variant of contextual inquiry inside the family's car. For this activity (with one exception where the child seemed to be uncomfortable with this), the parents were asked to stay inside the house in order to let the children to express themselves without being affected by the presence of their parents. When going out to the car, the children were asked to take the seats that they normally would if going on a car trip with the whole family. They then got to explain how they usually sat in the car, what they would do, where they would put their belongings, what they liked versus disliked with the car etc. For instance, if they usually played music or radio in the car, they got to show how they did this with simple walkthroughs, see chapter 3.6, while they were asked questions about it. The final part for this activity was to ask the children what they would like to change or add to the car if they could. They were encouraged to think outside of the box for this.

The last activity of the *Family Home Sessions* was a picture ranking activity divided into two rounds. This was done inside the house where the children were provided with a set each with pictures of things/activities one can do inside and outside a car. In total there were 21 pictures in each set and all participants got the same pictures. No further explanation about the pictures was given to the children, instead they were asked to interpret the pictures in their own way if they were hesitant about the meaning of a picture. In each set there were also some additional blank papers to enable the participants to come up with other activities, not represented by the pictures.

For the first round, they were asked to, individually, pick approximately five pictures that they thought they did the most inside the car. After doing this they were, one at the time, asked to rank the pictures by placing them in a row, from what they thought they did most often to the least often out of these. After doing this, they each got to explain what they had in mind when picking the pictures and why they sorted them in the way they did.

Introducing the second round, a short part of a video of the 360c concept by Volvo Cars (Volvo Cars, n.d.) was shown. Showing the video was done to expand their imagination and ideas of a future car. After this, all the pictures were again placed on the table, and this time, they were instead asked to pick approximately five pictures of what they would most like to do, if they thought of this sort of futuristic scenario. After they had chosen their pictures they were once again asked to rank them and explain their thoughts in the same manner as in the first round.

As a closing activity, both parents and children were asked to fill out a survey about how they had experienced both the *Instagram Diaries* and the *Family Home Session* which were then collected and analysed. As a reward for the participation in both the *Instagram Diaries* and the *Family Home Session,* each participatory family member received a cinema ticket.

Participants
In total, eight families participated in the *Family Home Session,* see Figure 19. The children were from the same families as in the *Instagram Diaries,* except for one family who decided to drop out. The families were from Karlstad, Gothenburg, and Lerum in Sweden. They all owned one or more cars and a majority lived in a villa.

Figure 19 - Participants in Family Home Sessions

Family no.	Family code	Participant Children	Age	Gender	City	No. of Participating parents
1	TH	TH1	15	Girl	Karlstad	2
		TH2	13	Boy	Karlstad	
		TH3	11	Girl	Karlstad	
2	LO	LO1	14	Girl	Karlstad	2
		LO2	12	Boy	Karlstad	
3	WI	WI1	15	Girl	Karlstad	1
4	ST	ST1	10	Girl	Karlstad	2
		ST2	13	Boy	Karlstad	
5	SA	SA1	12	Boy	Karlstad	1
		SA2	10	Girl	Karlstad	
6	AN	AN1	17	Girl	Gothenburg	1
		AN2	15	Boy	Gothenburg	
7	SU	SU1	17	Boy	Lerum	1
8	AP	A1	13	Boy	Lerum	2
		A2	12	Boy	Lerum	

4.3 ANALYSIS

Both qualitative and quantitative analyses were performed based on the data from the *Parent Interviews, Instagram Diaries,* and *Family Home Sessions.* The analyses are further described below.

4.3.1 Qualitative Analysis

The first step in the analysis phase was to perform a KJ Analysis, see chapter 3.7, to process the qualitative data from the different user studies. All *Parent Interview*s and *Family Home Sessions* were recorded in order to enable transliteration of quotes that could be used in the qualitative analysis. The quotes were written on digital post-its in Figma[1] and were marked with the code for the family interview it originated from, such as “SA” or “AN”. Quotes that expressed future desires or wishes were marked with a pink stripe on the side of the note. The quotes from the *Parent Interviews* were marked with a purple stripe and text colour.

In several iterative steps, the quotes were grouped and regrouped into different categories with mutual themes by discussing analysing the underlying needs of the quotes. The quotes that described or referred to an activity that the users did inside the car were placed in the same area.

When the grouping of the notes was viewed as completed, another round of analysis took place. Each group of quotes was revisited and the found needs for the group were written on new notes and other insights regarding the target group, context etc. were written on another type of notes.

[1] An online collaboration platform that brings together design features to create an efficient workflow.

The final step of the qualitative analysis was to go through all the notes with insights and needs, separately from the previous round, and to group them according to themes in the same manner as the quotes were processed in the beginning.

4.3.2 Quantitative Analysis

During the quantitative analysis, data from the *Instagram Diaries* and the last activity from the *Family Home Sessions* was processed. There were two type of data sets from the *Instagram Diaries*, the photos that the participants sent from their car rides and the answers to the questions accompanying each picture/car ride.

The pictures were primarily used as mediating objects for the *Family Home Sessions*, and it was mainly the answers to the questions that were taken into the quantitative analysis. Excel was used for making diagrams and tables of the data. The columns of the tables were divided with respect to the different types of activities they mentioned they did, the number of co-riders for each trip, the different types of trips, and the estimated length (short, medium, long). For the data sets that seemed to have interesting correlations, diagrams were created to better be able to make comparisons and visualise the correspondences.

A similar methodology was used for analysing the last activity of the F*amily Home Sessions*, which was the picture ranking activity divided into two rounds, see chapter 4.2.3. The rankings were summarised in charts comparing what the participants thought they did the most in the car today and what they would most like to do in a future car context.

4.3.3 Activities Sitting Posture Study and Analysis

The purpose of performing a sitting posture study and analysis was to understand how a specific activity found affects the sitting posture of a passenger within the target group. The sitting posture affect the seat belt position, see chapter 2.2, and thus directly affect their safety. Since it was not possible to find exactly how they sit during the user studies, this additional sitting posture study was performed by simulating the activities in the right context.

Initially, a more comprehensive sitting posture lab study was planned where participants representing the target group were supposed to perform the found activities in a car. For each activity, the lateral and the sagittal sitting postures was to be precisely measured with cameras and markers on the body. Due to the extraordinary societal situation caused by the COVID-19, the study had to be cancelled and replaced by a smaller study excluding any external participants from the target group was performed instead.

The sitting posture study was a type of self-study performed by the researchers where the different sitting postures were tested in a car and documented with photos and notes. Some information about specific sitting postures was known from the previous studies, e.g. if a participant in the *Family Home Sessions* had expressed how they usually sat when doing a specific activity. This was considered when performing the activity during the sitting posture study.

The analysis of the sitting postures was made according to the specifications of sitting postures from the study made by Jakobsson et al. (2011), see chapter 2.2 for further explanation. The analysis of the lateral position was adjusted, based on if the lateral position was straight, leaning ‘inboard’, IB, or leaning ‘outboard’, OB, see Figure 20.

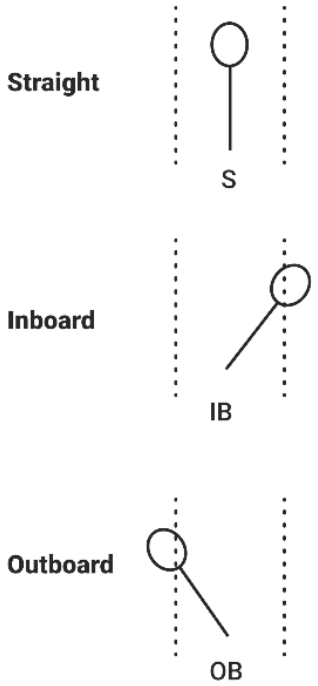


Figure 20 - Lateral sitting posture definitions

4.3.4 Method Evaluation

The methods that were used for gathering insights about the target group (*Parent Interviews, Instagram Diaries,* and *Family Home Sessions*) were developed in this specific project. Hence, they are not commonly used or established as user-centred data gathering methods. Therefore, there was a need to evaluate the methods for possible future usage. The goal with the method evaluation was to evaluate the methods in relation to how appropriate each method is for finding the needs of the target group in the context of a car.

Firstly, the *Instagram Diaries* and the *Family Home Sessions* were evaluated with participants. The youth participants were asked to fill out a survey about how they experienced the study. This included open-ended questions, multiple choice questions and scales, see Appendix C. The parents were also asked to fill out a survey regarding both their own experience, but also about how they thought it was for their children to participate, see Appendix D. The survey for the parents also contained open-ended questions, multiple choice questions, and scales.

Secondly, a method assessment (see Appendix E for template) was designed to ensure that the methods were evaluated in the same manner and against the same criteria to enable both objective and subjective comparisons between the methods. The method assessment was designed for this project, and the different evaluative and descriptive aspects were assessed as important to evaluate, compare, and understand how to use the methods in the future.

The method assessment was divided into three sections. The first part was evaluative scales that gave indication of the appropriateness to the target group, how valuable the method was, and how demanding it was for both researchers and participants. The scales were from 1-5, from low/negative to high/positive. Some of the scales were filled in with the response from the participants evaluations in mind.

The second part contained descriptive and objective scales such as what type of data the method generated, the character of the study (for instance, if it was a constructed or natural context), the knowledge level of the information received etc.

The third part contained open-ended questions about the method where it was possible to reflect and discuss to a higher extent. The questions concerned the type of data received, process timing, for what studies it was suitable, and the appropriateness for the target group.

4.4 SPECIFICATIONS

In this section, the implementations of the chosen specifications, which were chosen to complete each other, are described. Behavioural archetypes, Behaviour Mapping, and Impact Mapping all together communicating the result. In addition, a Requirement Specification was created for bringing all requirements and desires together.

4.4.1 Behavioural Archetypes

As mentioned in chapter 3.8, there are several ways of creating a representation of the users in a target group. For this project, behavioural archetypes were chosen because of its suitability for the project as well as the company. Volvo Cars is currently using behavioural archetypes (Palm, personal contact, 2020), which would make it both comprehendible and usable when delivered. Based on the result from the analyses, behavioural archetypes were created to represent what different types of behaviours can occur in the target group.

The behavioural archetypes were created by identifying behaviours within the KJ analysis and from the observations during the user studies. From this it was possible to brainstorm what different behavioural archetypes exists within the target group. The brainstormed behavioural archetypes were iterated, where some were kept, some were merged, and some were discarded. The behavioural archetypes left were then completed with needs from the KJ analysis and this was also iterated in several rounds. During these iterations, some behavioural archetypes were

again added, merged, or discarded. This process continued until each behavioural archetype had the three most important needs connected to them.

These behavioural archetypes were then described with a few sentences and with a quote from the user studies to enhance the understanding of each behavioural archetype. The behavioural archetypes were used in the Impact Map.

4.4.2 Behaviour Mapping

Based on the behavioural archetypes, a visualisation was made to understand how the behavioural archetypes related to each other. Each behavioural archetype was mapped out with a circle or oval on a graph with the axes: chill to active and solo to social. This gave an indication of what type of possible design that could affect the most behavioural archetypes.

4.4.3 Impact Mapping

To compile and visualise the result from the analysis, it was decided to use the method Impact Mapping, see chapter 3.9. Firstly, the behavioural archetypes created were ranked based on which were the most common or desired by the target group. Related to each behavioural archetype, needs from the analysis were distributed and then reduced or merged to the three most important ones per behavioural archetype. Connected to each need, some capabilities and possible functions were assigned. In the centre of the Impact Map, a design goal, see chapter 3.11, and general aims and metrics for the solution was formulated.

The next step of the Impact Mapping process, was to create an excel sheet where each behavioural archetype was weighted, based on their ranking. All needs were given a score relating to the behavioural archetypes and their weights by estimating if the behavioural archetype would appreciate a solution for each specific need; a lot, some, or not at all. The scores gave an indication on what impact it would have to create a solution for that specific need.

4.4.4 Requirement Specification

As a concluding document for requirements and desires, a Requirement Specification was created, see chapter 3.10. Each desire was weighted for the use of it in the concept evaluation. The requirements were categorised based on topic and justified with its origin.

4.5 DESIGN CONCEPT DEVELOPMENT

The concept development can be described with four phases, see Figure 21. These contained both convergence and divergence processes, as described in chapter 3.1. Based on the behavioural archetypes and the Impact Map, phase one started with generating a large amount of ideas. The ideas were then grouped into different tracks based on what needs they solved.

In phase two, a new ideation session started based on the three different tracks. The generated ideas were combined into different constellations which resulted in several concepts. The concepts were reduced to three based on how well each concept fulfilled requirements and needs, but also based on having three diverse concepts.

In phase three, the three remaining concepts were further developed to both have a sufficient level of detail and to fulfil requirements. Before the concepts moved on in the process, each concept was evaluated to the requirements, to ensure that each concept fulfilled them. These concepts were during this phase evaluated with three different methods: PUGH, user evaluations, and sitting posture analysis. Based on the results of the evaluations, one concept was chosen as the winning concept.

During phase four, the winning concept was developed further and optimised based on the results from the evaluations. Lastly the concept was evaluated with experts which resulted in some changes and recommendations, which created the final concept.

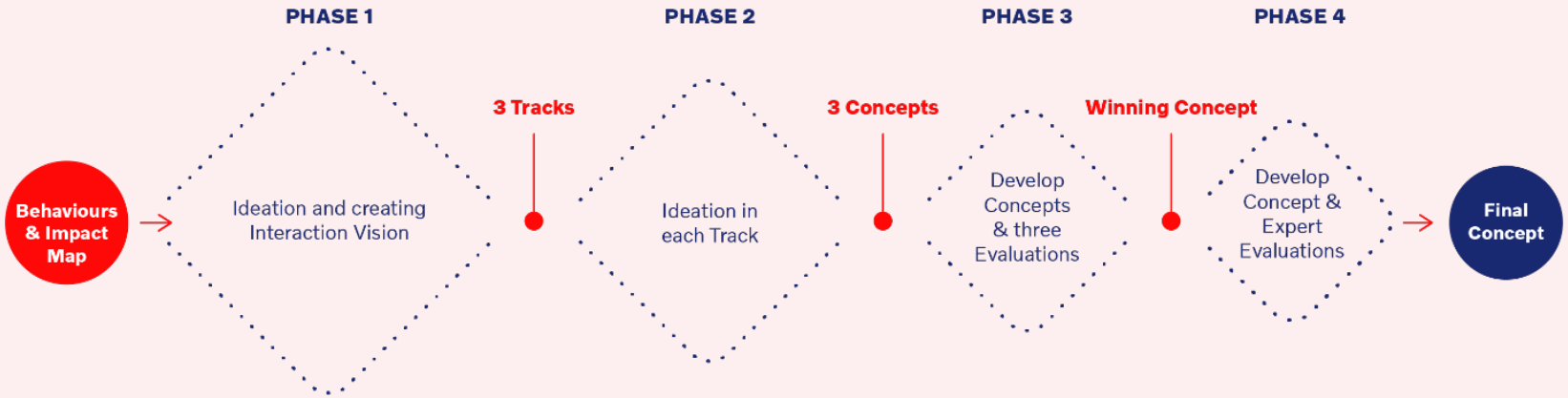


Figure 21 – The concept development process

4.5.1 Interaction Vision
As a way of completing the statement of the design goal but also act as an inspiration for the ideation, an interaction vision was formulated in phase one, see chapter 3.11. This was formulated in the beginning of the concept development phase to get a common vision.

4.5.2 Ideation
To come up with ideas, mainly Brainstorming, Brainwriting, and Braindrawing were used, see chapter 3.12. The ideas were iterated, evaluated, and developed throughout the concept development process. This resulted in that several ideation sessions were included during the concept development, in all four phases.

4.5.3 PUGH Matrix
To evaluate the created concepts in phase three, one of the methods used was PUGH matrix, see chapter 3.13. The three concepts were evaluated based on the desires from the Requirements Specification, but also on some other factors that was assessed as important even though it was not included in the Requirements Specification. Each concept was evaluated three times, acting as reference concept one time each. This, to ensure that the reference concept would not affect the result. The total from each matrix was then summed, resulting in a ranking of the concepts.

4.5.4 Concepts Sitting Posture Study and Analysis
In addition to the PUGH matrix, all the concepts in phase three were evaluated based on how each concept would affect the sitting postures related to the activities. This was performed in a similar way as the first sitting posture study and analysis, see chapter 4.3.3. The concepts were simulated using physical representations of the concept and tested for different activities, enacting the behaviour of the target group. Based on this, it was possible to analyse whether the sitting postures would be affected positively or negatively, and when different sitting postures could occur. What possible misuse the concepts could result in, and the sitting posture related to the misuse, was also analysed.

Based on this, it was possible to conclude how the concepts were likely to affect the sitting posture and compare each concept based on this.

4.5.5 User Evaluation
To complete the PUGH matrix and the sitting posture analysis in phase three, it was assessed as important to include the perspective of users from the target group. Therefore, a user evaluation was performed by doing interviews.

Method Design
To evaluate the concepts, interviews with users in the target group was performed. Each concept was presented separately by showing sketches and explaining the concepts and their functions. After each presentation, the interviewee was asked questions related to the usage and liking of the concept.

Lastly, all concepts were presented together, and the interviewee got to compare the concepts to each other. For instance, what concept they would want in their own car and why. The interviews were semi-structured, see chapter 3.3, and performed with video calls.

Participants
In total, three participants in spread ages and genders participated in the user evaluation. The participants of the study can be seen in Figure 22.

Figure 22 - Participants in User Evaluations

Participant code	Age	Gender
AS	12	Boy
EO	13	Girl
MG	17	Boy

4.5.6 Final Concept Sitting Posture Study and Analysis

To evaluate the final concept, whether it had improved the sitting postures or not, a third sitting posture study and analysis was done on the final concept. This was performed in a similar way to the concepts sitting posture study and analysis, see chapter 4.5.4, but this time comparing with the first analysis. The activities that was not affected by the concept were not evaluated.

4.5.7 Experts Evaluation

To evaluate the final concept in phase four, the chosen method was to evaluate with experts within important areas related to the project. This was assessed to be the most suitable method based on concept level, availability of users, but foremost since the result was intended to be used for recommendations on further development.

Method Design

The expert evaluations were based on semi-structured interviews, see chapter 3.3, using video calls. Firstly, the purpose of the thesis and the design goal was presented. Further, the concept was presented with a contextual visualisation of the concept and an illustrated storyboard explaining the concept and its sub solutions.

What was presented and in focus during each evaluation depended on the area of expertise. For instance, during the user experience evaluation, some of the most important behavioural archetypes was also presented. During the presentations, the experts asked questions and commented regarding the concept, which was followed by a semi-structured interview based on the areas of expertise.

Participants

The different participating experts were chosen because of their area of expertise. Three of the most central areas throughout the project was user experience, safety, and ergonomics. Because of this, all three were important to evaluate. In addition, it was also viewed as important to evaluate the technical feasibility of the concept. The different experts are presented in Figure 23.

Figure 23 - Participants in Experts Evaluation

Area of Expertise	Company	Title	Department
Technical Implementation	Volvo Cars	Technology Scouting Manager	91260 Human Centric Lab
Ergonomics	Volvo Cars	Technical Leader Ergonomics	91230 Ergonomics
Safety	Volvo Cars	Technical Expert Biomechanics	91490 Safety Interface
User Experience	Volvo Cars	Principal User Experience Architect	51110 UX Vision

5. RESULT AND ANALYSIS

In this chapter the result and analysis of the two first main areas are presented: (1) the needs of youths between 10-17 years when travelling in cars and (2) what activities they want to perform and how this affect their sitting posture. The result from each user study is reviewed, followed by the analysis and what needs derived from it. Lastly the different specifications are shown, such as the result of the behavioural archetypes and Impact Mapping, communicating the needs.

05

5.1 USER STUDIES

In this part, the direct results, or what type of knowledge that was received, from the user studies are presented. This includes the results from the *Parent Interviews, Instagram Diaries,* and *Family Home Sessions.*

5.1.1 Parent Interviews

In the *Parent Interviews,* a basis of knowledge about the target group was created. The parents were able to tell about what their children do in cars, but also give a comprehensive picture about their everyday lives. This included mostly their spare time activities and interests. The interviews were transliterated, and the result was processed in the KJ Analysis, see chapter 5.2.

5.1.2 Instagram Diaries

With the *Instagram Diaries*, it was possible to collect extensive data about the participants and their car riding habits. Because of the timing of the study, it was possible to collect both insights from their everyday car riding, but also about their car riding during a sports school break. In total, 81 trips were reported from 15 out of the 17 participants, see Figure 24. Two participants did not go on a single car trip during the time of the study, both the age of 17.

Figure 24 - Number of trips per participant

Code	Family Code	Age	No. of Trips
TH1	TH	15	10
TH2	TH	13	4
TH3	TH	11	2
LO1	LO	14	5
LO2	LO	12	2
WI1	W	15	1
ST1	ST	12	6
ST2	ST	10	9
TE1	TE	13	1
TE2	TE	17	0
SA1	SA	12	3
SA2	SA	10	8
AN1	AN	17	0
AN2	AN	15	2
SU1	SU	17	3
AP1	AP	13	12
AP2	AP	10	13
			Total 81

It was possible to see the number of reported trips and the different activities performed during the trips per age group, see Figure 26. This viewed how many activities were reported per participant in average in each age group, Figure 25. From this it is possible to see that the youngest, the 10-year olds, were the ones reporting the most activities, the 17-year olds the least activities (since there were no 16-year old participant), and otherwise a relatively even result between the age groups.

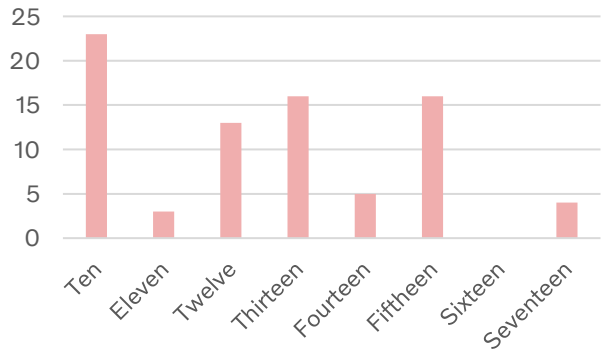


Figure 26 - The number of activities reported for each age group

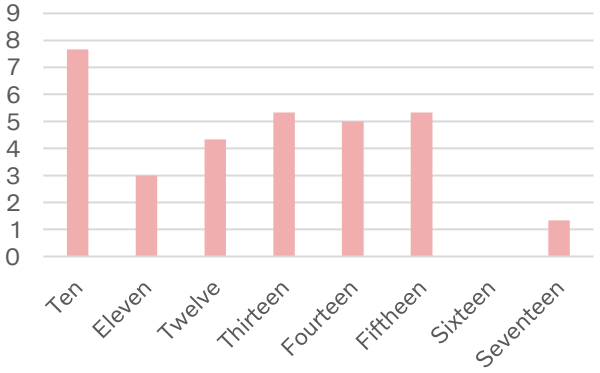


Figure 25 - Average number of activities per person in each age group

The different activities the participants reported that they did during the car trips can be seen in Figure 27. Out of the trips reported, nine of those included the participant doing multiple activities during the same trip. Thus, the total number of activities are more than the total number of trips reported. In the data collection, these were divided, to be handled separately. The most popular activities were talking, using their phone, and listening to music. Among the phone activities, the participants in some cases specified what they did when using their phones. The specification of their phone usage can be seen in Figure 28.

From the reported trips, it was possible to tell the destination. In Figure 29, the distribution of the different destinations is presented. The most common trips were going to and home from sport practise. Other common car trips were going on a ski trip, to family activities, and to school. The result is not representative for the actual distribution of trips, since several days of the study was during a school break, 'sportlov', therefore more trips than usual had destinations such as ski resorts.

The participants also reported who else was in the car during each trip. From this it was possible to see how many co-riders there were during the different trips, see Figure 31. Approximately, during 50 percent of the trips the participant was the only passenger.

From the reported destinations it was also possible to see if a trip was short (<20 minutes), medium (20-90 minutes) or long (>90 minutes). More than 75 percent were short trips, see Figure 30. The presented result is based on the raw data reported from Instagram, the complete data set can be seen in Appendix F.

Based on the result from the *Instagram Diaries*, a collage was created for each family containing a presentation of their week during the study, see Figure 32. Including a row for each child with all their pictures and text reports, spread out over the week. This collage was used during the *Family Home Sessions*, see chapter 5.1.3.

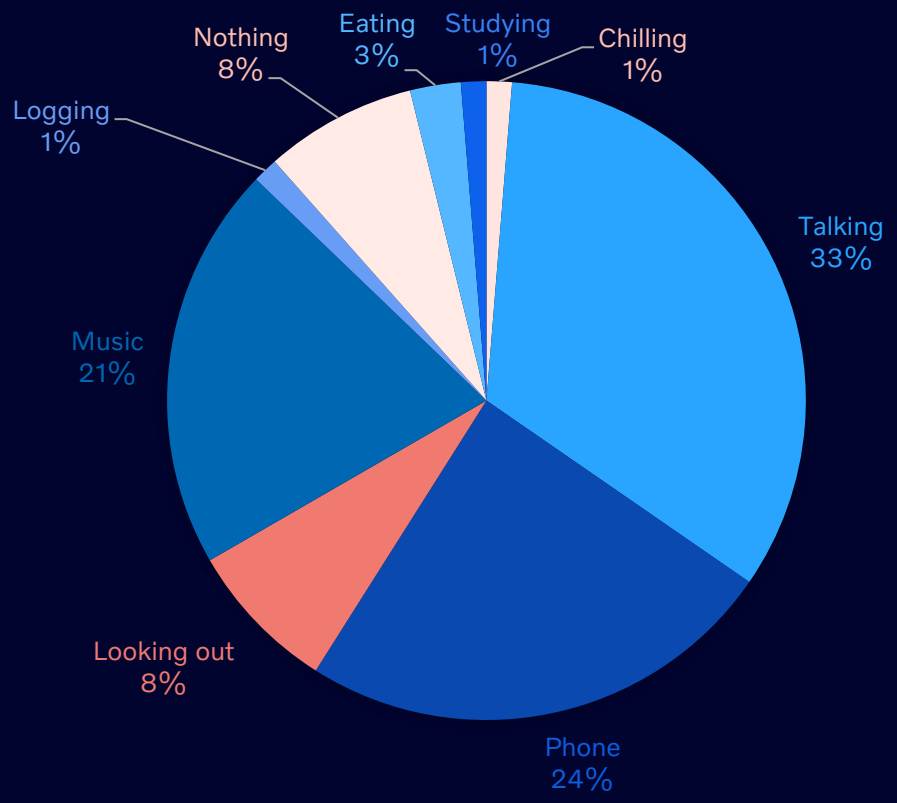


Figure 27 - Distribution of activities reported

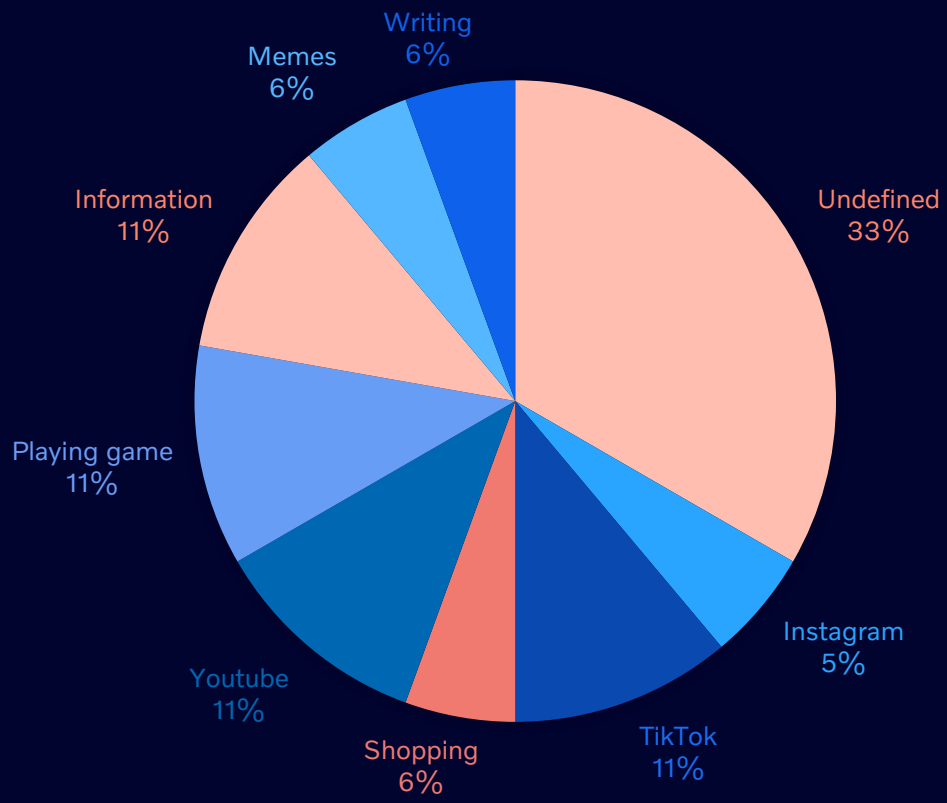


Figure 28 - Distribution of phone activities among the participants

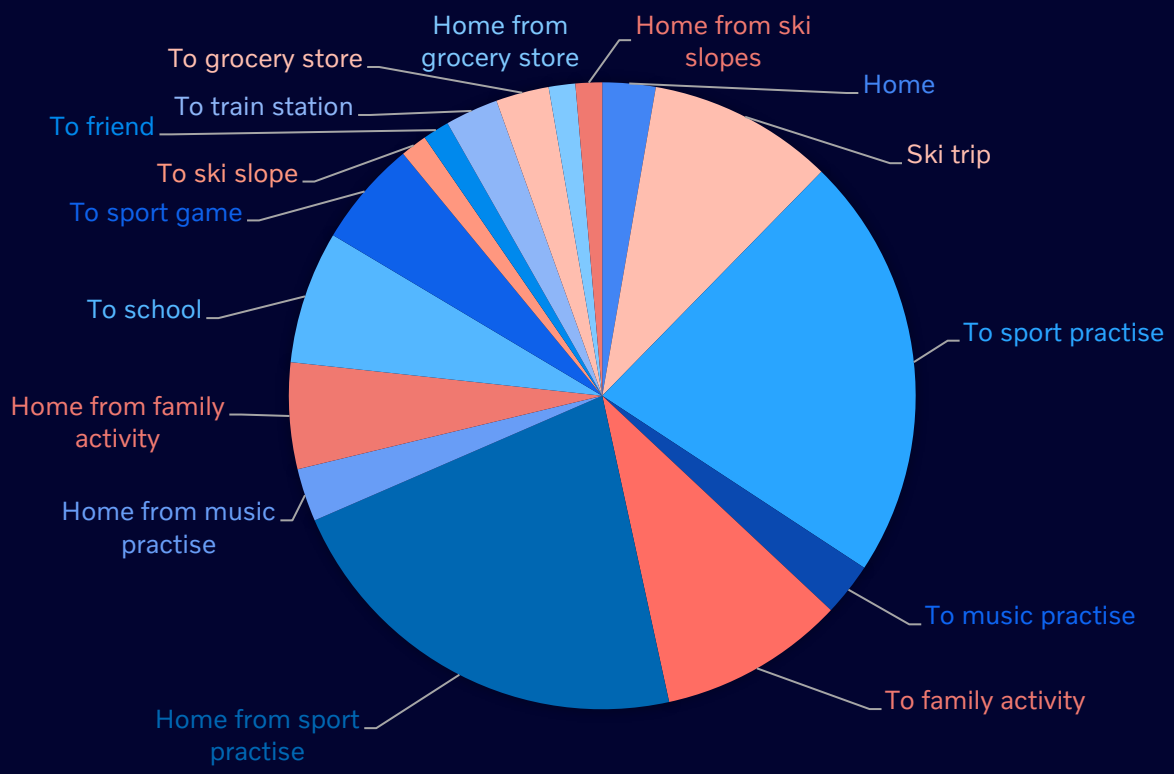


Figure 29 - Destinations of reported trips

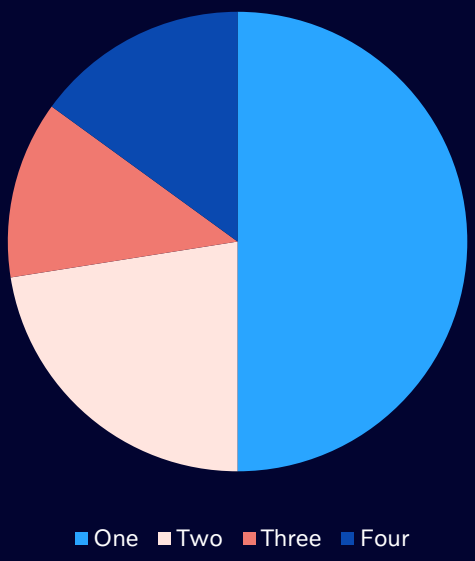


Figure 31 - Distribution of number of co-riders for the reported trips

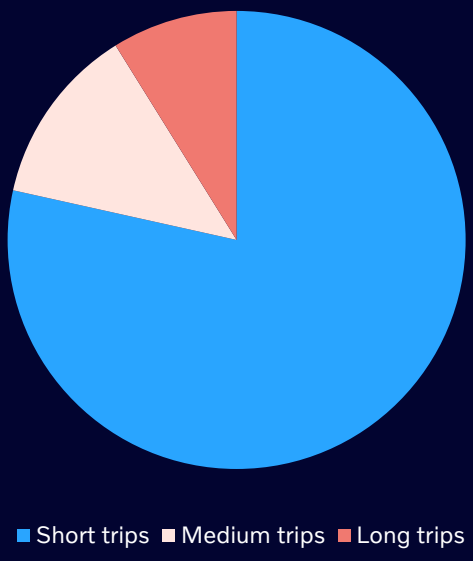


Figure 30 - Distribution of the length of the reported trips

5.1.3 Family Home Sessions

The *Family Home Sessions* were transliterated and analysed by categorising quotes in the *KJ analysis*.

Activity: Collage

The collages brought, see Figure 32, was used as a mediating tool and for remembering the trips. This made it possible for the participants to elaborate what they did during a specific trip. For instance, one of the youths claimed that during a trip

> *"We had her Air pods and listened together. But she does not have a very good taste in music, she listens to *Swedish artist*..."*

Another one said:

> *"I both talked and looked at my phone. Watched YouTube and Instagram."*

During the sessions, the participants got to explain how they felt during a trip by attaching emojis next to it on the collage. The result from one family can be seen in Figure 33. In addition, if the participants had forgotten a trip, they got to put on post-its explaining the trip.

Activity: Other trips

Also, other trips the family usually did, but that did not occur during the week of the study, were discussed. As a trigger, a poster was used, which of the result from one of these can be seen in Figure 34.

Activity: Car contextual inquiry

The insights and knowledge gained during the contextual inquiry in the families' cars, were used both in the *KJ analysis*, but also for the *Activities Sitting Posture Study.* During the contextual inquiry, the youths were able to show how they usually sat in the car and could point out things they liked and disliked with the car. For instance, one of the participants said:

> *"It's not very comfortable to have lots of stuff here, sit like this, and try to sleep."*

From another family, it was possible to understand what it is like when the entire family are riding in their car, see Figure 35. A quote from the participant sitting in the middle was:

> *"No, but since I'm the smallest, youngest and shortest, I usually get to sit in the middle. That makes me long until I get older too."*

Another quote from the car contextual inquiry, triggered by sitting in the car was:

> *"But there is nowhere to put your phone or so, if you want to watch a movie."*

Activity: Picture ranking

From the activity of ranking photos, it was possible to find out what activities the participants thought they often do when riding in the car. And for the second round, what they would like to do. An example of a participant's ranking can be seen in Figure 36.

From the result of this it was possible to create a compilation of how often the different activities were chosen. The distribution of the activities the participants said they usually did when riding the car can be seen in Figure 37. The activities the participants said they would like to do in cars can be seen in Figure 39.

In Figure 38, a comparison of what the participants say they do and what they would like to do is presented. Based on this, it is possible to see what they want to do more or less in comparison to what it is like today. For instance, they would like to watch Netflix, play cards, eat, sleep, play TV games and play computer games. According to the result they would like to listen less to music, look out less, talk less, and use their phone less.

Figure 32 - Example of collage created from Instagram Diaries

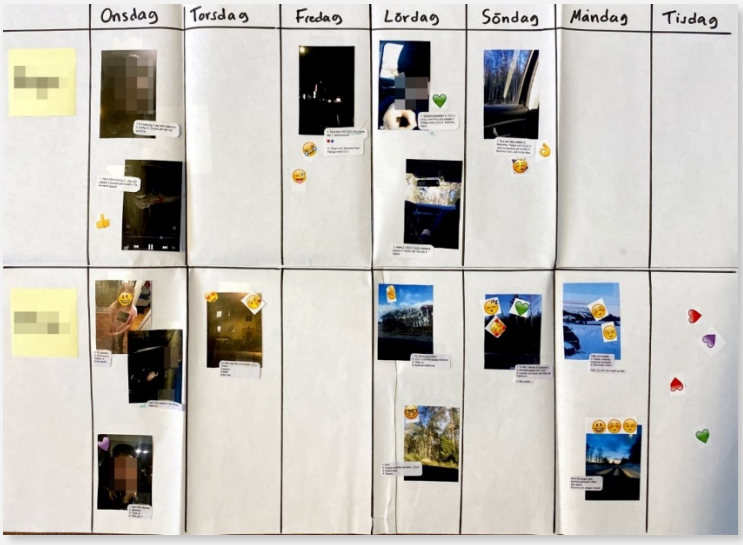


Figure 33 - Example of collage after Family Home Sessions

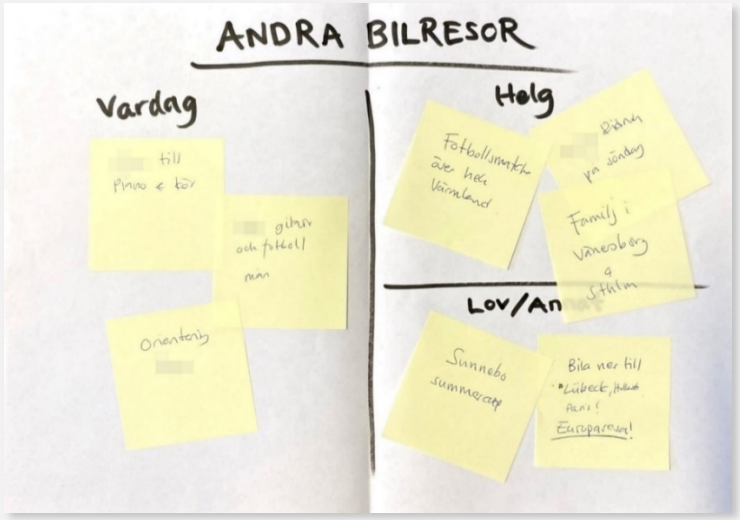


Figure 34 - Example of "other trips" poster

Figure 35 - One of the contextual inquires in a family's car

Figure 36 - Example of ranking from picture activity during Family Home Session

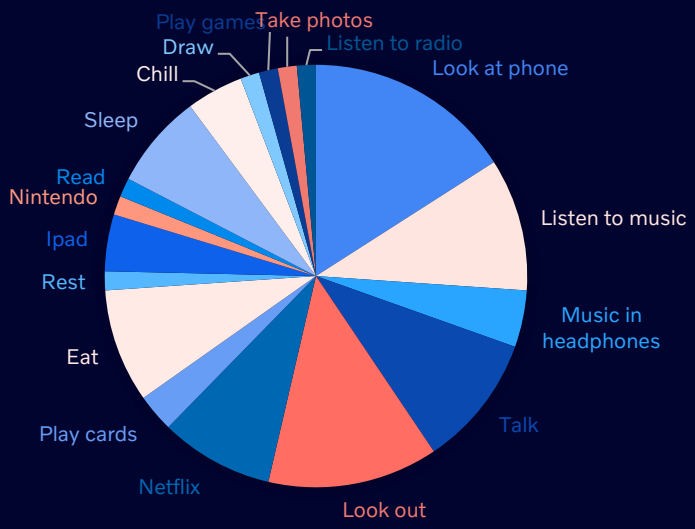


Figure 37 - Activities the participants do in cars

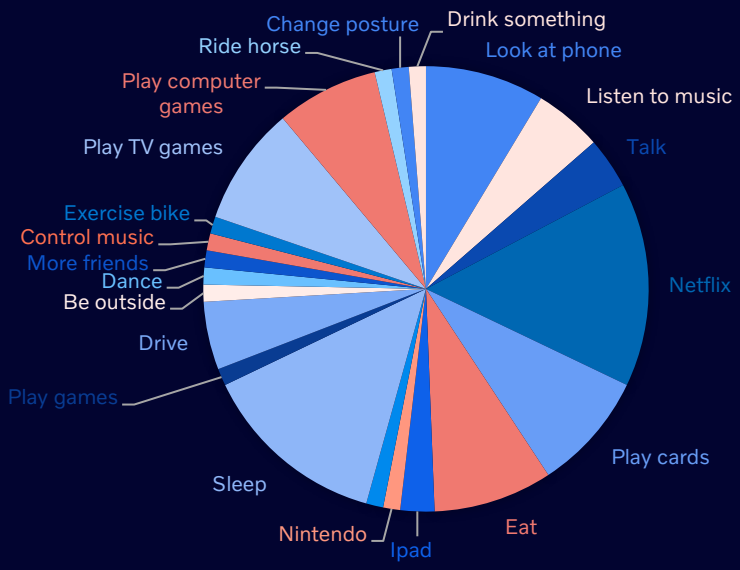


Figure 39 - Activities the participants would like to do in cars

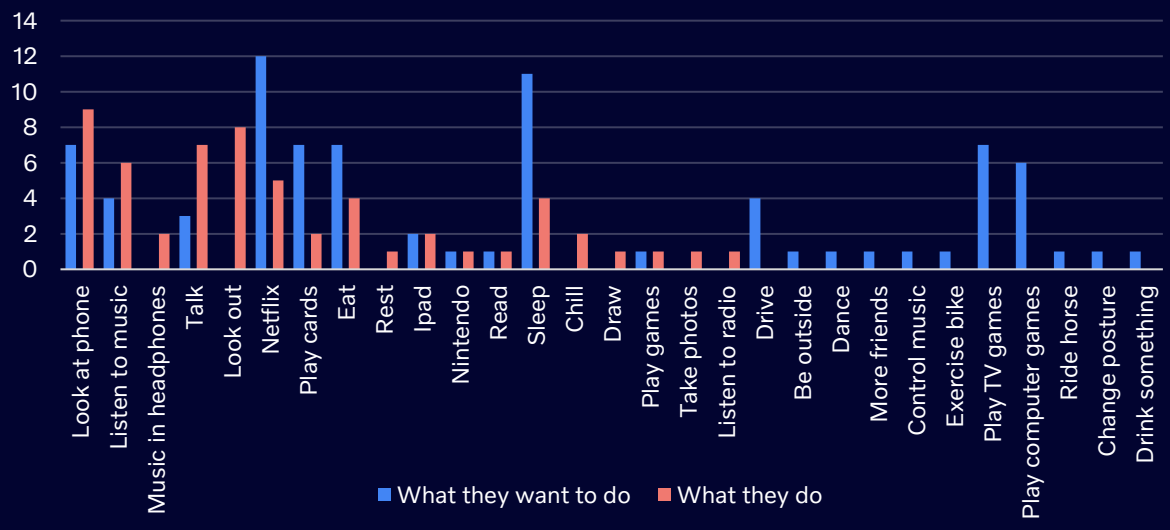


Figure 38 - Comparison of activities participants do and would

5.2 KJ ANALYSIS

For the qualitative analysis, quotes that expressed a need or revealed other interesting insights from the *Parent Interviews* and the *Family Home Sessions* were grouped in different categories and used to formulate general needs of or insights about the target group. See Figure 40 for a complete overview of the analysis. The yellow notes contain direct quotes from the studies, the red notes show general insights, the bright blue notes contain found needs for each category, and the dark blue notes display the name of the category.

5.3 INSIGHTS

Below is a summary of the insights. The insights are grouped according to common themes and are mainly based on quotes or other observations from the *Family Home Sessions* and the *Parent Interviews.*

About youths

- The impression was that they do not want to be treated as children - but rather as equals (adults).
- It seems like the youths, especially the younger ones, quickly grow tired of games or other things.
- The parents expressed that they thought the children behaved more politely if they got a ride with another adult.
- All youths were aware of safety factors and seemed to use the seat belt properly.
- Some youths were very environmentally cautious.

About siblings

- Almost all families with more than one child expressed that it is common that the siblings fight. They usually had different ways and systems for avoiding such events in the car.
- Many parents claimed that fuss is a sign of distress. But that it can also depend on if they are sitting close to each other, invading each other's personal space.
- Almost all expressed that fairness between siblings is very important.
- Some, often older siblings, explained that they sometimes resign on fairness in order to avoid fighting with siblings

After school activities

- Almost all youths in the study had one or more activities after school such as sports or music lessons. Many of the everyday car rides were to and from these activities.
- For youths with many activities (often in the younger span), the parents in some cases act like personal drivers.

When/how they get a ride

- Some of the youths said that they would get a ride when it is bad weather, when they would usually walk or bike.
- It seemed to be common that parents pick up their children when it is later in the evenings since they did not want them to take the bus alone at that hour.
- Some of the families explained that they would take turns with other parents to drive the kids to sport activities etc.

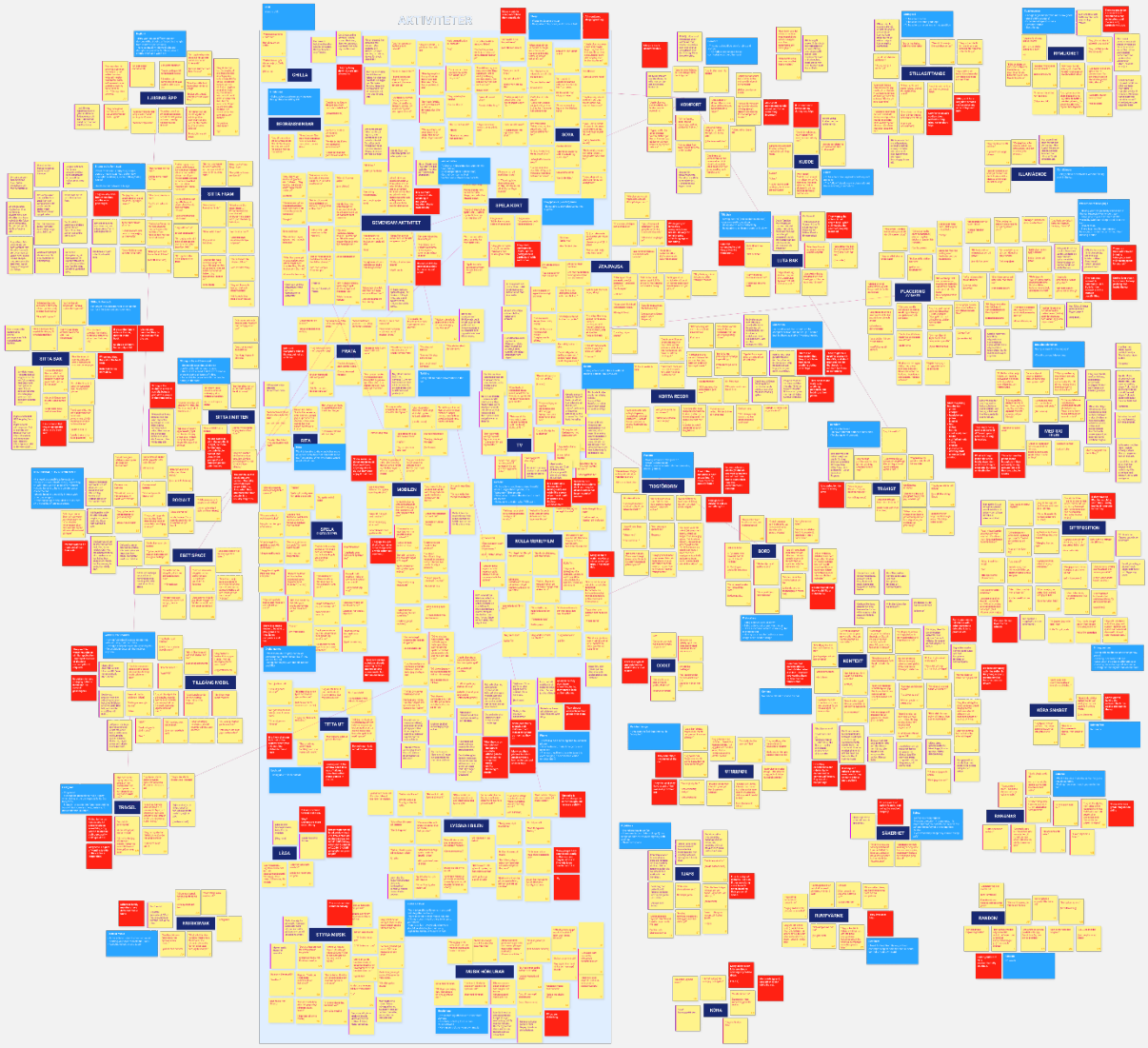


Figure 40 - Complete KJ Analysis

Different types of trips

- Weekday trips was often shorter trips, to and home from friends or after school activities. These trips seemed to be viewed as something necessary evil.
- Weekend trips was often 30 min to 1,5 hours and the reason for these trips was for example to visit someone, going on an excursion or to a sport game in another city.
- The vacation trips were often longer. Common destinations were skiing places, family members living in other parts of the country, vacation in Europe etc.

About short trips

- They claim that they do not have time to do anything during short trips.
- Some expressed that they sometimes experience that there is a need for a break in their life, and the short trips can be that break - a moment for them to do nothing.
- During short trips, they seem to not want to do anything but look at their phone.

About long trips

- Many of the families went on longer car trips once in a while, about 3-8 hours but sometimes even longer, when travelling in Europe.
- During long trips, many participants explained that they store luggage/things also inside the car cabin.
- The rear seat armrest is commonly used by the participants during long trips. Both for armrest purpose but also for extra storage possibilities.
- Most of the youths said that sitting still for a long time creates restlessness and ache in legs and bum.
- When the youths talked about what they would like to do in the car during long trips, it was shown that they enjoy being able to do several different types of activities.
- Many seem to watch movies or series on longer trips, on tablets or phones. They said that they enjoyed this a lot.
- These were the things they claimed to bring into the car for long trips:
    - Phone
    - Charger
    - Headphones
    - Pillow
    - Blanket
    - Laptop
    - Tablet
    - Bottles
    - Sports or music equipment
    - Books
    - Stuffed animals
    - Candy
    - Snacks
    - Power banks
    - Drawing stuff
    - Nintendo switch (and similar)

Taking breaks

- Many of the participants explained that they take breaks during longer trips.
- They claimed that taking breaks are usually for toilet breaks, stretching legs or for eating.

Pass time

- In comparison to adults, many of the youths did not seem to want to make a use of their time in the car, but rather pass it by (through entertainment / resting).
- A lot of the activities was referred to as pastime. To make the time pass by faster.
- The youths thought that time goes by quicker if you do something fun.
- Almost all expressed that they think it is boring to ride cars for a long time.

Where the youths sit in the car

- Many participants expressed that they usually sit in specific seats in the car. Sometimes, it seemed like this was based on where their booster chair was placed when they were younger.
- Almost all the youths claimed that they preferred sitting in the front seat. If they get to decide where to sit, they almost always choose to sit in the front due to several reasons such as more leg space, better overview, seat heating and the possibility to control the radio/music.
- It seems like the youths usually sit in front when they are the only passenger.
- Some participants expressed that sitting in the middle of the back seat is a way of easier talking with the people in the front seats.
- In all families with more than one child, they explained that the children sit in the back if the entire family rides the car together. This also applied to long trips.
- When asking a family with three children how often they used the middle seat, they estimated that it was probably less than 1 per every 30th trip.
- It seemed like the middle seat was mostly used during long trips for the families with three children.
- The youths expressed that they did not like to sit in the middle. They claimed that it was too narrow, no room for the legs, uncomfortable, cannot lean comfortably against something. Usually the youngest and smallest person would get that seat.

Private vs. social space

- Many said it was not very common that they did anything in particular together in the car. Many youths claimed to prefer doing activities on their own.
- They seem interested in playing games (card games in particularly) with each other.
- Many said that they used to play more "car games" together when they were younger, but not as much anymore.
- (Almost) everyone said that they talk in the car.
- It seemed as if the parents often wanted to be more social in the cars than their kids.
- There seem to be a trade-off between bringing belongings into the car and still having room for yourself.

Sleeping/laying down

- Almost all youths expressed that they, in the car, would like to sleep as they would do in an actual bed.
- They explained that they would try to lay down, but that the parents would not allow it.
- Many of the youths said that they wanted to sleep more than they actually did in the car.
- All mentioned sleeping/resting.
- Some suggested that they would like to be able to tilt the chairs back, while keeping the seat belt properly fastened.
- It seemed common to lean against the window when sleeping/resting.

Comfort

- Many expressed that they think cars are uncomfortable.
- Comfort seems more important during long trips, it was not mentioned as much for short trips.
- Almost all participants talked about comfort as something important.
- Almost all youths claimed to appreciate seat heating.
- It was common, among the participants, to bring a pillow during long trips for increased comfort.
- A majority mentioned that they would like a stable table inside the car.

Screens in the car

- It was common that they used to have screens in the cars before, but that they do not longer have it.
- They claimed that, when using and iPad in the car, they hold it resting in their lap.

- Many youths said that they would like to have a screen at your seat, similar to the ones in airplane cabins - with tv, games etc.
- Many expressed a strong desire to be able to play games in the car, as they do at home on computers and TVs.
- Among the youths, it was not common to read in the car. They claimed that this was due to devices being more entertaining.

Phone

- Everyone almost always had their phone with them in the car.
- The only time that the phone seems to not be brought is if they are younger (around 10 years old) or if they are going to sports practice.
- Some seem to use the phone because they do not have anything else to do, but not necessarily because that they enjoy it that much.
- It seemed like, at the moment they run out of things to do, they start to look at their phones.
- The youths expressed that they want to watch YouTube or similar application – but that they do not because it requires a lot of data.
- Some parents try to get their children to not look at the phone as much as they do.
- Many of the youths claimed to use their phones to watch movies/videos, both on longer and shorter trips.
- Almost all expressed that it is important to have charging options for devices in the car - for each passenger.

Music

- The most common activity they do together in the car seems to be listening to music.
- In most cases, they claimed, the radio was on in the background (or that they listened to it more actively).
- Many of the participants had connected Spotify to their car and played music that way. The youths knew how to control it.
- Some expressed that they think that wires in the car are disturbing, e.g. connecting the phone with USB to the car.
- The music taste in families often varies, and they often dislike each other's taste.

Looking out

- Doing nothing seems equal to looking out of the window.
- When looking out the window, many of the youths simultaneously either; did nothing, listened to music or talked with others in the car.
- In some cases, looking out of the window was a way of taking a break from other things they did in the car.

Opinions about their car

- Some of the youths seem to care about the design of the car.
- It seemed as they feel like they have a part of the ownership of their car.
- None of the participants keep belongings in the car.
- They did not seem to view their car as something personal, neither trying to personalise their car or their seat.

Luxurious and cool

- There seem to be a type of appreciation for products that are 'cool' or new, and a desire to have that yourself.
- There seems to be a correlation between experiencing a car as luxurious and the size of it. Particularly SUVs were viewed as more luxurious.
- Some youths, having interest in cars in general, seem to think it is cool to ride fast in the car.

Driving the car

- Many of the older youths have already begun to practice driving (16-17 years).
- Older youths, between 16-17, seem to get around on their own most of the time, either on their moped or with bus/train. And if they did go by car, it seemed common that the reason for going by car was to practice driving.
- Many of the youths expressed that they long until they can drive the car themselves.

Cosiness

- Riding in the car was by many experienced as something cosy. This seemed to be related to both their personality and the type of trip.
- For many of the youths, cosiness is a part of wanting to ride in the car for a longer time.

5.4 NEEDS AND DESIRES

The quotes and the insights were interpreted from the KJ Analysis as needs and desires, which were then grouped according to found themes. This resulted in 10 new groups of desires and needs. There was no prioritization or other type of assessment made at this point. A list of the needs and desires can be found in Appendix G.

5.5 ACTIVITIES SITTING POSTURE ANALYSIS

Based on the car activities found during the user studies and how the youths behave, a sitting posture study and analysis was performed, see chapter 4.3.3. The study and analysis were based on the sitting postures in the back seat. The activities found and included in the study were: talk to person in the front, talk to the person next to you, play cards, look at phone (YouTube), look at phone (scrolling), look at phone (texting), look out of the window, listen to music, nothing, study, draw, read, eat, sleep/chill, watch movie alone, watch movie together, play games, play Nintendo/similar, and look at phone showed by other. The result from the analysis can be seen Figure 41, the ones marked red are the critical sitting postures.

Some of the most critical sitting postures is leaning inboard, 'IB', which can lead to a displacement of the belt. This means that some of the most critical activities are talking to person in the front, sleeping/chilling, and watching movie together.

Another critical sitting posture is strongly leaning forward, 'dc'. This means talk to person in front, look at phone (YouTube), study, draw, sleep/chill, and look at phone showed by other.

Another critical sitting posture is strongly leaning the neck forward, 'ac'. This occurs when talking to a person next to (while rotating), looking at phone (all phone activities), and playing games (tablet). This position could potentially also be critical from an ergonomic point of view.

The most optimal sitting posture is when having a neutral head and torso 'aa'/'ba' and sitting straight 'S', and thus what to strive for. This occurs when looking at phone held high, looking out of the window, listening to music, sleep/chill, and watching movie on a tablet standing on a table on the back of the front seat.

What is not covered in this analysis is that the participants mentioned sitting with their legs up in different positions. Also, rotated torso or neck occurred in some cases, but could not be analysed with the method.

The activity 'doing nothing' could not be analysed, for obvious reasons. Based on the insights that doing nothing often equals looking out, see chapter 5.3, it is likely that doing nothing results in the same postures as when looking out of the window.

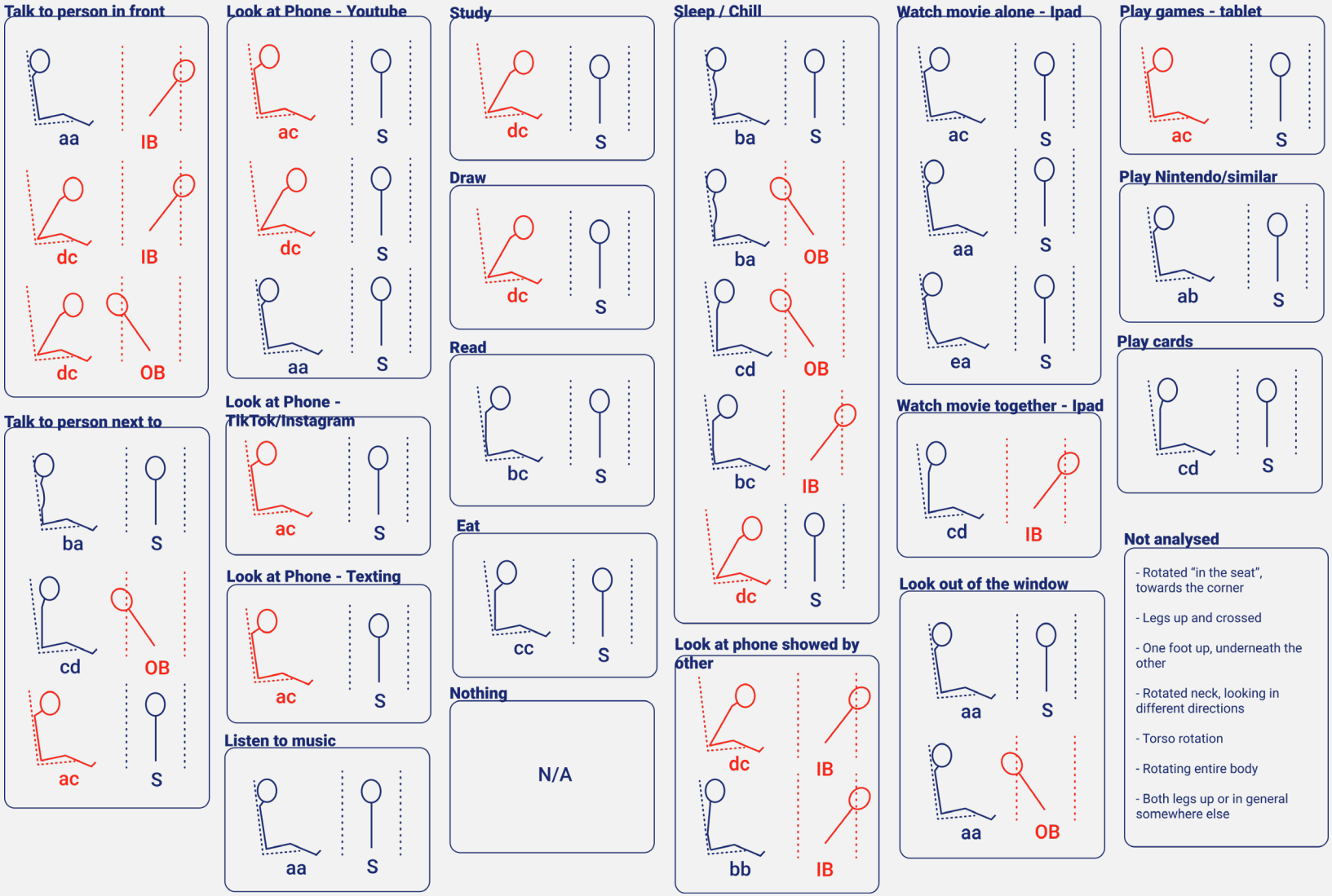


Figure 41 - Activities sitting posture analysis

5.6 SPECIFICATIONS

In this part, the result from the different specifications are presented.

5.6.1 Behavioural Archetypes

Based on the needs and findings, seven different behavioural archetypes were created. In this section, all seven are explained.

The Fun Seeker

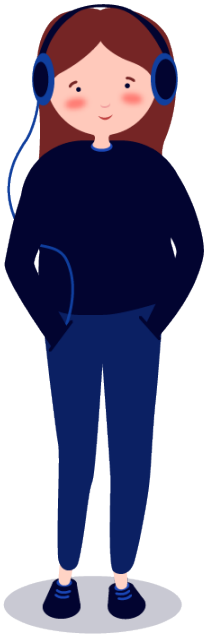
Always looking for new options and variations of entertainment. Sees opportunities of being entertained in the car. Wants to feel like there is endless of entertainment without limitations. See Figure 42.

One quote from the interviews, from a typical Fun Seeker behaviour is “I usually watch YouTube when I get Wi-Fi. Snapchat and play some games as well. And a little bit of TikTok.”

Three of the most important needs related to the Fun Seeker behaviour are:

- Needs to have the opportunity of being entertained at all times.
- Needs to be able to choose from different alternatives of entertainment.
- Wants their things easily accessible in the car without them moving around.

Figure 42 - The Fun Seeker



The Solo Rider

Enjoys having a private space and creating their own bubble. Does not want to be disturbed by others and prefer doing activities on their own. Wants to be independent. See Figure 43.

One quote from the interviews, from a typical Solo Rider behaviour is “I would want a hatch here, a wall there, so it becomes as your own room.”

Three of the most important needs related to the Solo Rider behaviour are:

- Does not want to be disturbed by nor disturb other passengers.
- Needs private space.
- Needs to do what they want on their own terms, not based on directions/initiatives from others.

Figure 43 - The Solo Rider

The Social Butterfly
Enjoys hanging out with others and being social. Appreciates having conversations and doing activities together with other people in the car. Finds shared experiences valuable. See Figure 44.

One quote from the interviews, from a typical Social Butterfly behaviour is “When someone else sits in the front seat, I like (...) to lean forward so that you can be with the ones in the front”.

Three of the most important needs related to the Social Butterfly behaviour are:

- Needs to be able to make conversation with all people in the car.
- Wants to be able to perform activities together with others.
- Wants to feel as a part of a social context in the car.

Figure 44 - The Social Butterfly

Figure 45 - The Time Killer

The Time Killer
Believes that the car riding is a waste of time which induces the feeling of powerlessness. Wants to escape from the boring present and strives to obtain a sensation of doing something. Really focused on the destination. See Figure 45.

One quote from the interviews, from a typical Time Killer behaviour is “I would just like to skip forward... or to pass out”.

Three of the most important needs related to the Time Killer behaviour are:

- Wants to pass time and fight boredom.
- Wants to be able to do the same things as they do in their home.
- Wants to feel unlimited.

The Set-Upper
Brings several belongings when going on a trip and arranges the things in different accessible places. Creates a cosy set-up in the car and prepare themselves for the trip. See Figure 46.

One quote from the interviews, from a typical Set-Upper behaviour is “I bring a lot of stuff on long trips (...) I want to have access to them. Usually I put my bag here or here and my bottle here”

Three of the most important needs related to the Set-Upper behaviour are:

- Being able to create their own setting in the car.
- Wants their things easily accessible in the car without them moving around.
- Want to be able to lean/mount a (brought) device in order to create a good view angle.

Figure 46 - The Set-Upper

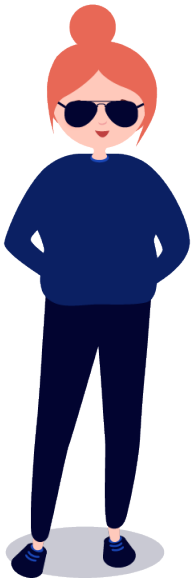


Figure 47 - The Pilot

The Pilot
Wants to control different settings and adjustments. Appreciates to have a clear overlook, both inside and out of the car. Wants to be the one controlling the music and adjust their seat etc. See Figure 47.

One quote from the interviews, from a typical Pilot behaviour is “You have better overview here (in the front seat) and get to control the music”.

Three of the most important needs related to the Pilot behaviour are:

- Wants control of different settings and adjustments of the passenger environment inside the car.
- Needs control of the speakers in the car.
- Wants a clear overlook both inside and out of the car.

The Harmony Seeker
Seeking personal space and a time out from everyday life (me-time). Sees the car riding as an opportunity to get some relaxation and time for reflection. See Figure 48.

One quote from the interviews, from a typical Harmony Seeker behaviour is “I think it’s quite nice just take a moment and sit and relax”.

Three of the most important needs related to the Harmony Seeker behaviour are:

- Needs personal space.
- Wants a moment of lowered demands.
- Must be able to rest comfortably.

Figure 48 - The Harmony Seeker

5.6.2 Behaviour Mapping

Among the behavioural archetypes, it was possible to see common factors. For instance, some are more active and other less active. Other behavioural archetypes have a focus on being on their own or together with others. Each was therefore mapped out on a plot area, see Figure 50.

Based on this it was possible to see patterns and relations between the behavioural archetypes. The highest concentration of behavioural archetypes is on the active (positive) side of the y-axis. This shows an indication of what behavioural characteristics are more or less common. The mapping was thus in this stage used for narrowing the design scope. Based on where most of the behavioural archetypes mapped out, it was decided to target the design scope to the first and fourth quadrant, but also covering the entire scale from solo to social. This is called 'The Target' in Figure 50.

5.6.3 Design Goal

Based on the result from the *Behavioural Mapping*, a design goal statement was developed, see chapter 3.11.

> "Enable youths to be active in the backseat of a car, either together or by themselves."

The users are the 'youths', the solution should enable the youths to be 'active', the place is the 'backseat of a car', see chapter 1.4, and 'together or by themselves' further explains what the solution should support.

5.6.4 Impact Mapping

The design goal is used as the aim in the centre of the Impact Map, see Figure 51. The dimensions and their metrics were chosen since those are relevant for all behavioural archetypes and passengers in the target group, based on needs and requirements.

Behavioural archetypes ranking and weight

In the Impact Map, all behavioural archetypes were ranked, see chapter 4.4.2. The final ranking can be seen in Figure 49. In the next step of the Impact Mapping, each behavioural archetype got a weight based on the rank and their importance, see Figure 49.

The Solo Rider, Social Butterfly, and The Time Killer were all assessed as equally important and thus weighted equally.

Figure 49 – The ranking and weights of the behavioural archetypes

Ranking	Behavioural Archetype	Weight
1	The Fun Seeker	5
2	The Solo Rider	4
3	The Social Butterfly	4
4	The Time Killer	4
5	The Set-Upper	3
6	The Pilot	2
7	The Harmony Seeker	1

Final Impact Map

Based on this, the visualisation of the Impact Map was created with the centre, ranked behavioural archetypes with needs, capabilities, and functions. The final Impact Map is presented in Figure 52.

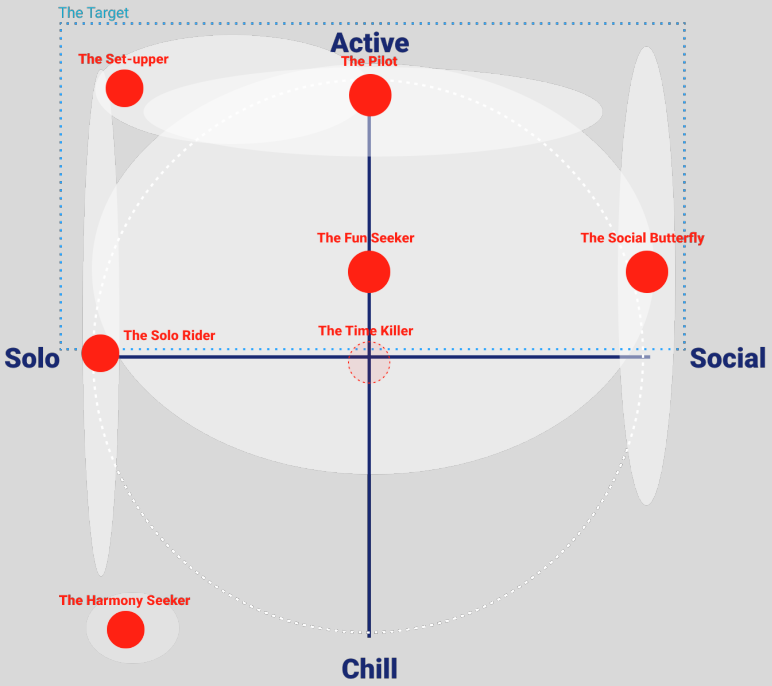


Figure 50 - Mapping of behavioural archetypes

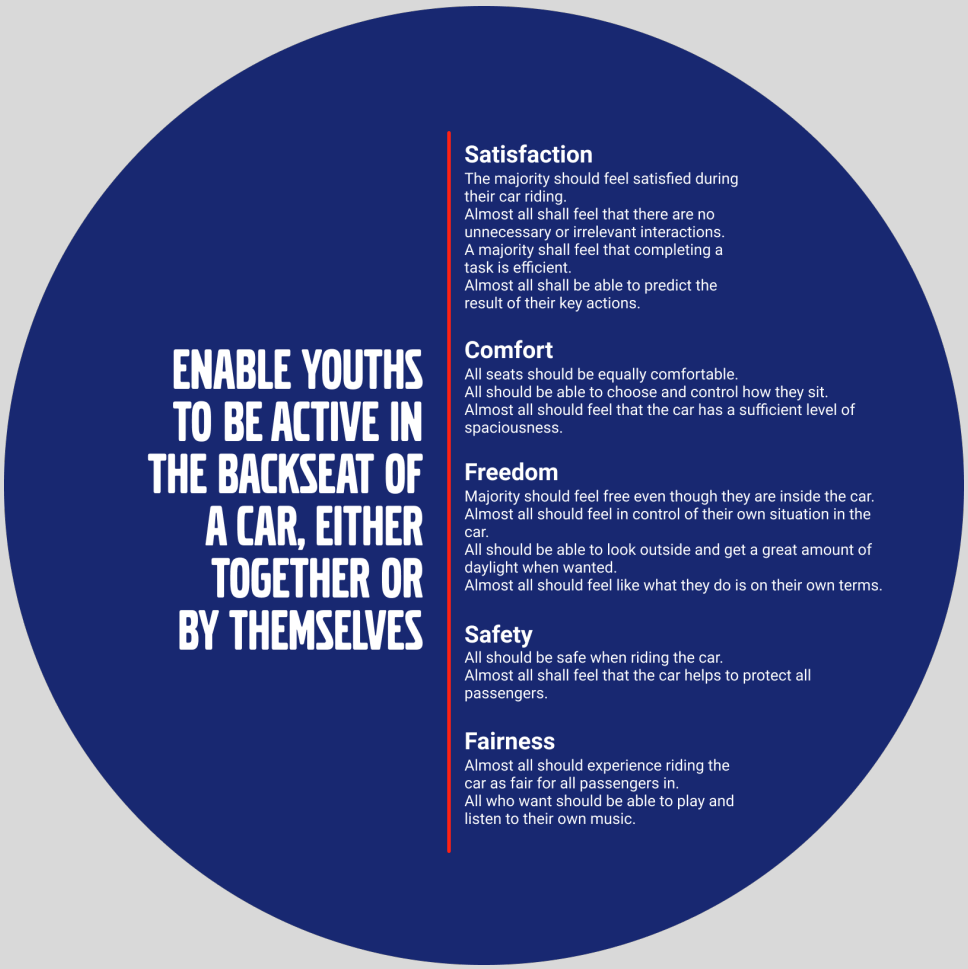
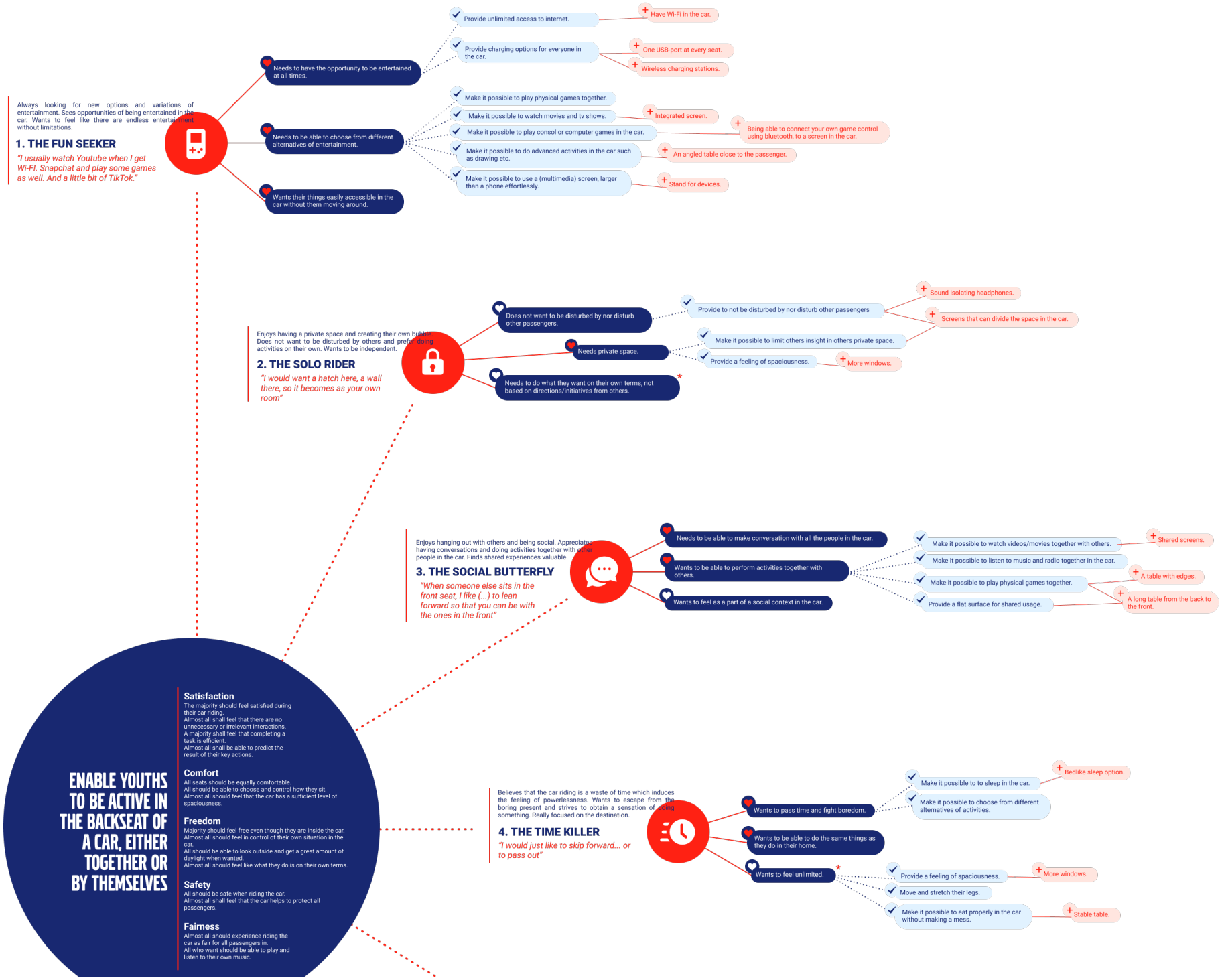


Figure 51 - Centre of the Impact Map


ENABLE YOUTHS TO BE ACTIVE IN THE BACKSEAT OF A CAR, EITHER TOGETHER OR BY THEMSELVES
Satisfaction
The majority should feel satisfied during their car riding.
Almost all shall feel that there are no unnecessary or irrelevant interactions.
A majority shall feel that completing a task is efficient.
Almost all shall be able to predict the result of their key actions.
Comfort
All seats should be equally comfortable.
All should be able to choose and control how they sit.
Almost all should feel that the car has a sufficient level of spaciousness.
Freedom
Majority should feel free even though they are inside the car.
Almost all should feel in control of their own situation in the car.
All should be able to look outside and get a great amount of daylight when wanted.
Almost all should feel like what they do is on their own terms.
Safety
All should be safe when riding the car.
Almost all shall feel that the car helps to protect all passengers.
Fairness
Almost all should experience riding the car as fair for all passengers in.
All who want should be able to play and listen to their own music.
Always looking for new options and variations of entertainment. Sees opportunities of being entertained in the car. Wants to feel like there are endless entertainment without limitations.
1. THE FUN SEEKER
"I usually watch Youtube when I get Wi-FI. Snapchat and play some games as well. And a little bit of TikTok."
Needs to have the opportunity to be entertained at all times.
Provide unlimited access to internet.
Have Wi-Fi in the car.
Provide charging options for everyone in the car.
One USB-port at every seat.
Wireless charging stations.
Needs to be able to choose from different alternatives of entertainment.
Make it possible to play physical games together.
Make it possible to watch movies and tv shows.
Integrated screen.
Make it possible to play consol or computer games in the car.
Being able to connect your own game control using bluetooth, to a screen in the car.
Make it possible to do advanced activities in the car such as drawing etc.
An angled table close to the passenger.
Make it possible to use a (multimedia) screen, larger than a phone effortlessly.
Stand for devices.
Wants their things easily accessible in the car without them moving around.
Enjoys having a private space and creating their own bubble. Does not want to be disturbed by others and prefer doing activities on their own. Wants to be independent.
2. THE SOLO RIDER
"I would want a hatch here, a wall there, so it becomes as your own room"
Does not want to be disturbed by nor disturb other passengers.
Provide to not be disturbed by nor disturb other passengers
Sound isolating headphones.
Screens that can divide the space in the car.
Needs private space.
Make it possible to limit others insight in others private space.
Provide a feeling of spaciousness.
More windows.
Needs to do what they want on their own terms, not based on directions/initiatives from others.
Enjoys hanging out with others and being social. Appreciates having conversations and doing activities together with other people in the car. Finds shared experiences valuable.
3. THE SOCIAL BUTTERFLY
"When someone else sits in the front seat, I like (...) to lean forward so that you can be with the ones in the front"
Needs to be able to make conversation with all the people in the car.
Make it possible to watch videos/movies together with others.
Shared screens.
Make it possible to listen to music and radio together in the car.
Wants to be able to perform activities together with others.
Make it possible to play physical games together.
A table with edges.
A long table from the back to the front.
Provide a flat surface for shared usage.
Wants to feel as a part of a social context in the car.
Believes that the car riding is a waste of time which induces the feeling of powerlessness. Wants to escape from the boring present and strives to obtain a sensation of doing something. Really focused on the destination.
4. THE TIME KILLER
"I would just like to skip forward... or to pass out"
Wants to pass time and fight boredom.
Make it possible to to sleep in the car.
Bedlike sleep option.
Make it possible to choose from different alternatives of activities.
Wants to be able to do the same things as they do in their home.
Wants to feel unlimited.
Provide a feeling of spaciousness.
More windows.
Move and stretch their legs.
Make it possible to eat properly in the car without making a mess.
Stable table.

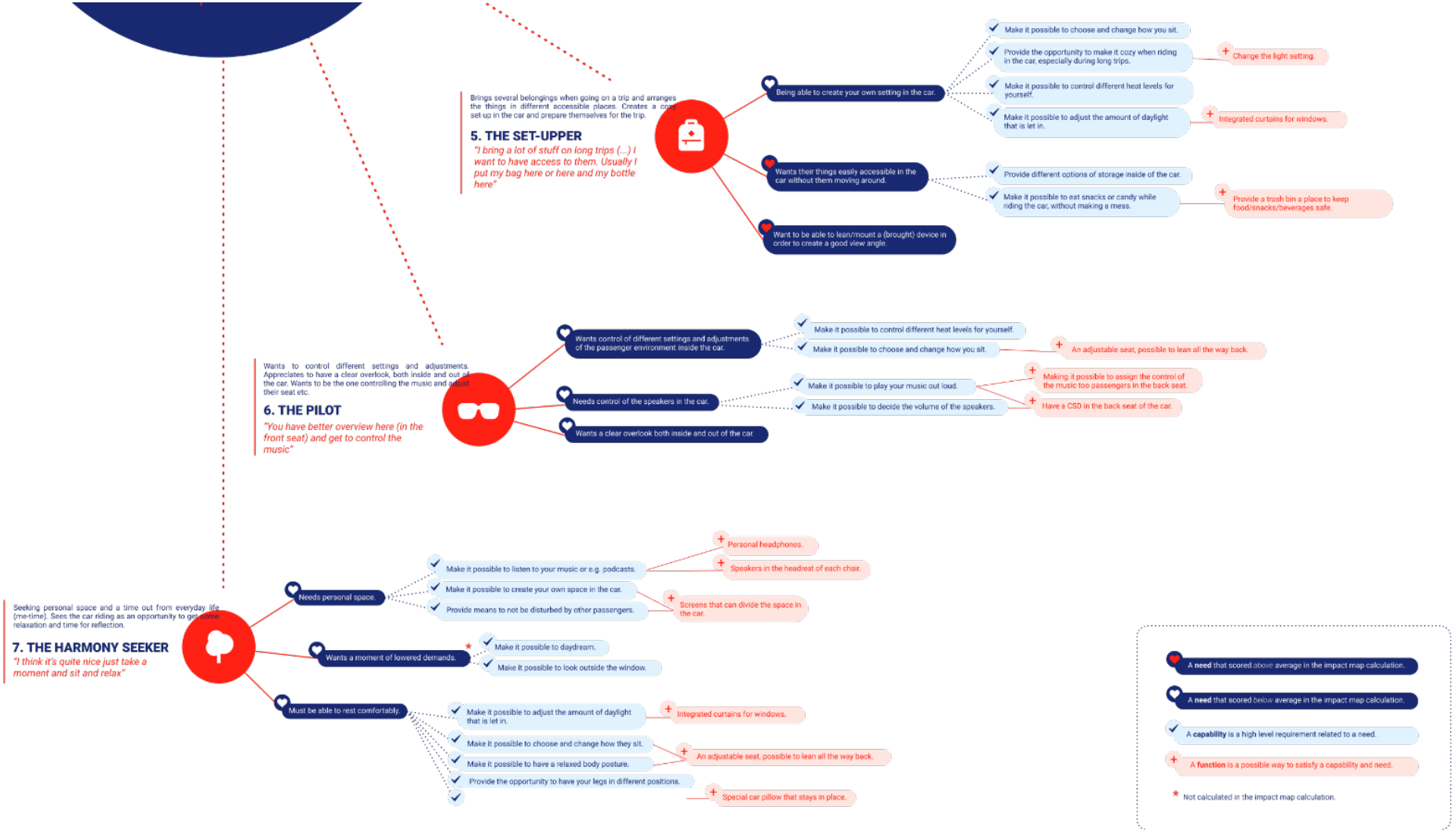


Figure 52 - The Impact Map

Ranking of needs
Evaluating the needs in relation to the different behavioural archetypes resulted in a ranking of the needs, see Figure 53 which indicates what need would make the most impact if fulfilled. All needs with a rank above average is in Figure 53 marked with a bold and coloured score. The calculation of the impact of each need can be found in Appendix H.

The needs with a rank above the average is marked with a red heart in the Impact Map, see Figure 52, and were also the needs that were prioritised further on in the project process.

5.6.5 Requirement Specification
The Requirement Specification can be found in Appendix I. The specification contains both requirements (marked as 'R') and desires (marked as 'D'). Each item is accompanied with a description of where it originates from, which is shown in the column 'Justifications'. Each desire is also weighted from 1-5. In what manner it should be verified/evaluated was not specified because of the conceptual level.

The Requirement Specification is general, meaning that it can be applied to most developments of products for this specific context and target group, i.e. in the back seat of a car and for youths 10-17 years. The Requirement Specification is divided in categories which were chosen since they turned out to be important during the user studies, or because of other important factors such as safety in the car.

Figure 53 - Impact ranking of needs

Needs	Score
Wants to pass time and fight boredom.	17
Want to be able to lean/mount a (brought) device in order to create a good view angle.	17
Needs to be able to choose from different alternatives of entertainment.	14.5
Wants their things easily accessible in the car without them moving around.	14.5
Wants to be able to perform activities together with others.	14.5
Wants to be able to do the same things as they do in their home.	13
Needs private space.	12.5
Needs to have the opportunity to be entertained at all times.	12
Needs to be able to make conversation with all the people in the car.	11.5
Being able to create your own setting in the car.	8.5
Does not want to be disturbed by nor disturb other passengers.	8.5
Wants to be able to adjust the amount of daylight that is let in.	8
Wants to feel as a part of a social context in the car.	7.5
Needs control of the speakers in the car.	6.5
Wants control over different settings and adjustments of the passenger environment inside the car.	6
Wants a clear overlook both inside and out of the car.	6

6. METHODS EVALUATION

In this chapter, the different evaluations of the methods developed in this project (*Parent Interviews, Instagram Diaries* and *Family Home Sessions*) are presented. This is divided into two parts: the participant study evaluation and the method assessment.

06

6.1 PARTICIPANT STUDY EVALUATION

After each *Family Home Session*, both parents and youths filled out a survey regarding their experience of the study. See Appendix C and Appendix D for the survey templates. The responses from the youths and parents are separately presented below.

6.1.1 Survey Responses - Youths

The survey was divided into two parts, the first part was about the *Instagram Diaries* and the second was about *Family Home Interview.* In total, 15 youths filled out the survey, of which 14 had used Instagram for reporting their car rides and one used text messages since she did not have Instagram.

Instagram Diaries

The first part contained three scales of 1-5, where 5 was the most positive and 1 was the most negative. The average scores can be seen in Figure 54. On average, the youths scored 4,40 regarding what they thought of the amount of time they had to spend on the study, meaning most of them did not think it was too time consuming. The score for how clear the instructions were on how to perform the study was on average 4,80, meaning that most of the participants thought it was easy to understand. The last one concerned what they thought of participating in the study where 1 was 'Boring' and 5 was 'Funny'. For this, the average was 4,27.

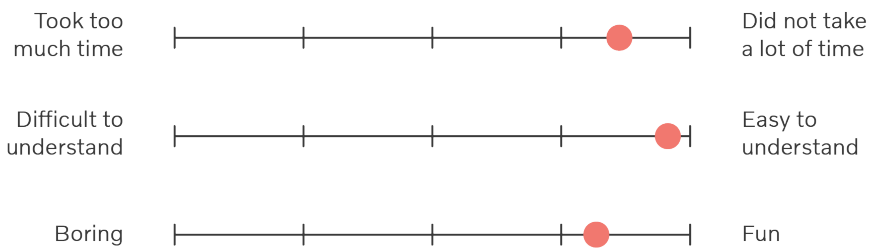


Figure 54 – Average scores of youths' survey scales for Instagram Diaries

The fourth question was a multiple-choice question regarding the Instagram posts and how the participants had experienced them. The alternatives were 'Motivational', 'Annoying', 'Funny', 'Cheesy', 'Unnecessary', 'Interesting', 'Did not use Instagram' or they could write their own alternative. See Figure 56 for a summary of the answers. The ones that were never chosen, are not included in the figure.

The fifth question regarded what the participants had thought about using Instagram (or text messages) for reporting their trips. This was also a multiple-choice question with five alternatives: 'Fun', 'Boring', 'Easy', 'Difficult', 'Troublesome' or they could write their own answer. See Figure 57 for an overview of the answers. The ones that were never chosen, are not included in the figure.

The last two questions about the *Instagram Diaries* were short text answer questions regarding what the youths thought was good or less good about the *Instagram Diaries*. The answers to what was good about the study varied a lot, but some interesting answers were:

"Fun to participate and to think about future cars",

"The cinema tickets",

and

"To think about what you wanted to do, what you could do (in a car)".

Most of the answers, nine in total, regarding what was less good was 'Nothing'. Two wrote that:

"Sometimes it was hard to come up with something to write on question four"

which referred to the question "What would you like to do if you could choose freely?" that they were supposed to answer to each picture they sent in. Another wrote that he/she usually did not bring their phone to the sport practise which he/she had to do during the study, and one participant thought that it took too much time to write the answers to questions in the car.

Family Home Sessions

The next part of the survey, about *Family Home Sessions,* began with two scales from 1-5, where 5 was the most positive and 1 was the most negative. The average scoring can be seen in Figure 55. On average the participants scored 4,77 on how clear the instructions of the different activities of the *Family Home Sessions* were, meaning most of them thought it was clear. The second regarded what they thought of participating in the study from where 1 was 'Boring' and 5 was 'Funny' and the average score was also 4,77.

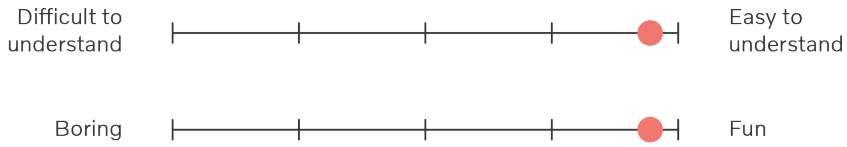


Figure 55 – Average score of youths' survey scales for Family Home Sessions

Question 10 was about how the youths experienced that the researchers had come to their homes for the *Family Home Sessions*. It was a multiple-choice question, see Figure 58 for an overview of the answers. One of the answers is from the participant which of his/hers *Family Home Sessions* was performed using video call.

The final three questions about the *Family Home Sessions* was about what the participants thought was good and what was less good. Many wrote that they thought it was either fun, interesting, or that they got the opportunity to say what they would like to have in a car. The most answers to what was bad about the study was 'Nothing', but one participant thought that the session took more time than expected.

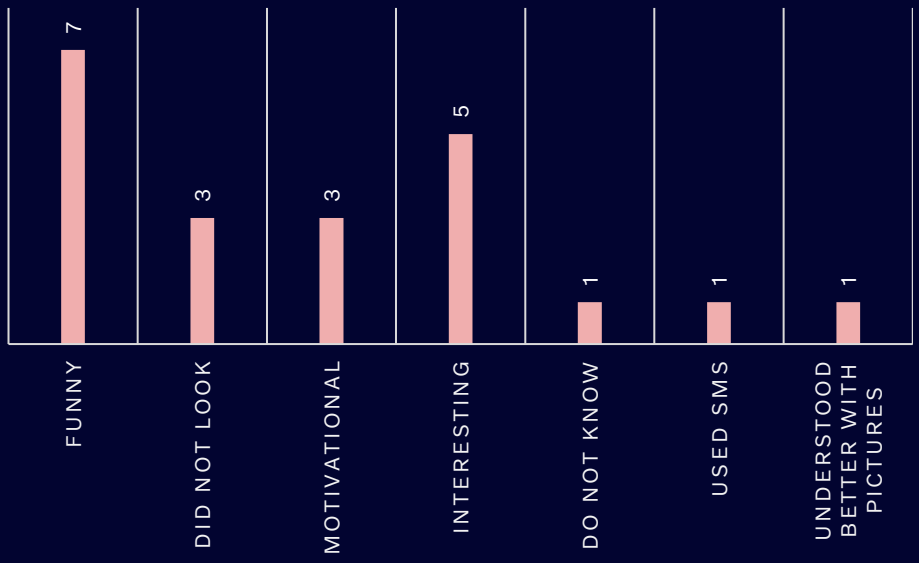


Figure 56- Answers to question no. 4 Survey Youths: "What did you think about the posts on Instagram?"

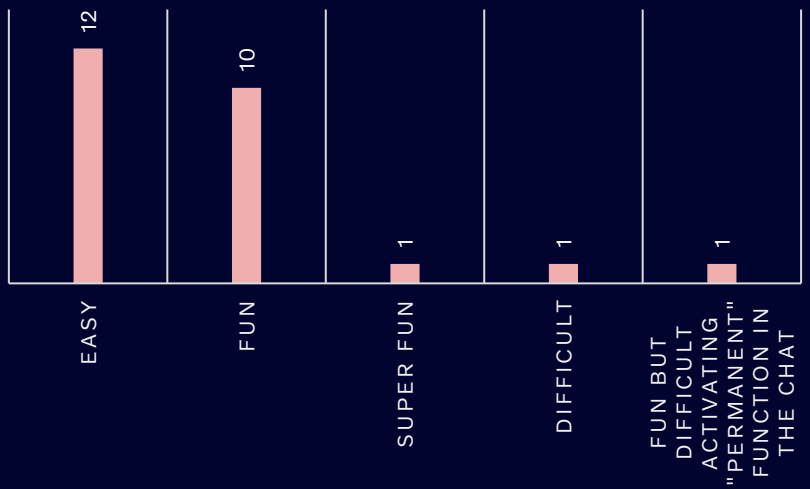


Figure 57 – Answers to question no. 5 Survey Youths: "What did you think about using Instagram (or SMS) for logging your trips?"

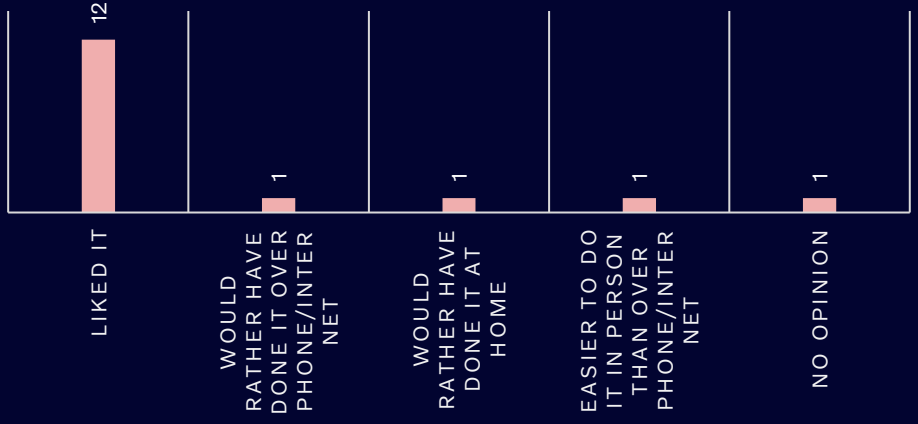


Figure 58 – Answer to question no. 10 Survey Youths: "What did you think about the researchers coming to your home?"

6.1.2 Survey Responses - Parents

The parents' survey covered both *Instagram Diaries* and *Family Home Sessions.* In total, 13 parents answered the survey.

The first part contained six scales from 1-5, where 5 was the most positive and 1 was the most negative. For the average scorings, see Figure 59. On average, they scored 4,92 on what their general impression of the study was, which implies that most of them liked it. The second one was about how time consuming they thought it was for their children to participate, and the average score for this one was 4,69. Hence, most of them did not think it was too time consuming. The third scale was about the parents' impression about how easy it was for the children to understand what they were supposed to do, of which the average score was 4,67. The fourth scale was about how the parents believed their children experienced taking part in the study. The average score was 4,23 where 1 was 'Boring' and 5 was 'Funny". The fifth question was if the study had met the parents' expectations where 1 was 'Worse than expected' and 5 was 'Better than expected', the score for this was 3,58. The last scale was about the compensation they received for taking part in the study where 1 was 'Not enough' and 5 was 'More than enough'. The average score was 4,46.

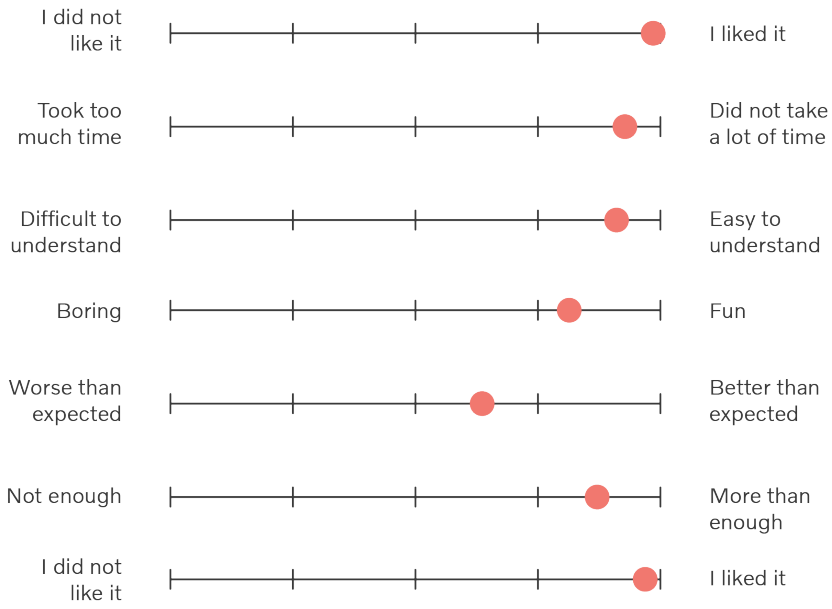


Figure 59 – Average score of parent survey scales

The next question was whether they might agree to participate in a similar study again, where 12 answered that they would, and one answered that they might.

Question number eight was a short text answer question about what the parents thought was good with the study. Some interesting answers were:

"Fun! Easy for the children to participate since it was done with a tool they knew (i.e. Instagram)"

"Did not take much time each day. Nice to use social media. Clear instructions."

"Nice to engage the children and that they were in focus"

The next question was instead about what they thought could have been done differently where eight parents did not write anything or "Do not know". Some other answers were:

"The study could have included two weekends since we go on longer trips then"

and

"A longer study to cover different types of trips".

On a scale from 1-5 about the welcome package the families received before the study, the average score was 4,83, which implies that they were satisfied with it, see Figure 59. The following question was about whether they thought something was missing or could be changed in the welcome package and no one of the parents wrote anything.

In the last short text answer questions, all parents wrote they thought using Instagram or text messaging for reporting the children's car trips worked well and was effortless. Most of the parents thought that the study gave a correct picture of how their children behave in cars but many of them thought that their children used their phones more in the car than what the study showed. One parent added:

"Nice structure and form of the interview. The children were relaxed and dared to speak up. Good with the overview of the week."

6.2 METHOD ASSESSMENT

In this part of the chapter, the assessment of the methods used and designed is presented. The assessed methods are *Parent Interviews*, *Instagram Diaries*, and *Family Home Sessions*. An overview of the descriptive characteristics of the different methods are presented in Figure 60. In the following sections, each method is described based on several parameters including evaluative scales, descriptive scales, and other aspects. The result from the participant study evaluation was taken into consideration for the method assessment.

Figure 60 - Descriptive scales of the methods developed

Descriptive Scale	Parent Interviews	Instagram Diaries	Family Home Sessions
Interference with actual behaviour	Not relevant	Both interference with actual behaviour and non-interfering	Not relevant
Participants awareness of observation	Open	Open	Open
Type of behaviour	Constructed	Natural	Constructed
Level of participation	Participative	Self-reporting	Participative and observed
Type of data generated	Qualitative	Quantitative and qualitative	Qualitative
Type of knowledge explored	Explicit	Explicit and observable	Explicit, observable, tacit and latent
Appropriateness for ages	10-17	11-17	11-17

6.2.1 Parent Interviews

The *Parent Interviews* method design and implementation can be found in chapter 4.2.1, following is the assessment of the method.

Evaluative Scales

The evaluative scales show estimated measures on a five-point scale for different aspects of the method. See Figure 61 for the evaluative scales for the *Parent Interviews.*

Descriptive Scales

The descriptive scales show characteristics of the method. See Figure 62 for the descriptive scales for the *Parent Interviews.*

Type of data and information

Parent Interviews generates qualitative data based on the parents' observations and knowledge about their children. The data is highly dependent on the type of questions that are asked. It is also dependent on the participant, to what extent they are expressing themselves. The data generates explicit knowledge. It is particularly important to confirm this data with other methods, since this is not expressed by the target group themselves.

Since the interviews were performed as a pre-study, the knowledge generated were not deep. Even though, the interviews can be adapted to also generate deep knowledge.

Study type suitability

Parent Interviews are suitable for studies that are related to finding the needs or behaviour of children, when the parents have direct knowledge about it. For instance, it is likely that it is not suitable if the study is about how the children behave with friends or in school.

Project process timing

It is suitable to perform *Parent Interviews* as a form of pre-study in the very beginning of a project, to be able to design the upcoming user studies. It might also be suitable for confirming generated knowledge. But it can also be suitable for evaluation of concepts, as a complement to the target groups input.

Target group suitability

From what was seen during the *Parent Interviews* performed in this study, it was suitable for the entire age span of the target group. It might be even more suitable for this study because the context of a car: all usually ride with their parents.

It is possible that it is more suitable for studies about children of lower ages. The older they get; the parents seem to know less.

Unexpected

Something that was unexpected with the method was that the result was saturated quickly, the participants answered very similarly even though the families were in many ways different.

Miscellaneous

The low effort in relation to the data it generated was a positive aspect with this method.

Figure 61 - Evaluative scales of the Parent Interviews

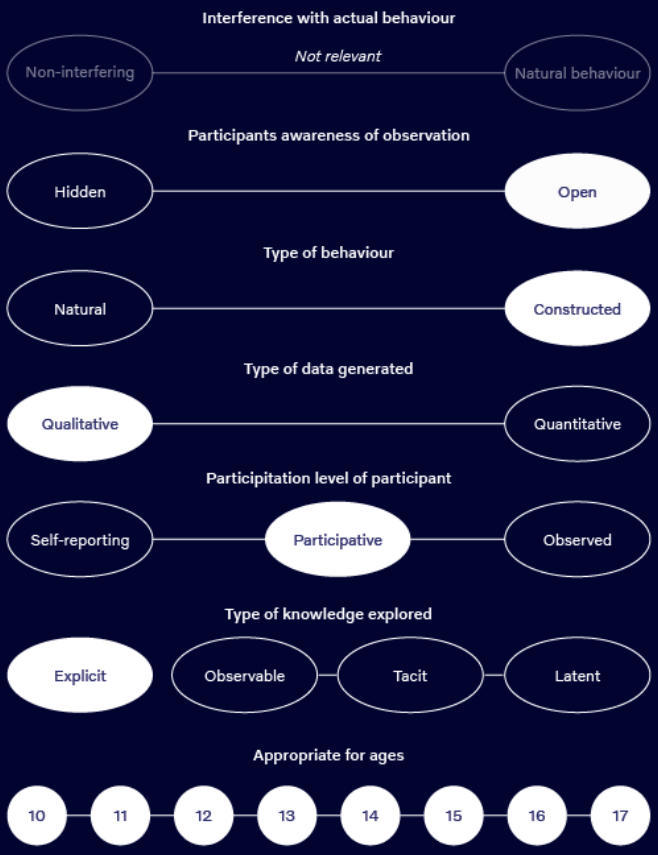


Figure 62 - Descriptive scales for the Parent Interviews

6.2.2 Instagram Diaries

The *Instagram Diaries* method design and implementation can be found in chapter 4.2.2, following is the assessment of the method.

Evaluative Scales

The evaluative scales show estimated measures on a five-point scale for different aspects of the method. See Figure 63 for the evaluative scales for the *Instagram Diaries.*

Descriptive Scales

The descriptive scales show characteristics of the method. See Figure 64 for the descriptive scales for the *Instagram Diaries.*

Type of data and information

The data generated from *Instagram Diaries* is short answers to questions and pictures/short movies. It is 'data in the moment', describing the participants' experience in a specific context. The data is based on the instructions for the photos and the questions asked. The method is suitable for short answers, not long and elaborated answers. The data can be analysed both qualitatively and quantitatively. In this study, the result was shallow and mostly functioning as a way of sensitising the participants. Because of that, the data collected is even more useful when combining it with another method, e.g. a generative session.

Study type suitability

Instagram Diaries is suitable for studies related to some sort of everyday behaviour or usage.

It is important to consider whether the target group uses Instagram in their daily life, if not, Instagram is not suitable. Instead, another communication tool/app/social media could still be used.

Project process timing

To perform *Instagram Diaries*, a pre-study is required. This in order to know if Instagram itself is suitable, but also to know what questions are relevant and interesting to ask. It is recommended to use during an explorative phase, to get to know the user. Could be used as a pure sensitising tool to prepare participants for a generative session or other type of user study.

Target group suitability

In this study, it was suitable for the target group since Instagram is something many use daily. This seemed to create engagement and a simple way for them to self-report. In addition, it enabled a natural way for the researchers to communicate and level with the participants.

According to Instagram's guidelines, children under 13 should not use the app without consent from parents/guardians. Many under 13 years still use Instagram, but it is important to ethically consider this fact when designing the study. In this study, this was not a problem since many participants already had Instagram and the parents allowed them to use it.

What was found though, was that the two out of the three ten-year-olds experienced that it took more time to come up answers and that it sometimes required support from parents.

Unexpected

It allowed parents to be a part of the study without interrupting or taking over. Many of the parents also followed the Instagram account and some even liked and commented on photos that were published.

The majority of the pictures were in themselves not very interesting. It was common that the participants took photos out of the window, not representing what they actually did. The photos were useful as a way of remembering the trip, when used in the *Family Home Sessions*.

Figure 63 - Evaluative scales of the Instagram Diaries

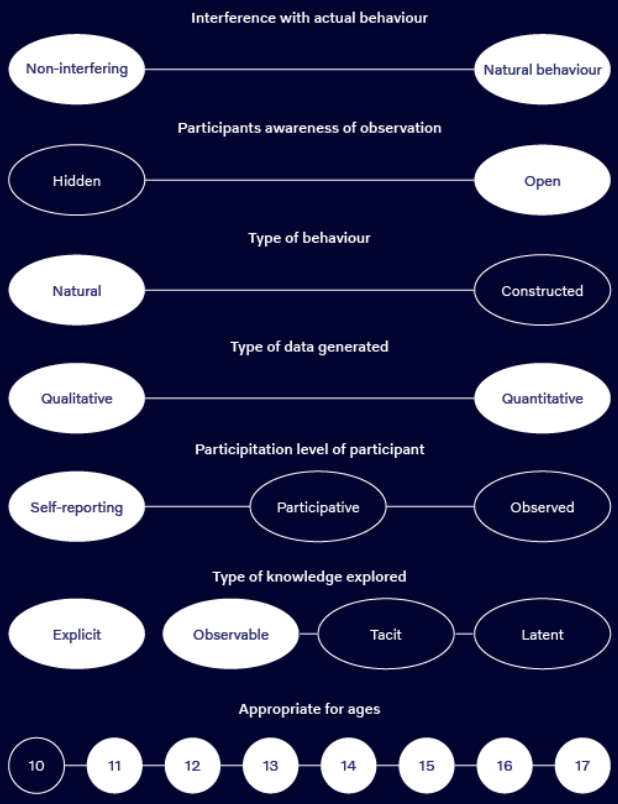


Figure 64 - Descriptive scales of Instagram Diaries

Miscellaneous
Using Instagram was good in several ways. For instance, being able to communicate live and direct, and confirm their reports continuously. It was not very formal, opening for a personal relation, which was suitable for this study and target group. Also, using Instagram enabled reminders in different ways without being too disturbing, since it is not only direct personal contact. It was uncomplicated to ask questions, making the researchers available and present.

Instagram algorithms could possibly affect if the posts are seen by the participants or not. It is difficult to know whether the participants are reached when using the feed. In comparison, stories and direct messages can be confirmed and tracked.

It is important to be aware of how the climate and usage of social media changes for the target group over time. This will affect how they use it and thus how the method should be designed.

A difficulty with this study was that the ages of the group varied, what is suitable and engaging for a 10-year-old is different from what is suitable and engaging for a 17-year-old.

For this study, text messages were offered as an option to Instagram. Using text messages fulfilled the purpose but was perceived as less engaging and communicative. If different ways of reporting are used within a family, it might cause strains. Because of this, the participants should either agree to use different ways of reporting or use the same.

6.2.3 Family Home Sessions
The *Family Home Session* method design and implementation can be found in chapter 4.2.3, following is the assessment of the method.

Evaluative Scales
The evaluative scales show estimated measures on a five-point scale for different aspects of the method. See Figure 65 for the evaluative scales for the *Family Home Sessions.*

Descriptive Scales
The descriptive scales show characteristics of the method. See Figure 66 for the descriptive scales for the *Family Home Sessions.*

Type of data and information
The data generated in *Family Home Sessions* is qualitative and deep, on all levels of knowledge. This, because of the different activities of the interview and the different mediating tools. Like any other interview, the data collected is highly dependent on how the participants and their elaboration of answers. The brought material made it possible to reach deeper.

Study type suitability
Family Home Sessions is suitable for any study where deep understanding of the users is desired. Since it is time consuming and demanding, it should be considered if there are enough resources for the required time and effort.

Also, it is suitable if the context is in some manner related to their home. If related to e.g. school or something else, it is probable that it is more suitable to perform this type of study there.

Project process
The method is suitable for an explorative phase of a project, to gain knowledge about users.

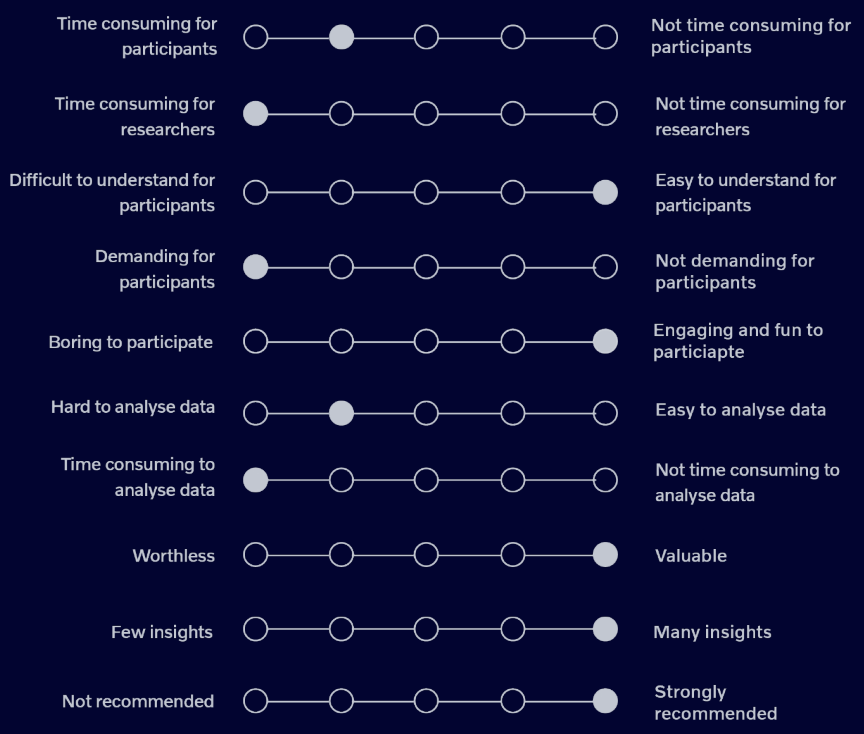


Figure 65 - Evaluative scales for the Family Home Sessions

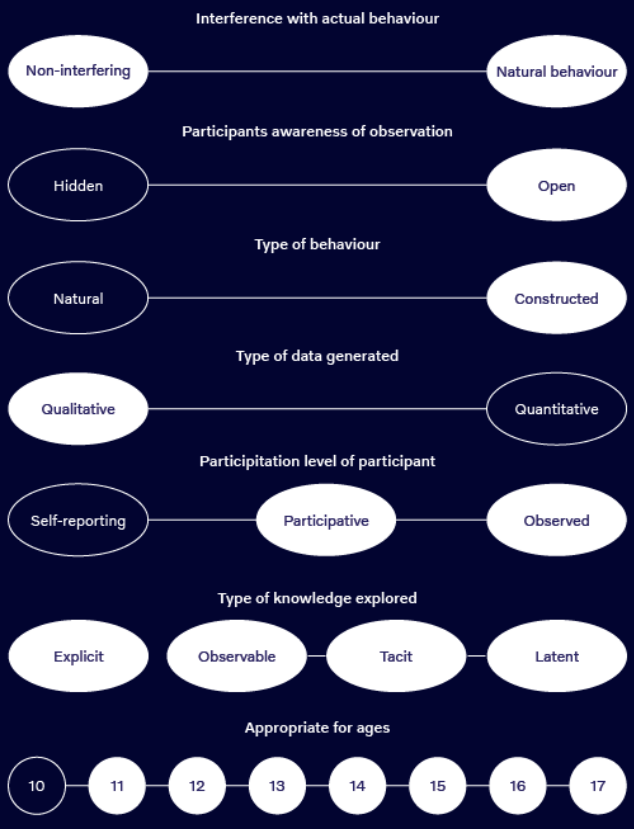


Figure 66 - Evaluative scales for the Family Home Sessions

Target group suitability
Being in their home seemed to make the participants relaxed and open. The youngest (ten years) seemed to think that it was difficult at times and they are also more restless and unfocused than older participants. They would perhaps have needed more play-like activities, a larger variation of activities, and longer breaks.

In families with children of large age differences, the communication had to level with the younger ones, which sometimes seemed to affect the older siblings negatively.

The method itself can most definitely be adjusted to different age spans by adjusting the way of presenting the activities etc. Especially for the younger participants, 10-11 years, some of the activities seemed too demanding. This could be explained by that they had not yet reached the same maturity level as the older youths and would thus have benefited other types of activities during the session, see chapter 2.1.1.

Unexpected
The picture ranking activity gave more depth than expected since the participants elaborated their thoughts and choices of pictures.

Showing the movie of a future concept car was very engaging and interesting for the participants, which exceeded the expectation.

Miscellaneous
The cinema tickets worked well as a motivating incentive, which was needed.

Having the parents being present in the beginning of the study created a safe setting, making the children comfortable in the situation. At the same time, it was rewarding to have some time alone with the kids since they opened up more and expressed themselves more freely. In some families it was an issue that the parents interrupted the children and took too much space.

For some families, especially the ones with three children or the ones with younger children, it was harder to stay within the time frame since they more easily got distracted and had a harder time to stick to the subject. For these, more time or adjustment of the activities might have been needed.

Since some participants did not share their thoughts to the same extent as their siblings, it would have been interesting to have more activities with the participants thinking on their own first, and then sharing.

7. DESIGN CONCEPT

In this chapter the result from the design concept development and evaluation is presented. The chapter is divided into four different phases, see Figure 67 on the following page. The three first phases explains the different iterations of the development and in the fourth phase the final concept is presented and evaluated.

07

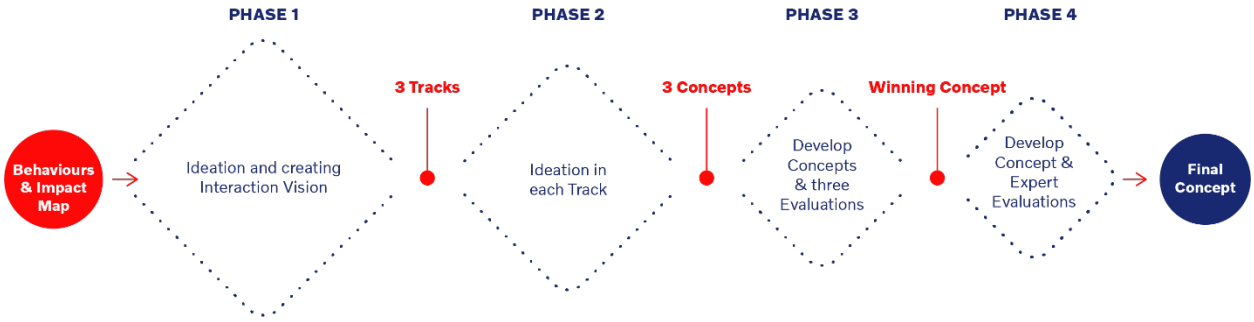


Figure 67 - The concept development process

7.1 PHASE ONE

The first phase included developing interaction vision and ideation, which resulted in three different ideation tracks.

7.1.1 Interaction Vision

An interaction vision was developed, see chapter 3.11. The picture chosen to represent the interaction of the solution was of a treehouse. Entering the car, should feel like climbing into your own treehouse. Related to the interaction vision, five qualitative characteristics were distinguished. These were safe, flexible, effortless, meaningful, and enjoyable, see Figure 68.

7.1.2 Three Tracks

During the first ideation session, several different ideas were generated. Because of the large design scope, it was decided to focus the ideation by creating ideation tracks.

The highest ranked needs from the Impact Map, see chapter 5.6.4, was grouped based on their subject and correlation. This led to three groups of needs, see Figure 69. The grouped needs were then translated into three tracks for ideation, see Figure 70.

7.2 PHASE TWO

In phase two, ideas were generated and iterated. These were first narrowed down to nine concepts and lastly to three concepts.

7.2.1 Track Ideation

Based on the different tracks, several ideas of solutions were created and iterated, see Figure 71. These included several ideas such as solutions to hang on the front seat, screening solutions, phone and tablet holders, redesigning the armrest in the back seat, different types of tables, high-tech solutions, entertainment stations, robots, and redesigning of the middle back seat.

Entering the car, should feel like climbing into your own treehouse.

Safe	It is safe in the way that it is enclosing and protected from the world in the treetop.
Flexible	It does not have to be complete and what you do inside is up to you.
Effortless	It's there. The only thing you have to do is go up.
Meaningful	The time spent there is meaningful. Either on your own or with others.
Enjoyable	It is nice to be in your treehouse.

Figure 68 - The interaction vision and qualitative characteristics

Track 1

- Needs to have the opportunity to be entertained at all times.
- Wants to pass time and fight boredom.
- Needs to be able to choose from different alternatives of entertainment.
- Wants to be able to do the same things as they do in their home.

Track 2

- Wants their things easily accessible in the car without them moving around.
- Want to be able to lean/mount a (brought) device in order to create a good view angle.

Track 2

- Wants to be able to perform activities together with others.
- Needs to be able to make conversation with all the people in the car.
- Needs private space.

Figure 69 - Grouped needs

Stay Active

Solutions for being able to choose from different things to do/ entertainment in an effortless way.

Bring Things

Solutions for being able to store, organise and use brought belongings in the car in an effortless way.

Select Space

Solutions for being able to switch between a social and a personal space in the car in an effortless way.

Figure 70 - The three ideation tracks

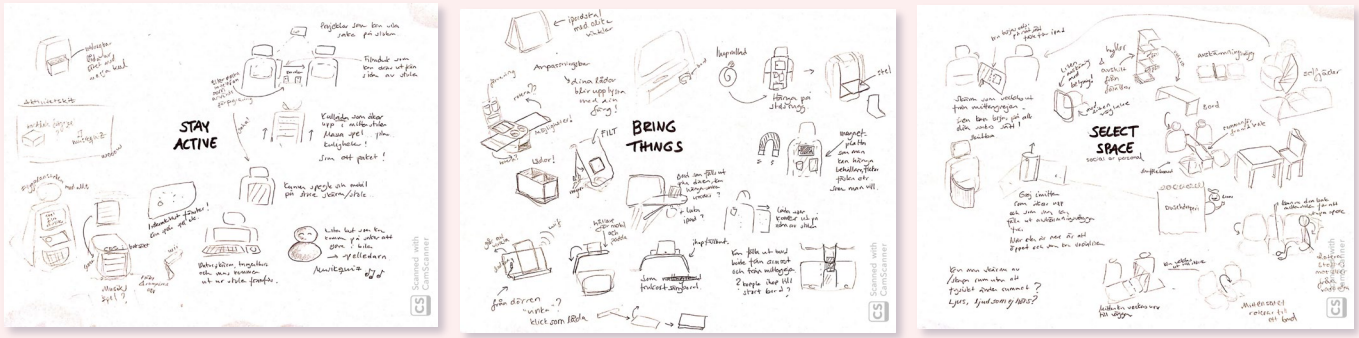


Figure 71 - Ideation of the three tracks

7.2.2 Nine Concepts

Out of the ideas generated, the nine most interesting concepts moved on in the process. The sketches of these concepts can be found in Appendix K.

Car corner
Located on the backs of the front seats. Combining a solution for screening, a table, and socialising. It is based on opening a hatch in different modes. In the 90-degrees mode it creates a private corner. In the 180-degrees mode it creates a social mode in the back seat, if both hatches are opened.

Foldable table
A table that can be pulled up from the small gap between the seats in the back. It can be used in several modes. Both for screening, as a table, and as a stand for e.g. phone or tablet.

Push back middle seat
Based on the idea that the middle seat is uncomfortable and unpreferable. The middle seat in the back is pushed back. When pushed back it expands which creates more space for the legs. This also creates more space for the other two in the back seat.

Modular middle in the back seat
Instead of the current seat in the middle, there is a modular station. This can e.g. be used for storage solutions, a seat, a booster cushion, a table, or etc. Opening for the car to be modular based on the needs of the family.

Modular storage on front seat back
With either a "wall" with holes or magnets, on the back of the front seats, offering all types of storages and holders. This could be adjusted to fit several types of needs and could include a hatch for screening.

Slidable screening
Pulled out from the short side of the front seat, a bendable screening is created. This can offer a private space for the ones on the side in the back seat.

Car-bot with game control
Based on the idea of making leasing a car more personal. The owner can bring the car-bot to any car, which personalises the car. The car-bot has two small game controls which can be used for playing different types of games. This is connected to projections in the back seat.

Flexible table
A table on the back of the front seat which is made of a flexible material. The table can be folded to different angles to offer the support of e.g. different devices or books. Also opens for including a screen for entertainment behind the table.

Back-seat hub
A personal platform for entertainment on the back of the front seats. By projections from the roof controlled either with touch or through the passengers' phone. Using face recognition to log in for an effortless experience. It enables to interact in different ways with other passengers. The Back-seat hub can have different modes and apps.

7.2.3 Three Concepts

From the nine concepts, three were chosen based on their fulfilment of needs and to differentiate the concepts. The three concepts that moved on in the process were Car Corner, Foldable Table, and Back-seat Hub. These were developed further in an iteration. All three are located in the back seat of a car, one for each window seat.

Foldable Table
The Foldable Table is a concept with five different modes. The idea is that when the table is not being used, it is stowed away in the gap between the seats in the back. When the passenger wants to use the table, it is pulled up. As seen in Figure 72 (the perspective looking forward from the back seat), the first mode functions as screening which creates a private space. The second mode is a regular table, which in the sketch below is folded, but it can also be unfolded to offer a larger surface.

In the third mode, the foldable part of the table can be put in an angle which can act as a stand for a phone or other devices. This surface also offers wireless charging for devices and has a holder for those to stand still and be fastened, see chapter 2.3. In the fourth mode, the table is folded over the middle seat which creates a shared table with the person in the other seat, offering a social mode. This can be used for e.g. playing games.

Car Corner
The Car Corner is a concept enabling both a private and social space by different hatches. It has several modes as seen in Figure 73. In the first mode, the car corner is closed and, hence, not in use. The second mode is the social mode when both back-seat passengers open the hatch 180 degrees. The hatches then attach to each other, creating a screen between the back and front seat. On the hatches, there is an attachment for a tablet or phone to enable watching something together, and for it to be safely fastened, see chapter 2.3.

The third mode is the private mode, where a table is supported and attached on the hatch when it is opened in 90 degrees. The table has a recess for leaning a device, acting as a stand. The table also has a mug holder.

The Back-Seat Hub
The third concept is a back-seat entertainment system called the Back-Seat Hub, see Figure 74. It uses a projector on each seat, creating an interface with different apps. These apps can be for listening to music, playing games, etc. It offers a social mode by making it possible to interact with other passengers through the system. With face recognition, you are automatically logged in when entering the car, and the personalised interface appears. The idea is to replace a phone or tablet. The system could be controlled with touch or possibly gestures. This solution can include several different applications and thus different possibilities.

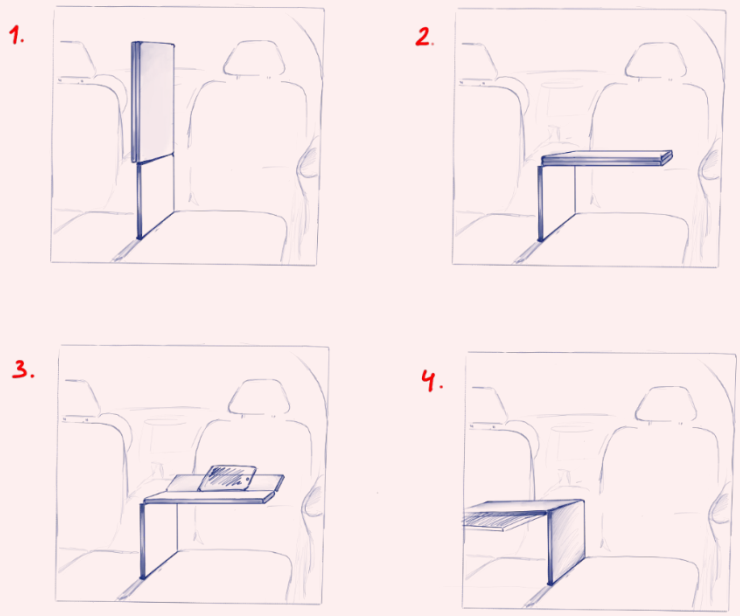


Figure 72 - Concept sketch of the Foldable Table

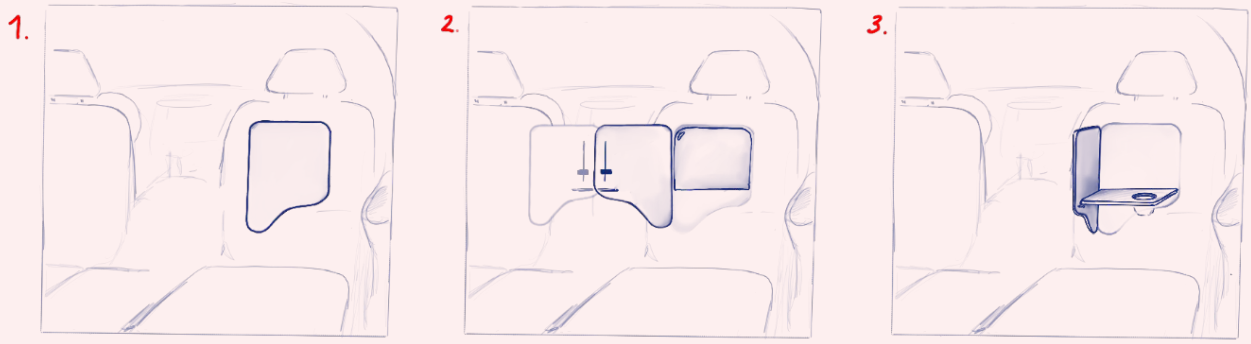


Figure 73 - Concept sketch of the Car Corner

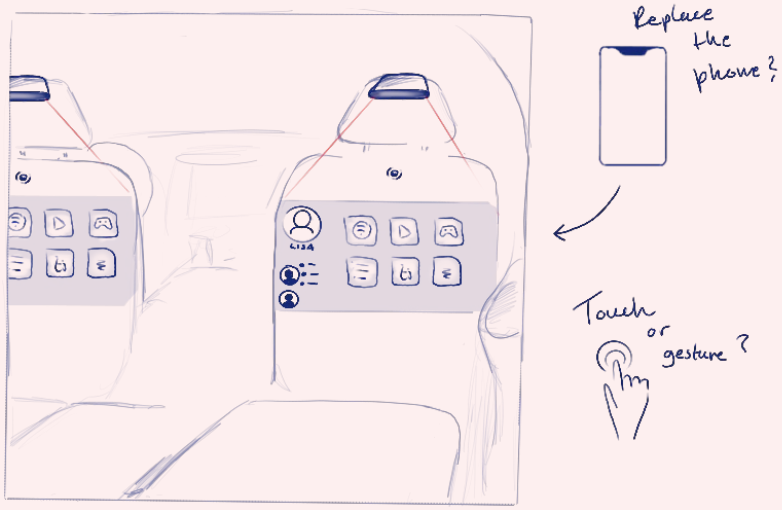


Figure 74 - Concept sketch of the Back-seat Hub

7.3 PHASE THREE

The three different concepts were further developed and optimised. Before moving on in the process, all concepts were evaluated regarding their requirements fulfilment from the Requirement Specification, see Appendix I. All concepts were assessed to fulfil all requirements. During phase three, all concepts were evaluated with three different methods.

7.3.1 PUGH Matrix

The first evaluation was a PUGH matrix, see chapter 3.13. Each concept was the reference concept one time, resulting in three rounds. The result of the evaluation can be seen in Figure 75. The entire calculation and criteria can be found in Appendix J.

Figure 75 - Result from PUGH Matrix evaluation of the three concepts

Round	**Round one**			**Round two**			**Round three**		
Concept	Car Corner	Foldable Table	Back-Seat Hub	Foldable Table	Back-Seat Hub	Car Corner	Back-Seat Hub	Car Corner	Foldable Table
Score	0	-21	37	0	53	27	0	-43	-34
Rank	2	3	1	3	1	2	1	3	2

When compiling the result, the car corner got a total score of -16, the foldable table got -55, and the Back-seat Hub 90. Based on this result, the Back-seat Hub completely outranked the other concepts.

7.3.2 Concepts Sitting Posture Study and Analysis

Each concept was also evaluated regarding their effect on sitting postures. Not all activities were evaluated, but the most central ones relating to the usage of the concept. The result of the analysis can be seen in Figure 76.

All concepts had seemed to improve the sitting postures in comparison to the current situation, see chapter 5.5, even though each concept included some sort of critical sitting posture. The Back-seat Hub had one critical sitting posture, the Foldable Table had two critical sitting postures and the Car Corner also had two critical sitting postures. From this analysis, it was assessed that the Back-seat Hub was likely to support the best sitting posture in comparison to the other concepts.

7.3.3 User Evaluations

The concepts were presented and evaluated with users from the target group. From the user evaluations it was possible to understand that all participants would appreciate all three concepts. All participants said the same thing regarding the Car Corner and the Foldable Table; that they would only use it during long trips and that it was important that it could be stowed away easily.

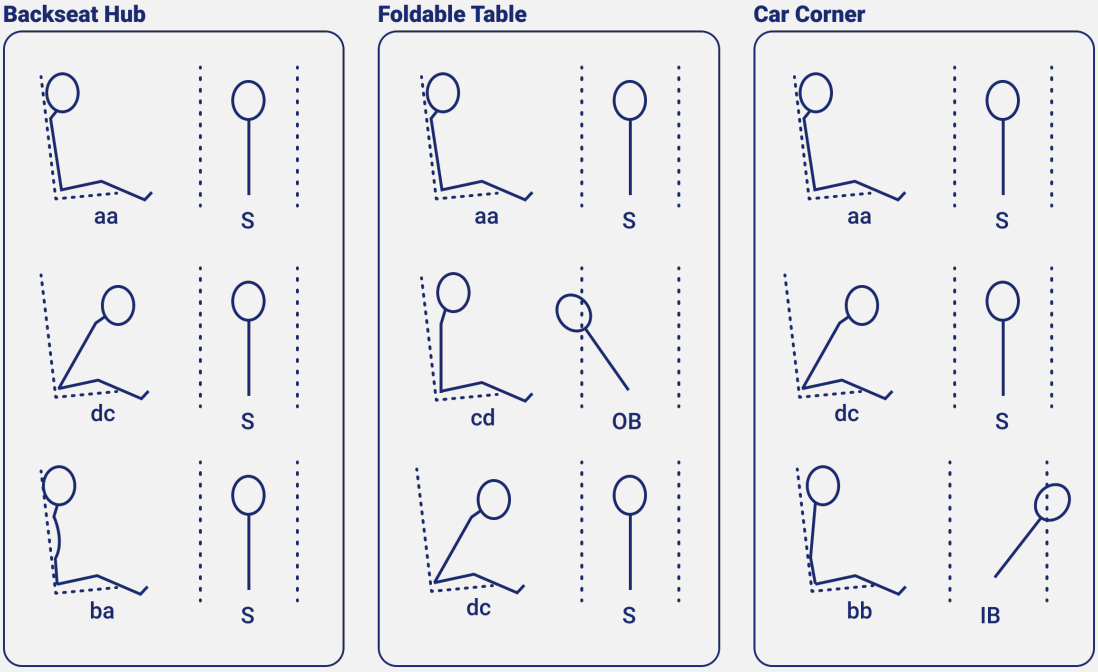


Figure 76 - Concept sitting posture analysis

All participants also claimed the Back-seat Hub as their favourite concept and as something they would want in their own car. One quote from a participant was:

> *"Back-seat Hub, I guess. Because the others were more like small nice tables [...]. If you have back-seat hub, then you would not need to set up your phone in the car corner."*

Another quote regarding why a participant liked the Back-seat Hub was:

> *"Instead of holding your phone like this (in your face) the whole trip when watching it, you have a much larger screen and a bit away."*

A third quote was:

> *"I'd rather sit in the back than in the front if this existed."*

The participants also pointed out that the concepts could be combined, e.g. combining the foldable table and the Back-seat Hub. combining the Foldable Table and the Back-seat Hub.

7.3.4 Winning Concept

From the result of the three different evaluations it was possible to choose a winning concept. All evaluations unanimously appointed the Back-seat Hub as the superior concept. This was thus the chosen as the winning concept.

7.4 PHASE FOUR

During the last phase, the winning concept was further developed and evaluated. The result from the different evaluations were used to improve the concept. Lastly the concept was evaluated with experts which led to some changes and recommendations and resulted in the final concept.

7.4.1 Final Concept: So-Hub

The final concept is called *So-Hub*, the solo and social entertainment hub. So-Hub is designed to fulfil the design goal

> *"Enable youths to be active in the back seat of a car, either together or by themselves."*

So-Hub is supposed to enhance the user experience of youths between 10-17 years while at the same time increase their safety inside the car. This is achieved by offering an entertainment system with many different options and support them in having a good sitting posture. Meaning that, when the youths do what they want to do in the car, they also get a desirable sitting posture.

The So-Hub concept contains four subsolutions: a physically adjustable screen, the interface of the screen, a wireless charging station for the phone, and an interface for the phone acting as a control. The concept is not design for a specific car model, and no dimensions are specified. The concept visualised in context can be seen in Figure 77. See Figure 78 for the storyboard of the concept.

Figure 77 - So-Hub

Storyboard **So-Hub**

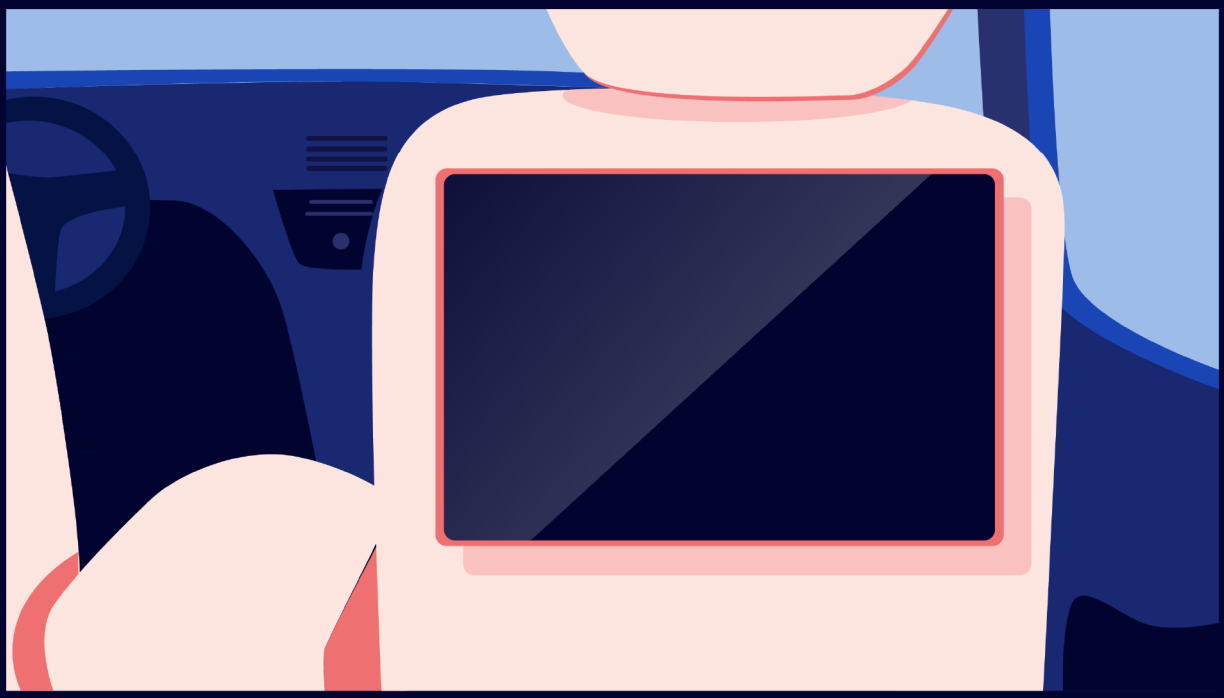
On the following pages, the concept So-Hub is presented through a storyboard. The storyboard explains the usage of So-Hub from entering the car, to using the different functions and applications.

Figure 78 - Storyboard of the So-Hub concept

STORYBOARD 01

Sara is 14 years old. Together with her family she will go to her grandparents who live one hour away. She enters the car in the back seat. The only thing she brings with her into the car is her phone.

STORYBOARD 02



In front of her is a large screen. The car has not yet started, so So-Hub is turned off.

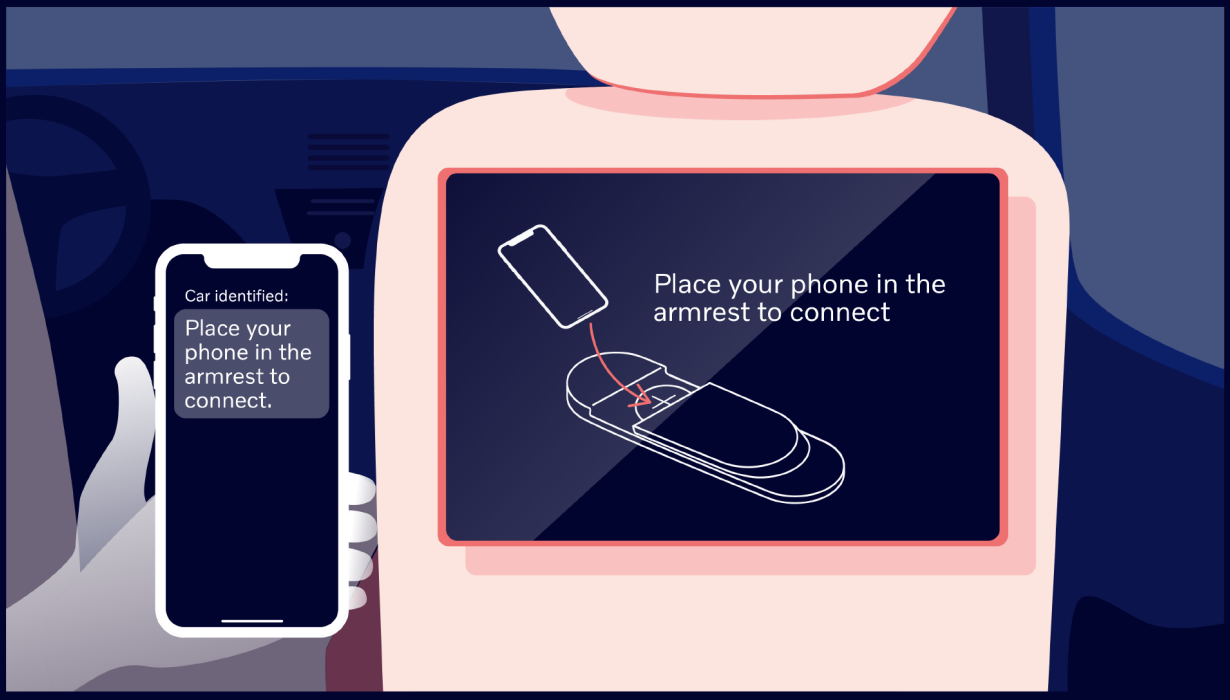
STORYBOARD 03

When the car starts, So-Hub also starts, instructing to connect the phone to the car's Wi-Fi.

STORYBOARD 04

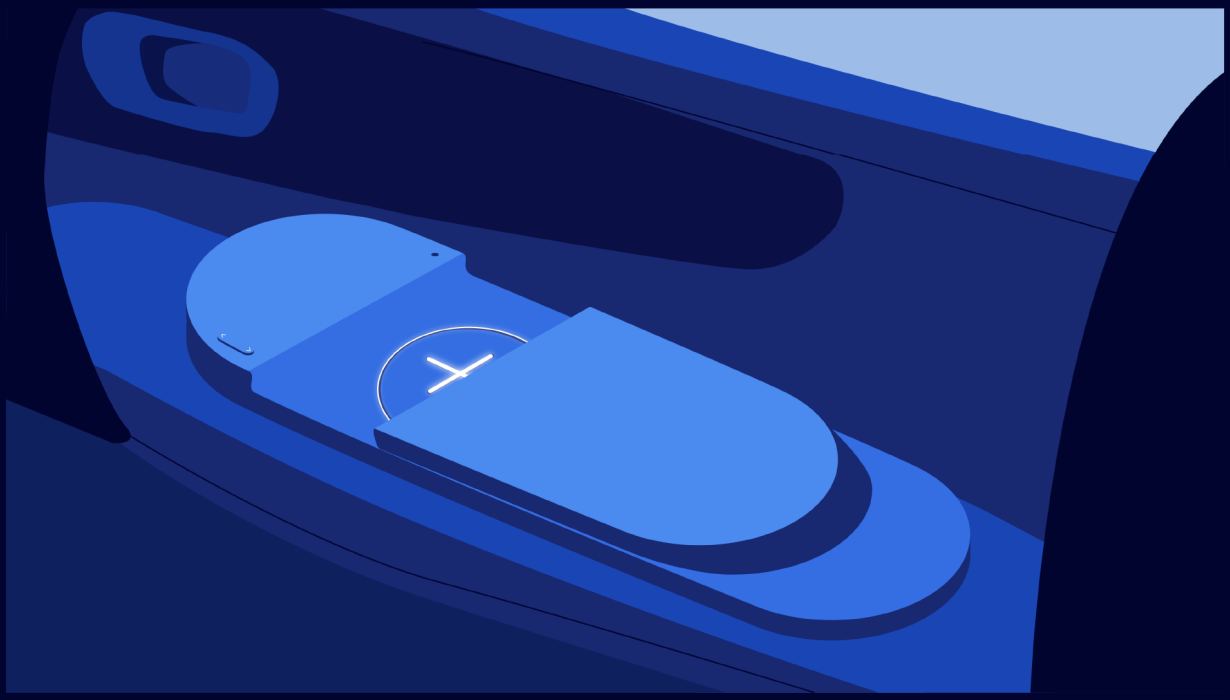
This is not the first time Sara rides in the car, using So-Hub, so her phone instantly connects to the Wi-Fi when the car starts.

STORYBOARD 05



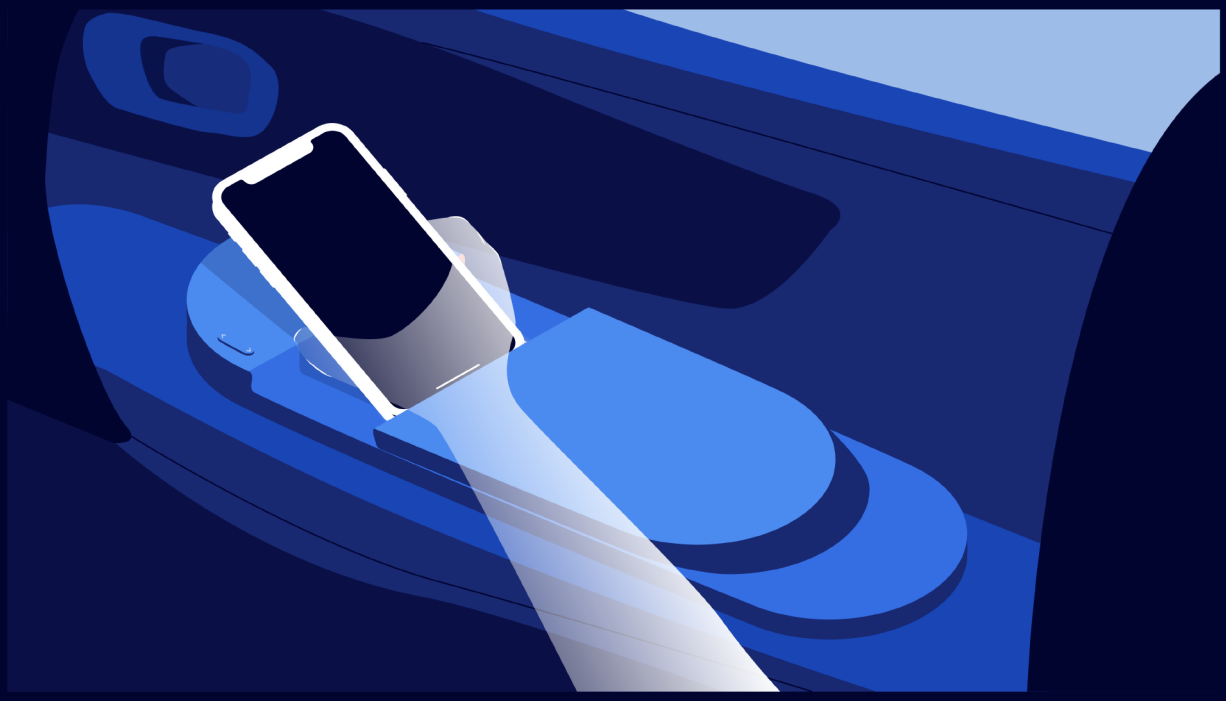
Both the phone and So-Hub identifies that there has been a connection. Thus, the phone receives a notification that a car is identified and that she should place the phone in the armrest to connect. Simultaneously, So-Hub instructs to do the same.

STORYBOARD 07



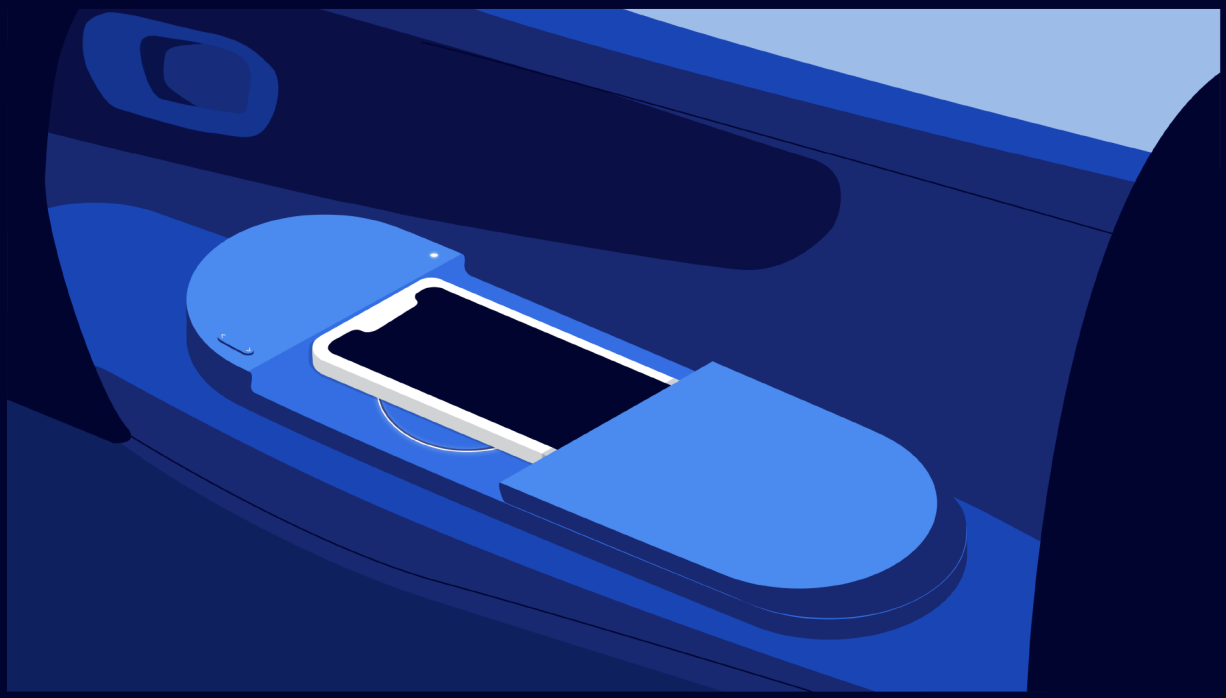
The phone station is located on the door next to Sara. When So-Hub identifies a phone, the charging symbol in the phone station lightens up, to invite the passenger to place their phone there.

STORYBOARD 08



Sara puts down her phone in the phone station by sliding it down. The back plate of the phone station smoothly slides back when she puts it down.

STORYBOARD 09



When the phone is placed, a small led-light light up to indicate that Sara's phone is charging successfully. When in place, the phone is safely fastened with the back plate pushing towards the front plate.

STORYBOARD 10

When Sara's phone is in place, So-Hub recognises which phone is connected to which screen in the car. In that way, So-Hub welcomes Sara when starting up. Simultaneously, the settings at her seat adjusts to her pre-sets. The seat leans back the way she like it, the temperature adjusts, and the seat heating is turned on.

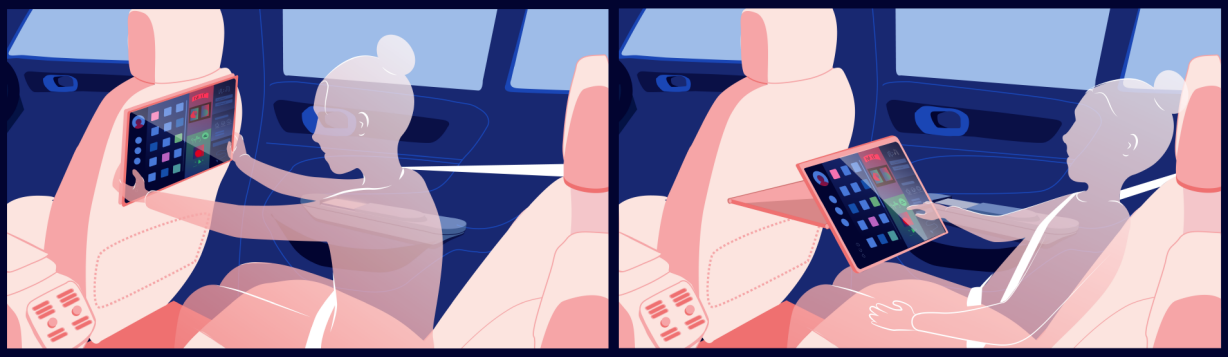
STORYBOARD 11

So-Hub turns into the home screen with several different options of entertainment available. In So-Hub it is possible to play games, watch movies, use social medias, etc. It is also possible to interact with other passengers in the car, or even with other friends who also have So-Hub in their car. In addition, when the phone is placed in the armrest, there is an area in the interface showing the time, notifications etc.

STORYBOARD 12

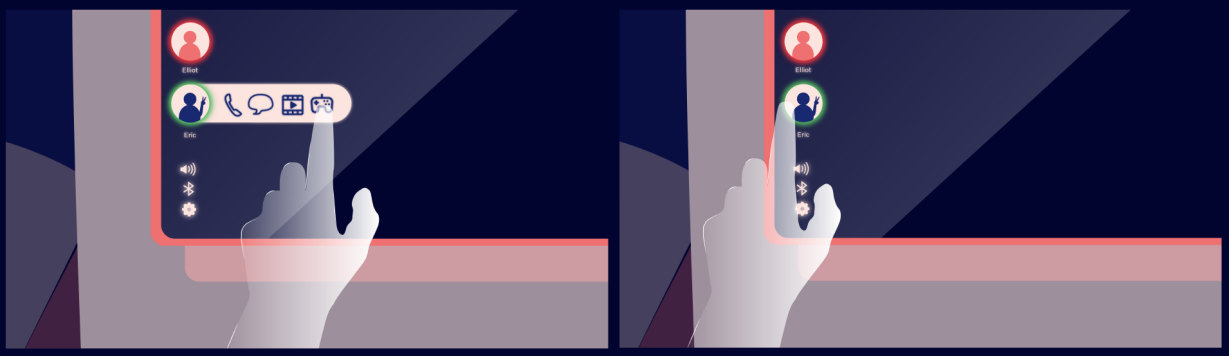
It is possible to adjust the height of the screen, to fit the eye sight level of the passenger. Sara adjusts it slightly to fit her better. This mode can be suitable for e.g. watching a movie or something on YouTube.

STORYBOARD 13



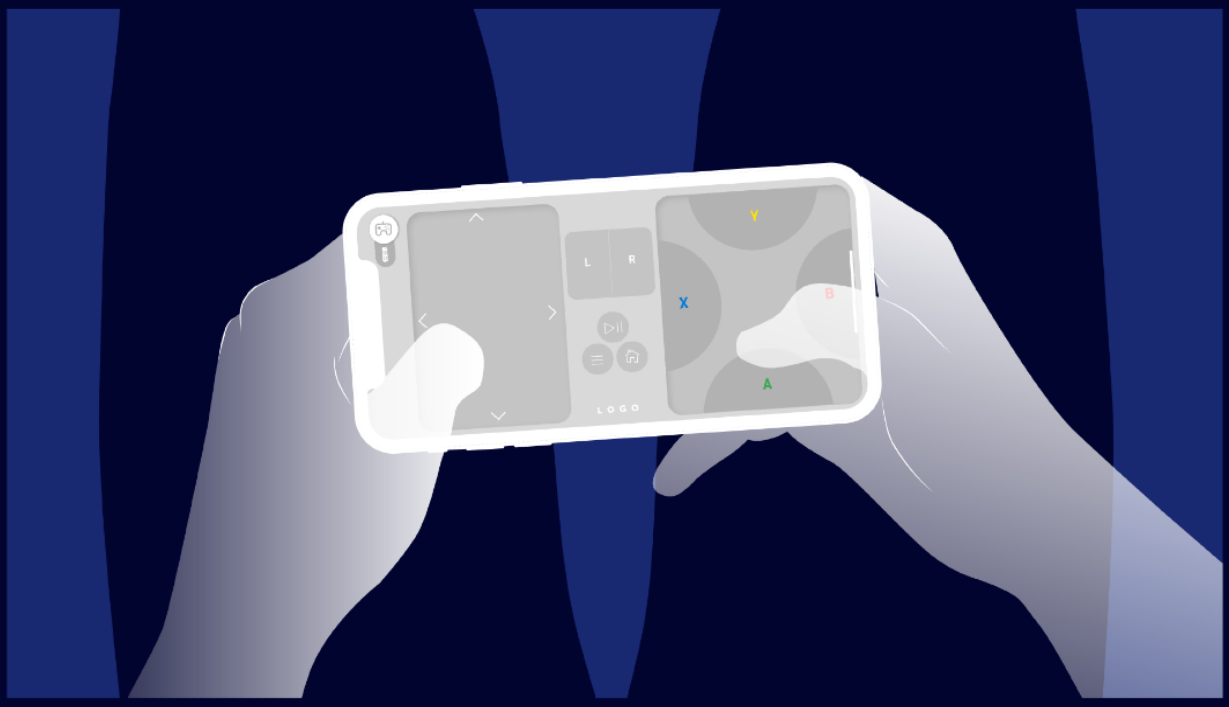
After a while Sara wants to scroll TikTok. She leans towards the screen to pull it closer to her and rotates it backwards to a nice viewing angle. In this way she can use the touch of the screen and switch between the different applications in So-Hub.

STORYBOARD 14



After a short while she gets tired of scrolling and looks at the status of the other passengers. Currently both Elliot and Eric are logged in, but Elliot does not want to be disturbed. Eric though, is open for suggestions. Thus, Sara decides to send him a request of playing a game together.

STORYBOARD 15



The request pops up on Eric's So-Hub and he accepts it, and both take up their phones from the stations to use them as game controls. This enables the passengers to sit upright, looking at the screen, while controlling it with the phone.

STORYBOARD 16

With So-Hub, the two youths play their game and forget that the time is passing by. They are having fun while at the same time sitting in a comfortable and safe position.

The phone station
Today, youths have their phone with them almost everywhere they go and use it several hours per day. When using the phone inside the car it often creates critical sitting postures. A part of the So-Hub concept is a wireless charging station for the phone in the door. With a slidable 'plate' the phone can be put down on the surface and safely fastened, no longer being a loose and unsafe object in the car. When put down, the phone charges, which is indicated with a LED-light on the phone station.

The placement of the phone enables it to be privately used, while still being easily accessible. In this solution the phone station is a part of the armrest in the door, which collapses safely in the case of a side collision. In the way that the phone station collapses is not defined, but it is of importance that it should not affect the door's design regarding how it behaves in the case of a crash. The phone station can be adjusted to move along the armrest with a button, to be reachable for people of different sizes, see Figure 79. The material for the phone station is intended to be the same as the rest of the door, to be experienced as smoothly integrated.

As mentioned in the storyboard, So-Hub detects a phone when connected to Wi-Fi and when placed in a specific armrest. It detects which phone should be connected with which screen by using Bluetooth Low Energy (BLE). Simultaneously, by using near-field communication (NFC), it adjusts the settings of the seat (if the seat has that functionality) and climate to the connected user's pre-sets.

Physically adjustable screen
The screen is physically adjustable to fit different needs which is enabled by the screen being attached to a plate which is, in turn, attached to the back of the front seat. Some of the different modes of the screen can be seen in Figure 80. Firstly, the screen can be raised or lowered to different eyesight levels. Secondly, it can rotate around two joints: on the seat and on the plate. The joint attached on the seat enables the screen to come closer to the user and the joint on the screen enables it to be adjusted to a good view angle.

The screen is designed to suit the entire target group in means of reachability, ergonomics, and safety. The construction of the physically adjustable screen must be entirely collapsible in the case of a collision to not be a safety risk.

The interface
The interface of the So-Hub screen is designed to suit the target group and their needs. The target group wants to kill time and to be endlessly entertained in different ways, while at the same time having control over their own situation. The suggested interface can be seen in Figure 81.

Starting from the left: in the top the passengers' profile and status can be seen, in this case Sara. Status means if a person is open for doing activities together with the other passengers. Beneath it is possible to see other passengers' statuses. In addition, So-Hub enables connecting with other friends having So-Hub in their car. Bottom left are different configurations such as settings, volume, and Bluetooth.

Next to the users' bar, there is an application area. Here it is possible to choose your own applications that are compatible with So-Hub. Such applications include apps for watching movies and tv-shows, social medias, games, etc.

Moving on in the interface it is possible to choose your own widgets of applications the users often use or want easily accessible, in this case Netflix and Spotify.

To the far right, there are three additional widgets. The upper one, is the phone widget. This appears when the phone is placed in the station and disappears when not. It includes the background picture of the phone, the time, connection, and notifications. By including this widget, it nudges the users to put away the phone while still being able to use it.

Figure 79 – The So-Hub phone station adjustability in depth

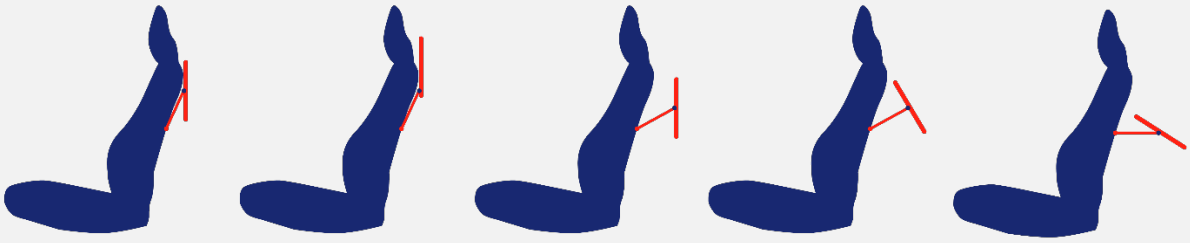


Figure 80 - Adjustability of the physical screen in the So-Hub concept

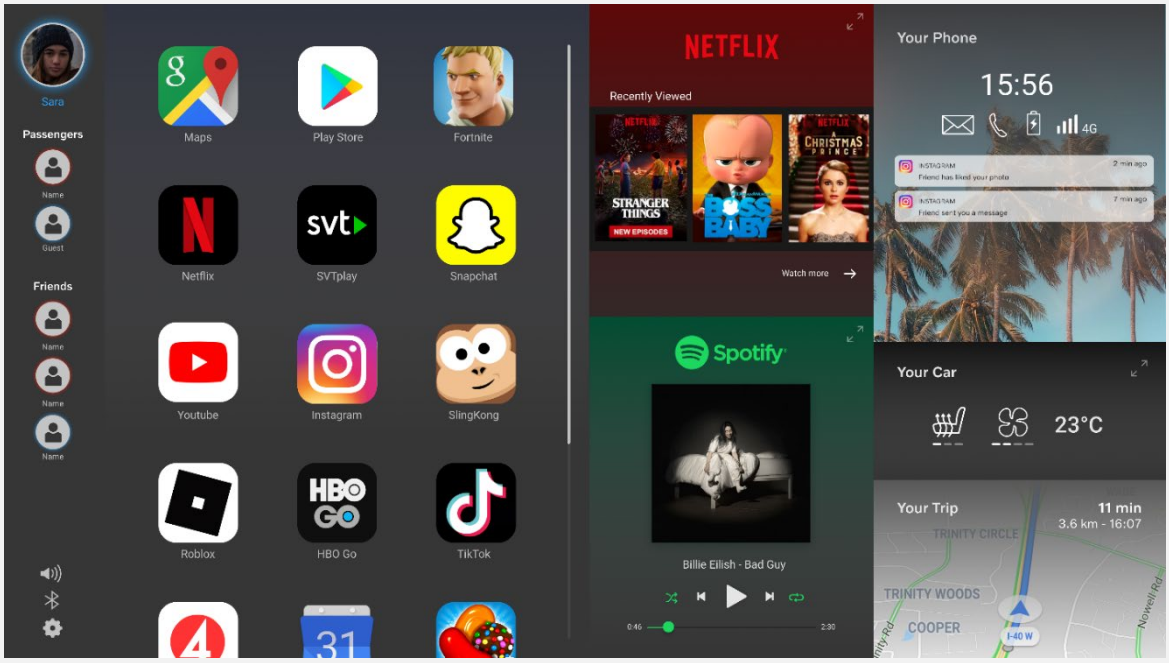


Figure 81 - The So-Hub interface

In the widget beneath, it is possible to set-up the car climate of the seat you are sitting in. This includes settings such as the temperature, the fans, and the seat heating. During the user studies it was understood that the target group in general enjoys having the control of your own settings, which this enables. This widget can also include different 'modes' that the user can set-up and save for future use.

In the widget in the bottom right corner information about the trip is shown, if there is a destination set in the car's navigator. It is possible to see the map, how far it is until the destination, and the expected arrival time. All widgets have the option to be resized to preferred size.

With So-Hub it is also possible to include the function of taking over the music in the car. The idea is that the passenger can send a request through So-Hub to the front seat, where they accept or deny the request. If accepted, the music controlled from So-Hub will be played out loud in the entire car. Another solution could be that all passengers can queue songs through their So-Hubs.

Solo and social
One of the main findings is that the target group wants to decide whether to be solo or social, meaning having the option of doing something privately on their own or socially interact with others.

The main way of enabling social interaction, is that So-Hub offers interaction with others both inside and outside the car. Being social 'out of' the car can be achieved through using social media or connect with friends that also has a car with So-Hub. A way to socially interact with the other passengers in the car, is by using So-Hub for different social activities. If clicking on one of the other persons profiles, there will show up options for different types of interaction. This could be e.g. watching a movie or playing a game together.

Besides, So-Hub includes functionality to enable "riding" solo. Firstly, So-Hub can be used by one person on their own, doing what they want. Also connecting your headphones, enhances the feeling of having your own space. If pulling the screen closer, this also strengthens the feeling of being private. Another function to support privacy is the appearance of notifications. The notifications from the phone pop up in the phone widget, without showing the content of it. The user can then either choose "show" in So-Hub or decide to open the notification on the phone, to enable a more private usage.

If a user wants even more privacy, there is an option to physically create a more private space. In the concept, a shield is included, see Figure 82. This is a lightweight shield made out a soft material spanned as a screen. This can be attached to all sides of the screen with magnets. By attaching it towards the middle, the shield act as an insight protection. The shield can also be fastened on the other sides of the screen to act as a protection for reflections from the sun. When the shield is not used, it could either be fastened on the back of the screen, or in a pocket in the car.

Phone application
The idea is that the phone creates all the functionality in So-Hub. By downloading the So-Hub app, a phone can easily connect to the system. This enables the users to not only use So-Hub in their own car, but also in others'. In the app, the user can choose what applications to have in So-Hub. The user also uses the app to set up their profile.

Using the app as the connection to So-Hub also enables the users to connect wireless headphones with Bluetooth to the phone, and the sound from So-Hub will only stream through the headphones.

It is possible that another type of technical solution might be more suitable, which should be investigated further. The So-Hub app also enables the phone to be used as a control.

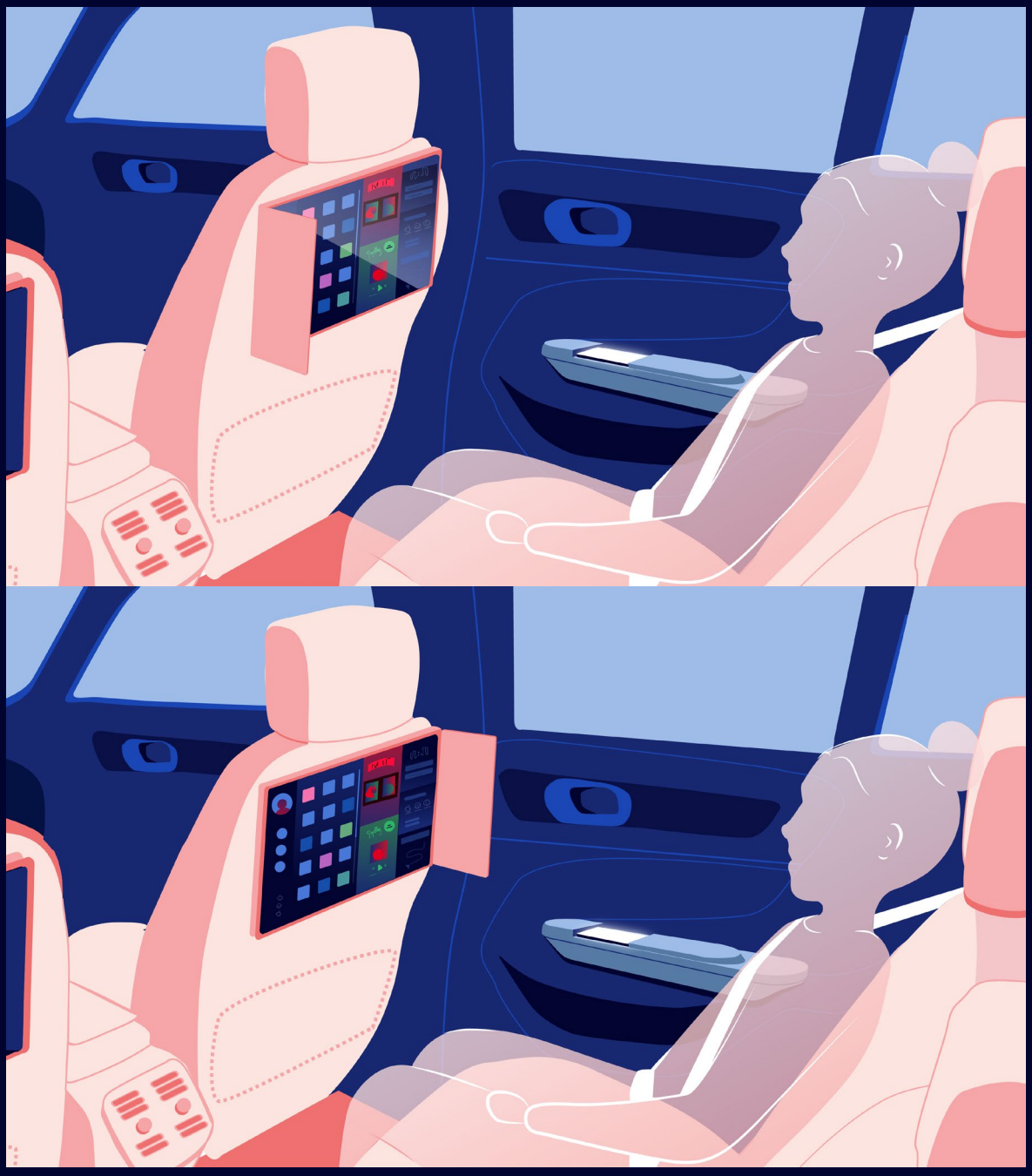


Figure 82 - The shield attached to the screen in two different ways

Phone as a control
Another part of the concept is that the phone act as a control for So-Hub. During the user studies it was understood that the target group almost always brings their phone, wherever they go. The car is not an exception. Because of this, the phone can be used as a part of the concept; as a control of So-Hub.

Firstly, as mentioned in the storyboard, the phone can be used as a game control. A suggestion for what the interface could look like is presented in Figure 83. The interface is designed to contain the same functions as conventional game controls such as PlayStation and Xbox[2], to ensure that there is no need to develop special versions of already existing games. Instead of the joysticks there are two areas of navigation and instead of the current buttons and arrows, these are placed on large touch areas distanced from each other. The reason for the design of the buttons is to enabling using the game control without looking down, and instead learn the location of them. To support this, different vibrations gives the user haptic feedback. In addition, the rest of the buttons, that are in general used less, are placed in the middle of the screen. Also, if the user has a regular game control, it should be possible to connect this to So-Hub.

With this solution, the users are enabled to play games like the ones they do when they are at home. At the same time, it enables them to have an upright sitting posture and upright eyesight when looking at the screen.

Within the app, there is also an option to use the phone as a remote control for So-Hub, see Figure 84. By using the phone as a remote control, So-Hub can be used in its upright position without being pulled closer. The interface contains a large touchpad area for navigation and by clicking the touchpad an option is chosen. In addition, there is a return button and room for other functions such as changing the volume. In the upper right corner of the interface, it is possible to switch between the game control or remote-control mode.

Other Ideas
During the development phase and evaluation, several other ideas related to the concept came up. In this section, possible other ideas to consider are presented.

Camera on the screen - This can enable logging in with face recognition. It can also be used for social medias or even talking with someone in the front. It could also be a way for the parents to view their children in the back seat without looking back. Before including such solutions, it should be ensured that restrictions regarding motion pictures are followed.

Camera in the front - In the user studies, it was understood that the target group enjoys sitting in the front. One of the reasons for this was the possibility of looking outside. If installing a camera in the front of the car, this could be shown in So-Hub, making the users “look through” the seat in front of them and being able to look out. A hypothesis is that this might also lower car sickness.

Adjustable armrest - The phone station could be developed to become an armrest that better fits the target group, if there is a possible solution where the phone can be close to the passenger without creating a safety risk during side collision. By including an armrest where the phone can be used simultaneously when the armrest is used, the hand is stabilised. There is a hypothesis that when using such an armrest, the desirable sitting posture is supported.

Games - With this type of solution, it also enables the company to develop their own So-Hub games. This could be e.g. a music quiz that the entire car could participate in.

Middle seat screen - The concept might also be possible to incorporate for the middle seat or even the front seat. This would require a different type of solution for the physical elements of the concept. It could be a decision of the buyer.

[2] Two types of home video game consoles for playing video games using handheld controllers.

Figure 83 - The phone as a game control in the So-Hub concept

Figure 84 - The remote control to the So-Hub concept

Incentives for using So-Hub
From the user studies and the found needs it was evident that the content of So-Hub is desirable among the target group. At the same time, it was seen that the current phone usage of the target group is an imprinted behaviour. To be able to change this behaviour, and make the target group use So-Hub, strong incentives are needed.

One incentive is that the phone is charging if placed in the phone station, while at the same time being close to the passenger, making them feel in control. Even though the phone is placed there, the phone can in one way still be used through So-Hub. From the user evaluations, see chapter 7.3.3, it was understood that the target group would appreciate So-Hub since it offers a larger screen but also since it does not require the user to hold it themselves, when using different phone applications.

In addition, many of the functions in So-Hub were during the user studies found desirable. For instance, it was mentioned several times that they would want something alike flight cabin entertainment in the car. Also, that watching movies and playing other types of games than what is possible on your phone is enabled. All this is effortlessly accessible in So-Hub. Further, another incentive could be that games available in So-Hub is only available there.

The opportunity to play games or watch movies together with others, which is not possible to the same extent in your phone, could also be an incentive. An incentive for keeping the phone in the phone station is that the phone widget disappears if taking away the phone from the station, and that notifications no longer will show there. At the same time, it will still be possible to use So-Hub even though the phone is removed.

Based on the findings, it is likely that the long trips will be less of a challenge in motivating them to use it, because of the desired functions. On the other hand, the short trips are a greater challenge. The main incentives during short trips is believed to be charging your phone, but also that the car climate and seat adjusts for the passengers pre-set. Besides, it is assessed to be an incentive during short trips being able to control the music in the car.

That it is effortless is also an incentive, making it easy to redirect the usage of the phone to So-Hub. If achieving the first step of connecting the phone to So-Hub in a seamless and easy way, it is probable that they would continue to use So-Hub for other activities as well.

7.4.2 Final Concept Sitting Posture Study and Analysis
The sitting postures of the final concept, in comparison to the activities sitting posture analysis, see chapter 5.5, showed in general an improvement. In Figure 85, the upper group of sitting postures derive from the found activities and the lower ones are for the concept. The faded activities are activities that are not affected by So-Hub. The sitting postures marked with green circles, are improved sitting postures and the ones circled with red are critical sitting postures generated by the concept.

The sitting postures that the concept improves are: all phone activities since these are transferred to So-Hub, studying and drawing (if done using the system), watch movie (both together and alone), using tablet (So-Hub), playing Nintendo/similar (using game control), and looking at content shared by someone else.

The concept generated two critical sitting postures. Firstly, when leaning forward for pulling the screen closer. This posture can also occur if passenger decides to use the touch screen in its upright position. In relation to the total usage, leaning forward for adjusting the screen is considered as momentary and hence less critical. Second, the passenger might lean outboard towards the door if using the phone when it is placed in the station.

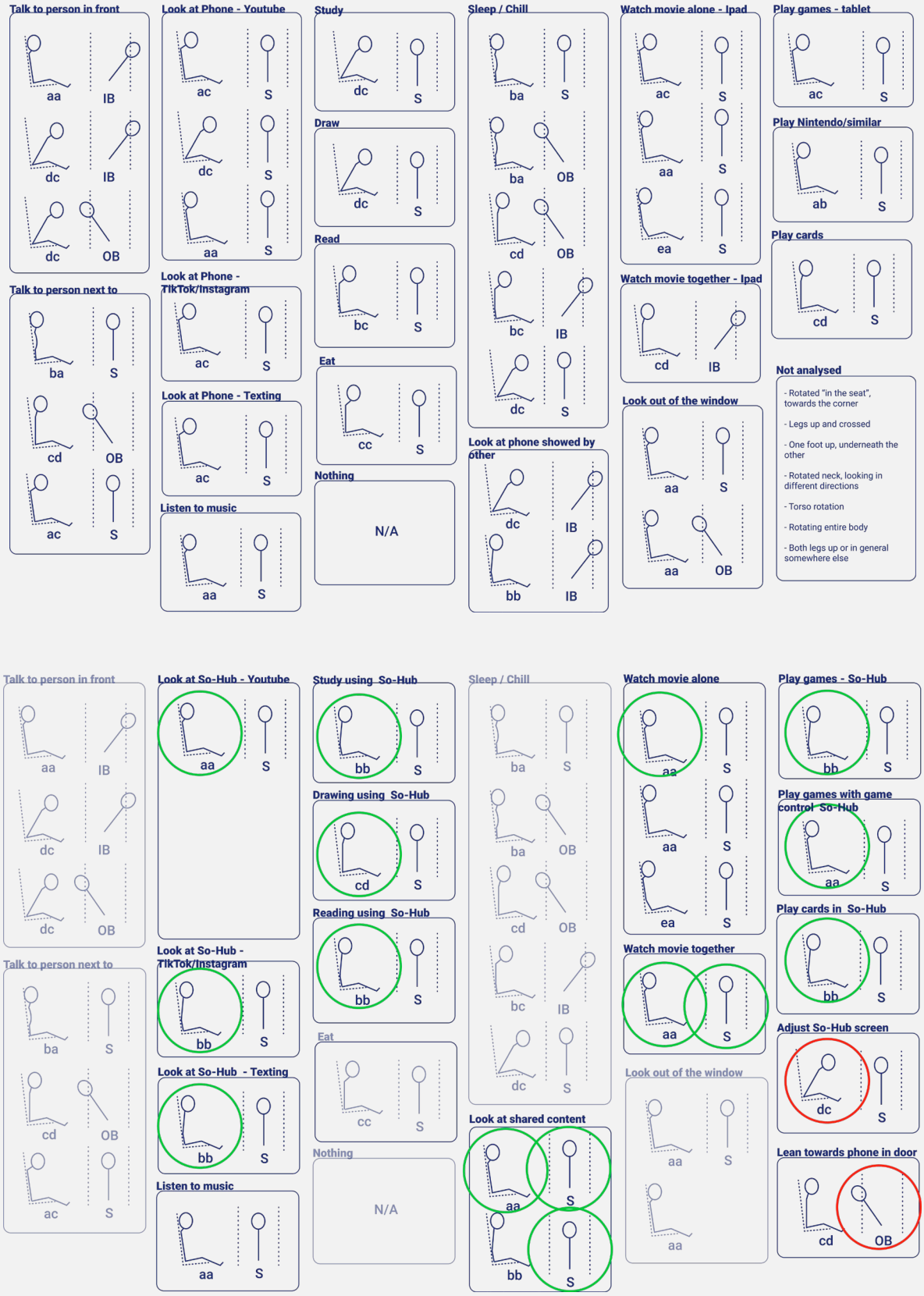


Figure 85 - Final concept sitting posture analysis

7.4.3 Experts Evaluation

The Experts Evaluations gave important insights regarding the feasibility and appropriateness of the concept through four interviews with experts within the fields: technical implementation, ergonomics, safety, and user experience. For a summary of each interview see Appendix L and chapter 4.5.8 for how the Experts Evaluation were performed.

Some of the most important insights were used to refine the concept further. Connecting a phone to the system was made easier by using BLE instead of choosing a seat in an application. The armrest was changed to be less adjustable to reduce complexity. The use case of the remote control was assessed as weak and thus down-prioritised. To give even more incentives for the target group to use So-Hub, the possibility of adjusting the seat and climate to a user's pre-sets when activating So-Hub was added. All physical elements are meant to be completely collapsible in the case of a crash, even though there is no suggested construction for this. To further support privacy and protect from reflections, the shield was added to the concept. Lastly, the notifications were adjusted to not show automatically to enhance privacy.

Below is a list of the most important insights from the Experts Evaluation:

1. Strive for a more effortless set-up of the system.

In order to overcome the threshold of putting down your phone, especially for people within this target group, the process of connecting to and start using the system must be quick and feel absolutely effortless.

2. The need of privacy is not yet fulfilled with this concept.

The user may not want others to see your notifications or e.g. a video you are viewing on the screen. The concept should be developed to offer more privacy.

3. The armrest is too far away from children with narrow shoulder width, which can result in the concept not being suitable for the entire target group.

Before the expert evaluation, the armrest was designed in a way that could make users with narrow shoulder width, i.e. probably a considerable amount of the target group, to lean towards the armrest. This could decrease the seatbelt comfort and lead to a less safe sitting posture due to the lateral offset.

4. The physical elements of the concept must be collision safe if they are placed in such a way that they could affect the user during a crash.

The physical solutions such as the screen and the armrest required a solution for being collapsible during different car crash scenarios. It was thought that this was possible to achieve, but to what extent of complexity and cost was discussed.

5. It is technically possible.

The expert confirmed that the digital solution including how to connect a smart phone and provide the different solutions in the interface were feasible.

6. What level of complexity of the solution is most suitable depends on the intended buyer, and thus the price of the product development.

Some of the solutions required complex, and thereby also costly, constructions. Therefore, recommendations of considering the buyer group was given. Accordingly, say if the target buyer is within a standard product range, then some of the solutions would have to be simplified.

7. Positive to the placement of the phone in the door.

All experts agreed on that the placement of the phone station in the door was superior in comparison to having the phone station placed in the middle of the back seat. This, due to the

fact that it was experienced as more private but also since it made it possible for someone to use the third seat simultaneously as charging the phone.

8. Positive reactions to the screen being mounted and adjustable.

Even though it was viewed as technically challenging to have the screen mounted and adjustable on the back of the front seats, the experts agreed on that it was a positive aspect of the concept.

9. Positive to the interface and its functions, including controlling the climate.

There were no negative comments on the functions in the interface. Rather, most of the experts expressed positive thoughts about the division of the elements etc.

10. The use case of using the phone as a remote control was debatable.

According to one expert, the target group would probably not use the phone as a control to the screen, but only use the touch function instead since that is what they are more used to.

11. The use case of using the phone as a game control was positive.

All experts were positive to the use of the phone as a game control to the screen. This, since the way of playing games on a tablet, does not always cover the functionality offered in a game control.

12. In general, how the solution affects the sitting posture was interpreted as positive with two exceptions: leaning towards the door and leaning forward to touch or move the screen.

These two occasions would probably lead to a decrease in accurate sitting postures, which was viewed as negative. Otherwise, they seemed satisfied with how the concept supported good sitting postures.

13. Positive to the usage of cameras, as long as restrictions are followed.

The experts saw possibilities in using cameras to different parts of the concept, such as adjusting the height of the screen automatically, viewing the road to decrease car sickness, and to interact with each other in a new way without having to lean or turn in different directions.

14. Main positive part of the concept is the encouragement of putting away your phone and create a safer usage.

All experts seemed to agree that this was the main benefit of the concept, and what could perhaps be developed further was how to encourage the use of the solution further.

15. Positive to that the users can interact with each other with the solution.

The fact that the users could interact and for instance play games with each other in a safe way was viewed as highly positive by all experts.

7.4.4 Needs Fulfilment

Of the highest ranked needs from the Impact Map, see chapter 5.6.4, it is possible to say that So-Hub supports or partly supports all those needs, see Figure 86.

Figure 86 - Fulfilment of highest ranked needs

Need	Supported in So-Hub?
Needs to have the opportunity to be entertained at all times	Supported
Wants to pass time and fight boredom	Supported
Needs to be able to choose from different alternative of entertainment	Supported
Wants to be able to do the same things as they do in their home	Partly supported
Wants to be able to perform activities together with others	Supported
Needs to be able to make conversation with all the people in the car	Partly supported
Needs private space	Partly supported
Wants their things easily accessible in the car without them moving around	Partly supported
Want to be able to lean/mount a device in order to create a good view angle	Supported

7.4.5 Interaction Vision Fulfilment

The Interaction Vision for the concept was, as seen in chapter 7.1.1:

"Entering the car, should feel like climbing into your own treehouse."

This was supposed to represent the exciting feeling a child has when climbing up to their treehouse and the feeling that they can do whatever they want in there. It is their own secure place where other obligations and demands can be put away for a moment.

The qualitative characteristics of the Interaction Vison is represented in So-Hub in different ways. The car context itself creates a feeling of being 'safe' since it is enclosed and that you are often in it together with family or friends that you know and trust. So-Hub further increases this feeling by offering a safe place to put your phone and in the way that the user can create privacy through different functions in the interface described above, and the shield that can be used for screening off other passengers.

So-Hub is 'flexible' both physically and in the different ways it can be used. The screen and the phone charging station can be adjusted to fit each user, the interface can be personally adjusted to each person, and the activities that can be performed are diverse and interchangeable.

Since it is easy to connect the phone and start using So-Hub, it could be viewed to be 'effortless'. Also, after connecting the phone, the user has all the activities they would like to do, such as playing games or watching movies, only one click away. Controlling the seat settings and playing music is in the same manner uncomplicated and accessible.

How So-Hub is 'meaningful' for the user, of course, depends on their goals, desires, and expectations. But in general, since the concept creates the opportunity to do almost whatever you want, it creates different meanings to each user. This could also enhance the feeling of that the time spent in the car is more valuable than just passing it by and reaching the destination as quickly as possible.

Lastly, since one of the main goals with So-Hub is to make the youths being able to entertain themselves, both on their own and together with others, it is now more fun to ride the car, and

hence, more ‘enjoyable’. It is also possible to create a more personalised setting in the car, which could increase the feeling of cosiness.

7.4.6 Behavioural Archetypes Fulfilment

In this section, it is explained how So-Hub meets the behavioural archetypes and their needs.

The Fun Seeker
Always looking for new options and variations of entertainment. Sees opportunities of being entertained in the car. Wants to feel like there are endless entertainment without limitations.

The Fun Seeker is likely to appreciate So-Hub since it offers several different options of entertainment, effortlessly accessible. With So-Hub, everything they need for having fun is right in front of them.

The Solo Rider
Enjoys having a private space and creating their own bubble. Does not want to be disturbed by others and prefer doing activities on their own. Wants to be independent.

With So-Hub, the Solo Rider can create their own space through several means. Firstly, by connecting headphones and using the shield, they screen off other passengers. They can do several activities on their own and choose their status to be “do not disturb”.

The Social Butterfly
Enjoys hanging out with others and being social. Appreciates having conversations and doing activities together with other people in the car. Finds shared experiences valuable.

So-Hub enable the Social Butterfly to interact with other passengers in the car, as well as with others outside the car. They can e.g. play different games and watch a movie together. So-Hub does not limit them in talking to the others in the car, although, it does not improve this.

The Time Killer
Believes that the car riding is a waste of time which induces the feeling of powerlessness. Wants to escape from the boring present and strives to obtain a sensation of doing something. Really focused on the destination.

With So-Hub the Time Killer can pass time and fight boredom. So-Hub can also enhance the feeling of that the time spent in the car is used for doing something. With the navigation widget, the Time Killer can also feel in control of the progress of the trip.

The Set-Upper
Brings several belongings when going on a trip and arranges the things in different accessible places. Creates a cosy set-up in the car and prepare themselves for the trip.

The Set-Upper can arrange and set-up So-Hub to their liking, e.g. by setting up their own climate and seat. But also, by being able to adjust the screen to different angles and heights, and arranging the interface of So-Hub. What is not supported is the arranging and storing of their brought belongings, except the phone.

The Pilot
Wants to control different settings and adjustments. Appreciates to have a clear overlook, both inside and out of the car. Wants to be the one controlling the music and adjust their seat etc.

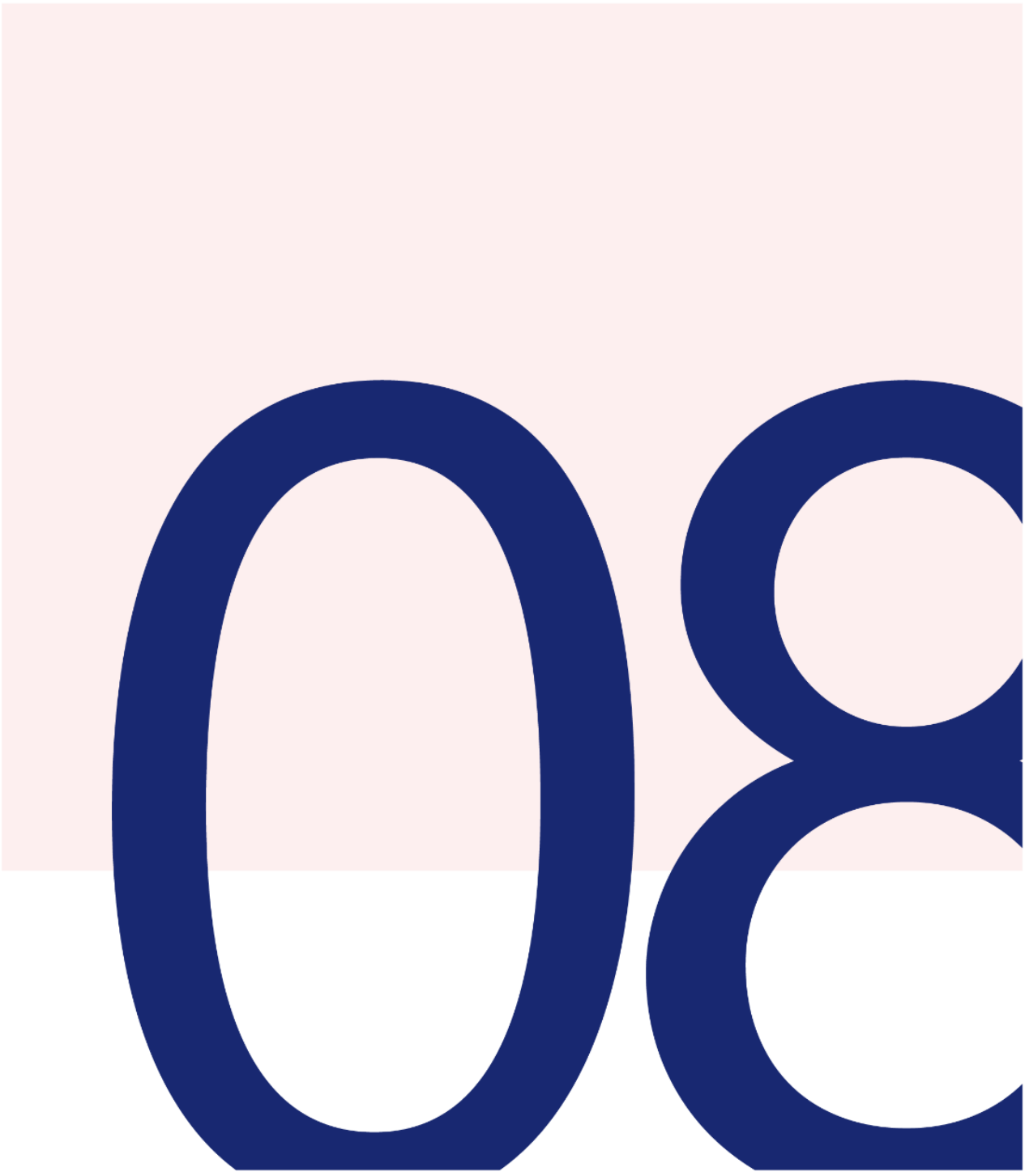
With the different settings available in So-Hub, the Pilot can be satisfied. By the opportunity of controlling your own seat and climate settings, and with the possibility to take over the music in the car. By seeing the different statuses of other passengers in the car, the Pilot can increase the feeling of having an overlook inside the car and if including the camera of being able to look out ahead, the Pilot can get an even clearer overlook outside the car.

The Harmony Seeker
Seeking personal space and a time out from everyday life (me-time). Sees the car riding as an opportunity to get some relaxation and time for reflection.

By using the shield and connecting headphones to So-Hub, the Harmony Seeker can create a personal space within the car. By being able to choose what to look at or listen to, the Harmony Seeker can decide something suitable for relaxation. What should be said though, is that the Harmony Seeker is the one behavioural archetype least supported by So-Hub.

8. DISCUSSION

In this chapter the different aspects that might have affected the outcome of the project is discussed. This includes a discussion of the methods performed, the found needs, but also the design concept itself. In addition, a short discussion about how COVID-19 affected the project is included.



8.1 METHODS

The methods *Parent Interviews, Instagram Diaries,* and *Family Home Sessions* were developed to collaboratively work as a mean of understanding the needs and desires of youths between 10-17 years. Because of this, there was a degree of interdependence between the three methods. For instance, the result from the *Parent Interviews* influenced the design, and thereby indirectly, the results of the *Instagram Diaries* and the *Family Home Sessions*. Also, how many trips the youths had done during the time of the *Instagram Diaries,* most likely affected their attitude towards the following *Family Home Sessions*. For instance, the participants that had not reported a single trip, seemed to be less engaged during the first activity of the *Family Home Sessions* because they had no trips to talk about. It is difficult to evaluate or predict how the result could have differed if one of the methods would have been performed independently, but there is a possibility that there would be a noticeable difference. This said, the result from the methods in many cases also completed and confirmed each other. Many of the things mentioned by the parents during the *Parent Interviews,* were for instance also mentioned/proved by the youths in the reports from the *Instagram Diaries* or in the *Family Home Sessions.*

8.1.1 Parent Interviews

The purpose of the *Parent Interviews* was to gain a first understanding of the target group in a non-demanding way for both participants and researchers. Due to this, the data gathered did not result in deep insights. The shallowness of the interviews could have been due to the format of the interviews. They were performed digitally and many of the participants were not able to use video calling which made it harder to see reactions and probe.

The data seemed to be saturated quite quickly which could imply that the data was confirmed by more parties, but it could also be explained by the fact that the participants were from similar societal and economical class. This could mean that their children to a high extent had the same prerequisites, and thereby, lived similar lives. If having a larger spread of participants regarding these demographic factors, other conclusions might have been drawn.

8.1.2 Instagram Diaries

The purpose of the *Instagram Diaries* was partly to gain "in the moment" data about the youths' car habits, but also to prepare them for the upcoming *Family Home Sessions.* When taking pictures and answering the questions about their car trips, it sometimes seemed to interfere with the youths' natural behaviour. This was especially evident for the very short trips (<5 minutes) where some participants expressed that they did not have time to do anything else. To come around this issue and solely document the youths' behaviour, an option would be to place a discrete camera inside the car and recording the car trips during a specific period. But for this study, where the purpose also was to sensitise the participants, answering the questions also had a reflective function, which could make this disadvantage 'affordable' in that sense.

Another drawback of the design of the method was revealed during longer trips. Since the participants were only asked to send one picture or video for each trip, many of the activities during long trips were not reported. A way to get around this issue would have been to ask them to e.g. report every hour or likewise. This would also have provided information about what activities were more common during different parts of long trips, which could have given input to e.g. the behavioural archetypes.

There are arguments both in favour and against the use of Instagram as the media to gather data and for communicating with participants. A disadvantage is, for instance, that if a person usually does not use Instagram, it is likely they will miss some of the posts appearing in their feed (which are supposed to work as reminders). Not being used to Instagram could also create a strain for the participant and thereby mean that they perhaps would not report to the same extent as someone who uses it daily.

One part that seemed to be helpful was the signs the participants received before the study to hang up inside the car. In one family, for instance, the youths had forgotten to report several trips that were done in other cars without the signs. This could, of course, have other causes but other participants also expressed that the signs had helped them to remember.

The *Instagram Diaries* were assessed to be quite time consuming to perform, see chapter 6.2.2. This was mainly due to this being the first time the method was done in this manner, which is further described in 8.1.6. Also, the *Instagram Diaries* took more time than necessary since they had to be done in two different rounds, for one week each. It would have been more efficient to perform all in the same week. Additionally, preparing the start packages also took some time since they contained several different components that were carefully designed to feel personal, professional, and provide the participants with enough information to be able to perform the studies. Since all the parents were also verbally informed about how to perform the study etc., one could argue that some of the content of the package could have been simplified or excluded. On the other hand, the package was mainly for the children of the family and reducing it could potentially lead to them feeling less engaged and motivated to perform the study. The participant surveys also showed that these were appreciated.

What could speak in favour of the reliability of the method, is that the study was performed twice, in two different cities, with different families, of which the result was comparable and similar. An aspect that might affect the reliability negatively, is that the method is influenced by the researchers' personalities and the way they communicate. If other people were to perform the same study, the result might thus have differed.

8.1.3 Family Home Sessions

The validity of the *Family Home Sessions* is considered high, since knowledge regarding the youths' car riding habits, behaviours, and needs were collected. Also, it was possible to understand some of their future and unknown needs. Because of this, the intended purpose of the method was fulfilled.

The sessions were adjusted for each family and partly based on the outcome from the *Instagram Diaries.* The interview questions and some parts of the activities slightly differed among the families. This, of course, affected the results, and thereby also the reliability of the study. This must be weighed against the fact that adjusting the sessions to each family also enabled better and more relevant discussions, creating a personal setting for the session, and more efficient use of the time.

The outcome of this method, in the same way as the *Instagram Diaries,* is highly affected by the personalities and behaviours of the researchers. The method depends on creating a personal and safe setting, being in the homes of the participants, sharing experiences and thoughts. Therefore, if other people were to perform the same study, the result might differ.

Also, the *Family Home Sessions* were assessed to be time consuming, see chapter 6.2.3. One reason for this is that the preparation for each session required some adjustments, as explained above, and that collages were created for each family consisting pictures the participants had sent in during the *Instagram Diaries.* If this activity would have been done differently, for instance by only viewing the pictures directly in Instagram, the time could have been used more efficiently. Why it was chosen to do it in this way, was partly to have a physical object that could engage the family more, but also it was a way to show the participants that what they had done during the *Instagram Diaries* actually resulted in something important and graspable.

Another reason for that it was viewed as time consuming, was that they were performed in the homes of the participants which in some cases required long travel time. This was mainly done to be able to make the children feel more relaxed, see chapter 2.1.3, and to be able to use their own car for a contextual interview. But also, it was a way of requiring less of the participants time in comparison to them having to travel to a location for the study. The participants did not get paid to participate, and therefore there was an urge to make it as easy as possible for them to

participate. If they would have gotten paid, one could argue that you could have demanded more from them, which could then reduce the time and effort required of the researchers.

8.1.4 Sitting Posture Study and Analysis

The different sitting posture studies and analysis of them were based on the methodology described in chapter 2.2. With this tool, it is only possible to represent the front and side views of the upper body postures, meaning the positioning of the legs and any rotation of the body was not possible to describe. Further, since the sitting posture analyses were performed as self-studies, it was also not possible to know if any slouching occurred for different activities. These factors could mean that an incomplete picture of the sitting postures was generated.

To what extent the "lost" sitting postures would affect different safety aspects, is difficult to conclude. But, if they had been measured and included in the analysis, and assessed to be large safety risks, the project could have been led into a different direction. The decision to re-scope the design concept development and focus on some of the needs, was partly made due to the critical sitting postures for the associated activities to the needs. Thus, other needs could have been prioritised if they were associated to more critical sitting postures e.g. leg position. The method used for analysing the sitting postures is developed for another target group than the one explored in this project. This might have resulted in the method not being as suitable for this project, since the target groups' behaviour and sitting postures might differ.

That the sitting posture studies were performed as self-studies also strongly affected the result. Both since it was constructed but also since the body sizes differs. It is probable that if studying the natural sitting postures of the target group, the result and analysis would have differed.

8.1.5 User Evaluations

The user evaluations of the three concepts Foldable Table, Car Corner, and Back-seat Hub were only performed with three users from the target group. Preferably, at least six evaluations with different users should have been performed. There is a possibility, even though they all seemed to agree with each other, that the result does not represent the opinion of the target group.

Additionally, the way the evaluations were performed, through video call, only showing a few sketches of each concept, could also have affected the outcome. This could have made it harder for the participants to understand the concepts and therefore have led to different interpretations of them. It would probably have been better to let the participants test physical prototypes of the concepts in the real context, i.e. in a car.

8.1.6 Method Evaluation

For the evaluation of the methods, several criteria and aspects were chosen to enable an equivalent evaluation of the methods. Many of the criteria/aspects were evaluated based on the responses from the user method evaluations, while some required more subjective interpretation. The evaluation lacks objective measures for comparing the methods between themselves since it was difficult to know from which specific method an insight, for instance, had originated from. The qualitative data was during the project analysed as a whole, which hindered these types of comparisons.

Also, the assessment is not entirely objective, since the researchers' previous experience of performing user studies will have affected the evaluations. For instance, the assessment of the evaluative scales cannot be entirely objective, since the judgement is affected by previous experience and knowledge about other more conventional methods. Related to this, all the user studies were developed during the project and implemented for the first time. Consequently, it is likely that it was experienced as e.g. more demanding to prepare the methods and harder to analyse the data, comparing to previous experiences. Next time performing the method, when the methodology is already available, it is likely that it would be experienced as less demanding.

Another aspect of the evaluation of the methods, is whether they performed better in revealing the needs and desires of youths than other more established methods. For this Master's Thesis

Project, the limited resources did not allow for any additional studies with the purpose of having methods to compare with. This would have been interesting since it would have enabled different types of comparisons, such as the amount of insights or evaluations of the methods by the participants. What became evident, however, was that the methods created engagement among most of the participants. For instance, many of the participants expressed that they enjoyed taking part in the studies, that they liked many of the posts on the Instagram account, and that they eagerly shared their thoughts and experiences during the *Family Home Sessions* etc. Whether other methods would have done this better or worse cannot be said. What can be said though is that the methods developed and used for this study successfully created engagement and were an aid in revealing the needs and desires of the target group.

8.2 NEEDS AND BEHAVIOURAL ARCHETYPES

The behavioural archetypes and related needs found in this thesis seem to mirror the target group well today. But the needs and behavioural archetypes have not been confirmed and verified with users. To be entirely sure that the found needs reflect the actual needs of the target group, it is thus important to confirm and verify these in another iteration with e.g. users' evaluations.

The needs of the target group were defined based on the findings from the user studies that were performed with a set of participants. Even though the participants came from different cities, it is still likely that the found needs are not fully representable for the target group. Most of the participants had similar economical and societal backgrounds, which could further affect the accuracy. How accurate the needs are for the target group, could also be affected by external factors, such as changes in the society, economy, and technical development.

Additionally, the needs of the oldest participants in the target group, i.e. the 17-year olds, were more difficult to elicit, than for ones of the younger participants. This could have several explanations. One is that they did not ride cars as much as the others, which made it difficult to find their needs during the user studies. Partly, since this made it harder to discuss what they did and wanted to do in the car. Also, there seemed to be a greater focus on driving the car than being the passenger since many were currently practicing for taking their driver's license. Another way to look at this, is the possibility that the needs and desires of the older participants, more assembles the ones of adults than of youths, and thus became less visible than the needs of the younger ones.

The needs found were attributed to seven behavioural archetypes. The reduction of the needs in the making and ranking of these was partly done through assessment of what was thought to be most important to the target group. Thereby, all the needs of the target group are not represented in the Impact Map in this report.

8.3 DESIGN CONCEPT

The purpose of the design of So-Hub is to both fulfil needs and desires of the target group, while at the same time improve the sitting posture of youths when riding in cars. How the sitting posture is affected, depends on how the user uses the screen, for how long, and for what activities. Thus, it is at this stage not possible to conclude whether So-Hub in fact improves the sitting posture even though this is likely. The concept is still on a conceptual level and no prototype testing was performed, no user evaluations in real context were done, and no detailed technical specifications are suggested. The different use cases are not separately evaluated, and thus misuse of the concept leading to safety risks could occur.

Since the main interaction with the screen is touch, there is a risk of users, especially if they are short, leaning forward to press the screen. This sitting posture could result in decrease of the desired functionality of the belt in case of a car crash. Also, using the phone when it is placed in the charging station in the door could lead to a less safe sitting posture, since it could lead to the

person leaning towards the door, i.e. OB ('Outboards'). During the expert evaluation, it was mentioned that this could especially be the case for small/young people since the distance to the armrest is larger for them.

The fact that the solution must fit many different body sizes, is challenging both in a safety and usefulness point of view. In the case of a car crash any safety function of the physical solution, e.g. collapsing, must work for different body shapes and sizes. Likewise, both an adult-sized seventeen-year old and a narrow-framed ten-year old must be able to use the solution in an ergonomically and satisfactory manner.

An additional safety risk is the fact that the shield (for being able to avoid light reflections on the screen and to reduce another passengers' insight of your screen) is detachable. If the shield is detached form the screen, it could become a safety risk since it would then be a loose object inside the car, see chapter 2.3. Whether this could lead to injury in a car crash needs to be further tested and evaluated. The shield could potentially also hinder the sight of the driver when wanting to look out through the backseat windows. This would mean a serious safety risk and would need to be carefully tested and evaluated.

In the way that the concept is designed at this stage, So-Hub would probably foremost suit the 'premium' category of cars. It requires quite expensive installations, technical solutions, and complex safe constructions. If wanting to aim for standard car offers, several adjustments of the concept could be done. For instance, the screen could be changed to a non-touch screen, and then the only way to control the screen would be with the remote function in the phone. Another possibility could be to limit the adjustability of the screen. If doing such changes to target standard class, there could be a trade-off between lowering the price and possibly not meeting the needs of the target group to the same extent.

The strength of some of the use cases for the concept needs further investigation. One example is, if people would use the phone as a remote control for the system. If it turns out that they use it, then an evaluation of the usage when the phone is placed in the armrest in the door must be done, as discussed above. If not used, then one could consider discarding this function to solely having touch for navigating and using the interface. Further, the use case of the game control function for the phone needs to be tested and evaluated. Some questions that needs to be answered are: Is it possible to use a touch screen in the same way as a regular game control (i.e. not having to look at it)? Would the users want to use their phone for this purpose? Would they appreciate such a solution?

Lastly, one of the main aspects with the concept that needs to be confirmed, is whether the incentives for using So-Hub are strong enough. Is it possible to change the powerful behaviour of almost always having your phone in the hand, endlessly scrolling different social medias, continuously connecting to friends, and so on? The phone and all its possibilities are always available, only one swipe or click away. Is using So-Hub enough effortless, attractive, and usable? Even though some indications were found within the project, this must be further evaluated with the target group. The user evaluations of the concept indicated that it could be strong enough, since the participants were positive to the thought of having and using such a solution. Also, several wishes and desires expressed related to future cars are supported by the concept. But as mentioned, the behaviour of scrolling different apps is dominant, and if that instinct is stronger, the incentives presented for the concept might have to be changed or completed in order to achieve the desired usage of So-Hub.

8.4 COVID-19

A factor that affected this Master's Thesis Project is the spread of COVID-19 during the early spring of 2020. The different restrictions following this, led to one of the main studies in the project being cancelled. This was planned to be a comprehensive sitting posture study performed in a lab environment with 14 participants representing the target group. The purpose was to gain

knowledge about how the different activities found in the previous user studies would affect the sitting postures, concerning age and size. The study was to be documented with several cameras inside the car, enabling measuring distances etc.

If it would have been possible to perform this study, it would have led to a greater understanding of how the found activities affects the sitting postures of the target group. If the study would have showed that other sitting postures were more critical than the ones found in the self-study, the scope of the design could have differed.

8.5 ETHICS AND SUSTAINABILITY ASPECTS

When engaging children in user studies it is important to consider several additional factors in comparison to if performing user studies with adults, see chapter 2.1. During the project this has been the main consideration of ethics, to ensure that all participants are willing and happy to participate, throughout the study. Also, all parents have been involved and allowed the participation of their child(ren), both verbally and in written text. Besides, all collecting of data has followed the law of GDPR and include the anonymity of all participants.

Regarding the ethics of the design, it has not been taken into consideration how the concept is suitable, or not, for passengers with different cognitive and physical functional variations. This needs to be considered if further developing the concept.

Sustainability has been taken into account, for instance by minimising the travelling to the user studies by concentrating the sessions performed in another city to only require one long trip, instead of many.

Regarding the ecological sustainability of the concept, mainly one aspect was considered. The So-Hub concept is designed for longevity, meaning that updated with new software and thus used for a long time. Also, it is suitable for other outside the target group, which increase the utilisation of it. Because of the conceptual level of So-Hub, materials and manufacturing has not been specified. This should be considered if developing the concept further.

The concept is to be implemented in a car, which itself has an ecological footprint. The concept will add to this footprint by using more material and is also likely to add weight to the car which increases the cars' energy consumption.

9. RECOMMENDATIONS

In this chapter recommendations on how to continue the work, if the findings and result in this thesis should be used or investigated further. This includes recommendations related how to further develop and test the concept, but also how the methods, needs, and behavioural archetypes can be used or developed in the future.

09

9.1 CONCEPT DEVELOPMENT

Firstly, continuing the concept development, a prototype of the concept should be made. Both a prototype of the physical elements to define its construction and dimensions but also digital prototypes should be created. The purpose of this would be to test the concept with users, to further understand the target groups' needs related to the specific solution.

Based on the findings, the concept should be further developed and tested. It would be interesting to test the concept both in context and regarding its long-term user experience. In addition, it is recommended to perform an extensive sitting posture study with users. As mentioned, due to COVID-19, it was not possible to perform a sitting posture study with users from the target group. The recommendation is to map the target groups' sitting postures related to the found activities in this thesis by performing a sitting posture study and analysis with users from the target group. Following, a similar sitting posture study should be performed with the prototype of the concept to be able to make a more certain conclusion regarding how the concept would affect their postures.

Further, it should be investigated how a safe construction of the physical elements in the concept would function. If it is not possible to create a safe construction with the concept, it must be iterated and adjusted to ensure safety of the passengers.

The concept consists of several sub-solutions functioning together to both enhance user experience and increase safety. If eliminating parts of the concept, one of these might be compromised. But if prioritising, what is highly valued with the concept is the combination of the screen with its entertainment opportunities and the phone station. These two functions together to change the way the target group uses their phone and tablets today. Secondly, it is the adjustability of the screen to suit different types of usage, behaviours, and ages of the target group. Following, comes the phone as a game control, since this can enhance the target groups' experience while at the same time support the desirable sitting posture. What sub-solutions are the least prioritised is most likely the phone as a remote control along with the shield. The concept could fulfil its main purpose without this. Even though this is the recommended prioritisation, the different sub-solutions should be evaluated with users from the target group to evaluate if their behaviours align with the prioritisation.

With this said, it is most important that everything is experienced as effortless. Otherwise, it is likely that So-Hub will not be used.

What is recommended to investigate further is whether the incentives for putting down your phone and using So-Hub instead are enough. In what situations do they decide to use it and when not? If they decide to not use it, what are the reasons for that? If being able to define this, it is believed that So-Hub can change the target groups' behaviours and improve their sitting postures and safety inside the car.

9.2 METHODS

The result of the methods showed that both using social media as a sensitising tool and going home to families to perform generative sessions were successful for the target group. From the methods, these are the main recommendations to follow if wanting to find the needs of youths between 10-17. What could be interesting would be to divide the target group into sub-groups since it was found that the users differed a lot, especially if comparing a 10-year-old and a 17-year-old.

From this thesis project it was possible to say that the methods developed engaged the target group and supported in finding their needs. What is not possible to say though, is whether the methods used in this project does this better in comparison to more common user study methods. To be able to conclude this, a comparative study should be performed. The

recommendation is to, in another study, perform methods from this project but also perform other more common methods, with the same participant group, and evaluate these based on the same criteria. The more common methods would act as a baseline for comparison and from this, it should be possible to say whether the methods developed in this thesis have better suitability or not.

Additionally, it is recommended to investigate whether it is possible to achieve the same results and insights if simplifying the methods. Some of the downsides with both *Instagram Diaries* and *Family Home Sessions* were the extensive preparation and work required from the researchers. If being able to reduce this, the methods could be used in projects with less resources as well.

9.3 NEEDS AND BEHAVIOURAL ARCHETYPES

The behavioural archetypes and related needs found in this thesis seem to mirror the target group well today. But, as mentioned in chapter 8, the needs and behavioural archetypes must be confirmed and verified with users.

In addition, the needs and behaviours of the target group could change in line with different societal developments. Because of that, the needs and behavioural archetypes found in this study might not correspond anymore. If wanting to use the needs and behavioural archetypes found, it is thus recommended to consider if these have changed over time.

10. CONCLUSION

In this final chapter, the conclusion of the project is presented.
The result for each main area of investigation is briefly concluded.

10

This Master Thesis has focused on four main areas and the conclusion of each is presented below.

1. What are the *needs* of youths between 10-17 years when travelling in cars *today* and what could be the needs of youths when travelling in cars *in the near future?*

Some of the most important needs of youths between 10-17, today and in the near future, are that; they want to pass time and fight boredom by choosing from different alternatives of entertainment, they want to effortlessly use their devices, they want to have their things easily accessible in the car, and they want to be able to decide whether to do things with others or on their own.

The needs of the youths are in this report communicated and prioritised through an Impact Map including the seven behavioural archetypes 'The Fun Seeker', 'The Solo Rider', 'The Social Butterfly', 'The Time Killer', 'The Set-Upper', 'The Pilot', and 'The Harmony Seeker'.

2. How will the *activities* in cars affect the *sitting posture*?

The activities performed in cars are affecting how the youths sit in a car. Based on the sitting posture analysis it was possible to find critical activities. If changing the way activities are performed, the sitting posture can be improved, and thus the safety can increase.

Some of the most critical activities found were different types of phone activities, talking to a person in the front, sleeping, watching a movie together in the back seat, and looking at a phone showed by another person in the car.

3. Based on the needs of youths, what is a possible *design* to support their activities in cars while at the same time offer a *satisfactory* and *safe experience*?

Based on the found needs and critical activities, a design concept was created. The proposed design concept is called So-Hub, which is a back-seat entertainment system, including an adjustable touch screen, a safe wireless phone charging station, a suggestion for the content of the interface, and enabling using a phone as a control. The design concept fulfils the highest-ranked needs of the behavioural archetypes. Evaluations indicate that the design concept improves most of the critical sitting postures, and thereby also the safety of the target group.

4. What *methods* are suitable to use when investigating the behaviours and needs of youths in cars?

The methods developed and used in the study were *Parent Interviews*, *Instagram Diaries* and *Family Home Sessions.* The evaluation of the methods and the number of insights they generated, indicated high suitability for the target group and the aim of the study.

References

Almefelt, L. (2019, January 23). Requirements Management with Product Innovation in Mind. *Requirements Management*. Gothenburg, Sweden: Chalmers University of Technology.

Almefelt, L. (2019, January 21). Systematic Design - Overview. *Systematic Design*. Gothenburg: Chalmers University of Technology.

Avrahami, D., Yeganyan, M. T., & LaMarca, A. (2011). The danger of loose objects in the car: Challenges and opportunities for ubiquitous computing. Bejing: Conference: UbiComp 2011. doi:10.1145/2030112.2030136

Berndtsson, J., Adzic, G., & Domingues, I. (2014, November 8). *InfoQ*. Retrieved from Getting the Most Out Impact Mapping: https://www.infoq.com/articles/most-impact-mapping/

Bowen, S., Sustar, H., Wolstenholme, D., & Dearden, A. (2013). Engagingteenagersproductivelyinservicedesign. *International Journal of Child-Computer Interaction, 1*(3-4), 71-78. doi:https://doi.org/10.1016/j.ijcci.2014.02.001

Börjesson, P. (2019, January 23). Interaction Design and Children. Gothenburg, Sweden: Chalmers University of Technology.

Cabrero, D., Winschiers-Theophilus, H., & Abdelnour-Nocera, J. (2016). Reconceptualising Personas Across Cultures: Archetypes, Stereotypes & Collective Personas in Pastoral Namibia. *International Conference on Culture, Technology, and Communication*, 96-109.

Cooper, A. (1998). *The Inmates Are Running the Asylum: Why High-Tech Products Drive us Crazy and How to Restore the Sanity .* Sams Publishing Pub.

Domingues, I. (2017, February 20). *InUse*. Retrieved from The Evolution of Impact Mapping: https://www.inuse.se/blogg/evolution-impact-mapping/

Domingues, I. (2018, September 19). *InUse*. Retrieved from Finally Ditch the Persona: https://www.inuse.se/blogg/finally-ditch-persona/

Doneva, R. (2017, July 25). *Behavioural Archetypes Instead of Personas*. Retrieved from Medium: https://medium.com/@RadinaDoneva/behavioural-archetypes-instead-of-personas-c7ccc5b8b998 2017

Hagen, P., Collin, P., Metcalf, A., Nicholas, M., Rahilly, K., & Swainston, N. (2012). *Participatory design of evidence-based online youth mental health promotion, intervention and treatment.* Abbotsford, Vic.: Young and Well Cooperative Research Centre. doi:http://handle.uws.edu.au:8081/1959.7/534977

Hiran, T., Fleming, T., Hetrick, S., & Merry, S. (2018). Co-design of eHealth Interventions With Children and Young People. *Frontiers in Psychiatry*, 481. doi:10.3389/fpsyt.2018.00481

Jakobsson, L., Bohman, K., Stockman, I., Andersson, M., & Osvalder, A.-L. (2011). Older Children's Sitting Postures when Riding in the Rear Seat. *Ircobi Conference.*

Nilsson Wikberg, Å., Ericson, Å., & Törlind, P. (2015). *Design - Process och Metod.* Lund: Studentlitteratur AB.

Palm, S. (2020, February). Personal Contact. Gothenburg: Customer Experience Centre 91200, Volvo Cars.

Pink, S., Horst, H., Posthill, J., Hjorth, L., Lewis, T., & Tacchi, J. (2016). *Digital Ethnography Principles and Practise.* London: SAGE Publications.

Renström, S. (2019, April 12). *Going Into the Everyday*. Gothenburg, Sweden: Chalmers University of Technology.

SAE International. (2018, December 11). *SAE International Releases Updated Visual Chart for Its "Levels of Driving Automation" Standard for Self-Driving Vehicles*. Retrieved May 20, 2020, from SAE International: https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-%E2%80%9Clevels-of-driving-automation%E2%80%9D-standard-for-self-driving-vehicles

SAFER. (2019). *Project - Assessment of Passenger Safety in Future Vehicles*. Retrieved from SAFER Research: https://www.saferresearch.com/projects/assessment-passenger-safety-future-vehicles

Sanders, E. B.-N., & Stappers, P. J. (2018). *Convivial Toolbox.* Amsterdam: BIS Publisher.

Simpson, C., Ataii, E., Kemp, E., & Zhang, Y. (2019). *Mobility 2030: Transforming the mobility landscape: How consumers and businesses can seize the benefits of the mobility revolution.* KPMG International. Retrieved May 6, 2020, from https://assets.kpmg/content/dam/kpmg/xx/pdf/2019/02/mobility-2030-transforming-the-mobility-landscape.pdf

Sleeswijk Visser, F., Stappers, P., van der Lugt, R., & Sanders, E. B.-N. (2005). Contextmapping: Experience from Practice. *International Journal of Cocreation in Design and the Arts*, 119-149.

Stappers, P., & Sanders, E. B.-N. (2008, March). Co-creation and the new landscapes of design.

(2019). *Ungar & medier 2019.* Stockholm: Statens Medieråd. Retrieved May 6, 2020, from https://statensmedierad.se/download/18.126747f416d00e1ba946903a/1568041620554/Ungar%20och%20medier%202019%20tillganglighetsanpassad.pdf

United Nations. (1989, November 20). *Convention of the Rights of the Child*. Retrieved from United Nations Humans Rights: https://www.ohchr.org/en/professionalinterest/pages/crc.aspx

Wallgren, P. (2016). Analysis of Data. *Analysis of Data*. Gothenburg: Chalmers University of Technology .

Wallgren, P. (2016). Question-Based Data Collection Methods. *Question-Based Data Collection Methods*. Gothenburg, Sweden: Chalmers University of Technology.

van Boeijen, A., Daalhuizen, J., Zijlstra, J., & van der Schoor, R. (2013). *Delft Design Guide.* Amsterdam: BIS Publisher.

Wikberg Nilsson, Å., Ericson, Å., & Törlind, P. (2015). *Design : Process och metod.* Lund: Studentlitteratur AB.

Volvo Cars, C. (n.d.). *Volvo 360c - A new way to travel*. Retrieved May 6, 2020, from Volvo Cars: https://www.volvocars.com/intl/cars/concepts/360c

Young, I. (2016, Mars 15). *Medium*. Retrieved from Describing Personas: https://medium.com/inclusive-software/describing-personas-af992e3fc527

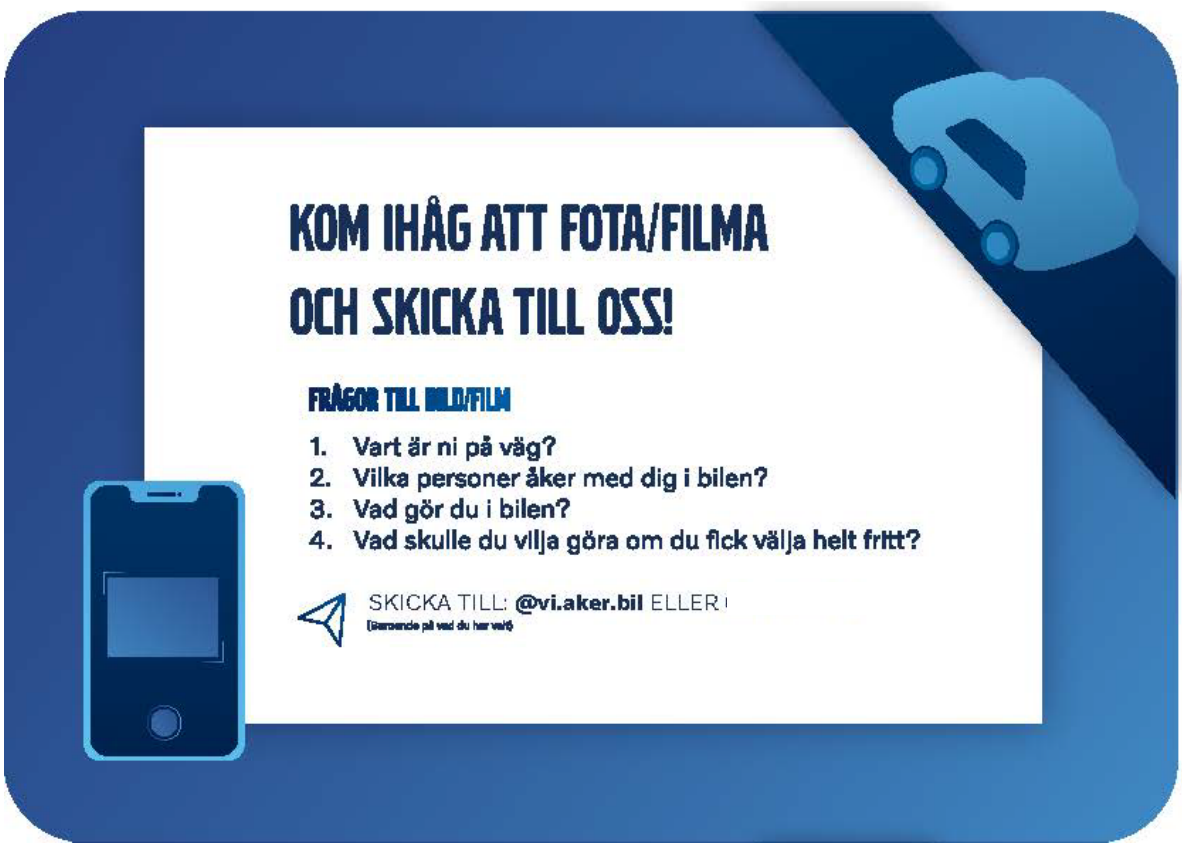
Table of Figures

APPENDICES

A. APPENDIX - INSTAGRAM DIARIES PACKAGE CONTENT

This Appendix contains what was included in the *Instagram Diaries* packages that were sent to each family.

The sign to hang in the car



The instruction / information letter

HEJ!

Här är vi: Maia till vänster och Mio till höger

Tack så jättemycket för att ni vill vara med i vår studie. Det kommer vara till stor hjälp för oss i vårt examensarbete och ge oss bättre förståelse för hur barn och ungdomar åker bil, för det har ju ni mycket bättre koll på än vad vi har. Vi gör vårt examensarbete för Volvo Cars, som jobbar för att ta fram framtidens bilar. Genom att vi i detta arbete kan förstå vad ni behöver och vill ha när ni åker bil, kan framtidens bilar göras ännu bättre!

I det här kuvertet får ni ett start-kit för att ni ska kunna komma igång. Studien består av två delar, en där ni själva ska ta bilder och skicka till oss när ni åker bil, och efter det kommer vi komma hem till er för att prata lite om hur det har gått och för att ni ska kunna visa er bil och hur ni brukar sitta i den m.m. Den första delen kommer ni göra under den kommande veckan med start på onsdag (eller torsdag, beroende på när ni får det här kittet).

SÅ HÄR SKA NI GÖRA

Här kommer en närmare beskrivning på hur vi tänker att ni ska göra det här.

Tanken är alltså att varje barn ska ta en bild eller spela in en film varje gång ni åker bil. Till det här kortet ska ni svara på fyra frågor om just den bilresan:

1. **Vart är ni på väg?**
2. **Vilka åker personer åker med dig i bilen?**
3. **Vad gör du i bilen?**
4. **Vad skulle du vilja göra om du fick välja helt fritt?**

Dessa bilder tillsammans med svaren på frågorna ska ni helst skicka direkt till oss när ni sitter i bilen och det kan ni göra på följande sätt:

- Om ni har Instagram och föräldrarna godkänner att ni använder det, så skulle vi vilja att ni följer kontot **@vi_aker_bil** och skickar bilderna till det kontot i DM. Det är vi som har skapat det privata kontot för just den här studien. Där kommer vi även göra lite uppdateringar om vad vi håller på med och det kommer även finnas inlägg med de här instruktionerna där. Vi kommer radera kontot i slutet på det här året när studien är avslutad.
    - P.S. kom ihåg att välj alternativet “behåll i chatten” / “permanent” !
- Om ni inte har Instagram kan ni skicka bilderna på SMS till någon av oss eller så kan vi hitta en annan lösning som passar er!

Vänd sida!

Detta kommer ni alltså göra under en vecka och det alternativ som varje person väljer att skicka bilderna till oss, är det som kommer gälla hela veckan för varje person. I det här kuvertet har vi också lagt i ett schema som ni skulle kunna hänga upp på kylen hemma (eller var ni nu vill ha det) där ni kan checka av efter varje dag.

Ni har också fått två stycken skyltar (det blåa pappren med snöre) som ni kan hänga upp på bak på nackstöden på framsätena, eller från handskfacket för att bli påminda om att ta kort när ni åker bil. Ni får jättegärna skicka en bild till oss när ni har hängt upp skylten eftersom det är roligt för oss att ha.

Första dagen är lite annorlunda. Eftersom vi båda inte har träffat er, så hade vi tyckt det varit kul om ni skulle vilja göra en presentationsfilm av familjen. Det behöver varken vara långt eller avancerat, bara så vi får en introduktion till vilka ni är! Dessutom hade vi tyckt det varit kul att ni i den filmen, eller i en separat, hade spelat in en film på er bil. Men just den biten är inget måste.

Om ni har några funderingar eller känner er osäkra på hur ni ska göra får ni jättegärna skriva eller ringa oss när som helst!

Sen har vi en present till er föräldrar vilket är ett kontrakt som ni behöver läsa igenom och skriva på för att tillåta att vi gör den här studien. Om det är något som ni funderar på med kontraktet är det självklart bara att höra av er så kan vi lösa det tillsammans.

Och självklart är godisbilarna till hela familjen!

Vi är verkligen så glada att just ni hjälper oss och vi ser fram emot att få träffa er snart!

Här är våra kontaktuppgifter också ifall ni skulle vilja kontakta oss (det kan vara om vad som helst):

Mio

Maia

Lycka till och ha det så kul!

Varma hälsningar,

The weekly schedule and checklist

VECKOSCHEMA ÅKA-BIL-STUDIE

Här kan ni tillsammans kryssa i om ni har åkt bil idag och om ni har skickat det till oss. Fyll även i hur många bilturer varder familjemedlem har gjort under dagen. När allt är gjort kan ni kryssa i "dagens ruta".

Familjen _____

DAG 1

- ☐ Skriv under kontrakt, scanna och skicka till Maia och Mio (förälder)
- ☐ Spela in introduktionsfilm av familjen och skicka
- ☐ Spela in introduktionsfilm av bilen
- ☐ Vi har loggat och skickat våra bilturer idag med bild/film och text
- ☐ Om ni inte åkt någon bil idag kan ni kryssa i den här rutan istället

Skriv namn och antal resor

Bilturer per barn? _____

DAG 2

- ☐ Vi har loggat och skickat våra bilturer idag med bild/film och text
- ☐ Om ni inte åkt någon bil idag kan ni kryssa i den här rutan istället

Bilturer per barn? _____

DAG 3

- ☐ Vi har loggat och skickat våra bilturer idag med bild/film och text
- ☐ Om ni inte åkt någon bil idag kan ni kryssa i den här rutan istället

Bilturer per barn? _____

DAG 4

- ☐ Vi har loggat och skickat våra bilturer idag med bild/film och text
- ☐ Om ni inte åkt någon bil idag kan ni kryssa i den här rutan istället

Bilturer per barn? _____

DAG 5

- ☐ Vi har loggat och skickat våra bilturer idag med bild/film och text
- ☐ Om ni inte åkt någon bil idag kan ni kryssa i den här rutan istället

Bilturer per barn? _____

DAG 6

- ☐ Vi har loggat och skickat våra bilturer idag med bild/film och text
- ☐ Om ni inte åkt någon bil idag kan ni kryssa i den här rutan istället

Bilturer per barn? _____

DAG 7

- ☐ Vi har loggat och skickat våra bilturer idag med bild/film och text
- ☐ Om ni inte åkt någon bil idag kan ni kryssa i den här rutan istället

Bilturer per barn? _____

Wow, grymt jobbat! Tack så jättemycket för att ni velat ställa upp på detta. /Maia & Mio

B. APPENDIX – SCHEDULE OF FAMILY HOME SESSIONS

Aktivitet	Beskrivning	Starttid	Längd	Ansvarig
Introduktion	• Duka fram fika. • **Ta kontrakt!** • Spela in med en liten kamera. • Presentera vad vi ska göra • Bordet runt: Säg namn, berätta om sina intressen och berätta om ett bilminne		10 min	Maia
Kollage-diskussion	• En dag i taget, berätta om varje dag. • Ställa frågor till varje resa. • Har de missat någon resa?		20 min	Mio
Post-it (andra resor)	• Fråga om andra resor som de brukar göra. • Vardag, helg, lov…		10 min	
Gå till bilen	Gå ut (och in).		5-10 min	
Intervju i bilen	Se frågor nedan. Utföra intervju i bilen, delvis för att få kontext och delvis för att ha en intervju utan föräldrarna närvarande.		15 min	Maia
(Om vi har tid)	Ranka och beskriva aktiviteter med hjälp av utskrivna foton. ELLER framtidsgrejen.		(10 min)	
Avslutning och utvärdering	• Avrunda sessionen och dela ut utvärderingar (separat till föräldrar och barn). • Avsluta med att dela ut **biobiljetter.**		15 min	

C. APPENDIX – YOUTH PARTICIPANTS STUDY SURVEY TEMPLATES

HJÄLP OSS BLI LITE BÄTTRE

Tack för att du var med i vår studie! Här får du svara några frågor om hur du tyckte det var. Det är anonymt, vi kommer alltså inte se att det är just du som har svarat.

Hur gammal är du: _____

Kryssa i det du använde för att skicka bilder

☐ Instagram ☐ SMS

Del 1 – Att skicka bilder/filmer när du åkte bil

1. Vad tyckte du om mängden tid du behövde lägga på studien?

Tog inte mycket tid ○—○—○—○—○ **Tog för mycket tid**

2. Hur tydligt var det hur du skulle göra?

Svårt att förstå ○—○—○—○—○ **Lätt att förstå**

3. Hur tyckte du det var att vara med i studien?

Tråkigt ○—○—○—○—○ **Roligt**

4. Om du skickade bilder via Instagram, vad tyckte du om de inlägg och stories som lades upp där? Du kan kryssa i flera svar.

☐ Motiverande ☐ Onödiga
☐ Jobbiga ☐ Intressanta
☐ Roliga ☐ (Använde inte Instagram)
☐ Töntiga ☐ Annat: _____

5. Hur var det att använda Instagram (eller SMS) för att skicka till oss? Du kan kryssa i fler svar.

☐ Kul ☐ Svårt
☐ Tråkigt ☐ Jobbigt
☐ Enkelt ☐ Annat: _____

5. Vad tyckte du var bra med studien?

6. Vad tyckte du var mindre bra eller dåligt med studien?

Del 2 – Intervju hemma

8. Hur tydligt var det hur du skulle göra?

Svårt att förstå ○ ○ ○ ○ ○ **Lätt att förstå**

9. Hur tyckte du det var att vara med i studien?

Tråkigt ○ ○ ○ ○ ○ **Roligt**

10. Hur tyckte du det kändes att de som leder undersökningen (Mio och Maia i det här fallet) kom hem till er? (Välj ett alternativ)

- ○ Jag gillade det
- ○ Jag hade hellre varit någon annanstans
- ○ Jag hade hellre gjort det över telefon/internet
- ○ Jag hade helst sluppit helt
- ○ Ingen åsikt
- ○ Eget svar: _____

5. Vad tyckte du var bra med studien?

5.Vad tyckte du var mindre bra eller dåligt med studien?

5. Något mer du vill tillägga?

TACK!

D. APPENDIX – PARENTS PARTICIPANTS STUDY SURVEY TEMPLATES

HJÄLP OSS BLI LITE BÄTTRE

Tack återigen för att er familj har deltagit i vår studie! Som avslutning skulle vi vilja ha lite input på hur det har varit för er att delta. Feedbacken är anonym.

1. Vad är ditt generella intryck av studien?

Jag gillade det inte ○—○—○—○—○ **Jag gillade det**

2. Upplevde du att det var tidskrävande för barnen att skicka bilder/filmer?

Tog inte mycket tid ○—○—○—○—○ **Tog för mycket tid**

3. Hur tydligt var det för barnen vad de skulle göra?

Svårt att förstå ○—○—○—○—○ **Lätt att förstå**

4. Hur tror du barnen tyckte det var att vara med i studien?

Tråkigt ○—○—○—○—○ **Roligt**

5. Var det som du förväntade dig?

Sämre än förväntat ○—○—○—○—○ **Bättre än förväntat**

6. Vad tyckte du om kompensationen?

Inte tillräckligt ○—○—○—○—○ **Mer än tillräckligt**

7. Hade du kunnat tänka dig göra något liknande igen?

- ☐ Ja
- ☐ Nej
- ☐ Kanske

8. Vad tyckte du var bra med studien?

9. Vad hade kunnat göras annorlunda?

10. Vad tyckte du välkomstpaketet?

11. Skulle något varit annorlunda eller var det något som saknades i paketet?

12. Vad tyckte du om användadet av Instagram/SMS för att logga bilresorna?

13. Tror du denna studie har gett en rättvis bild av hur dina barn beter sig i bilen?

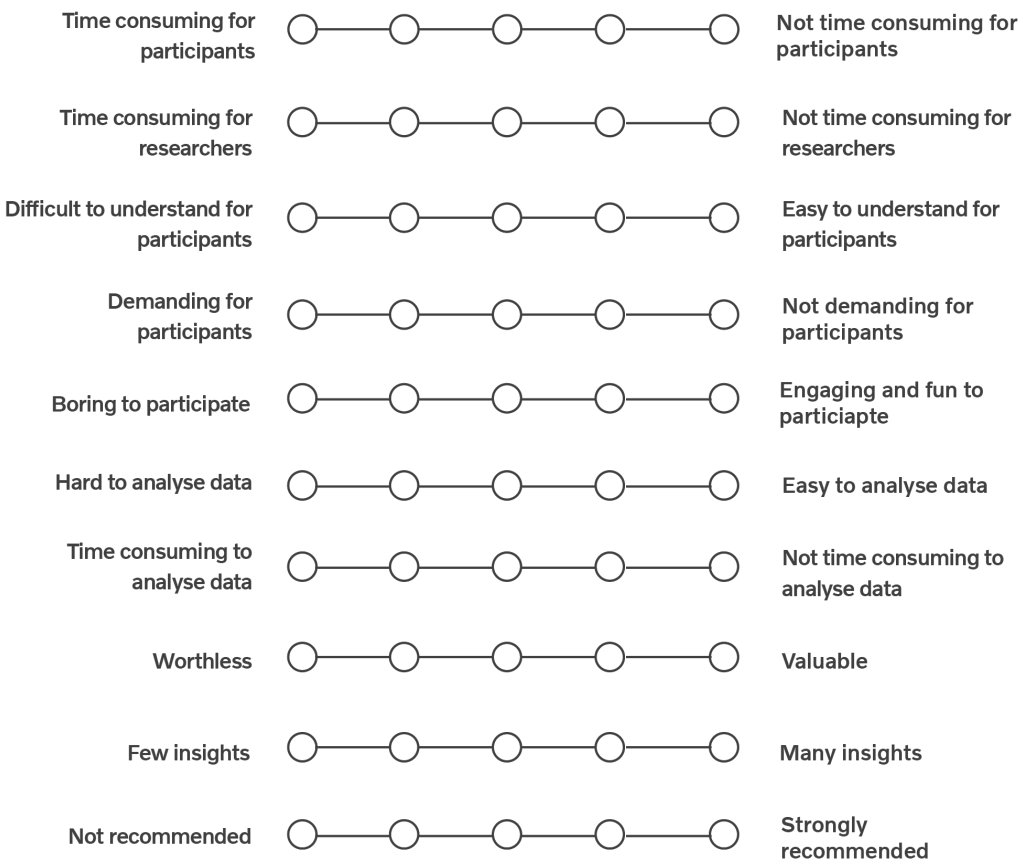
14. Något mer du vill tillägga? Har du några tips eller andra synpunkter du skulle vilja dela med dig av?

TACK!

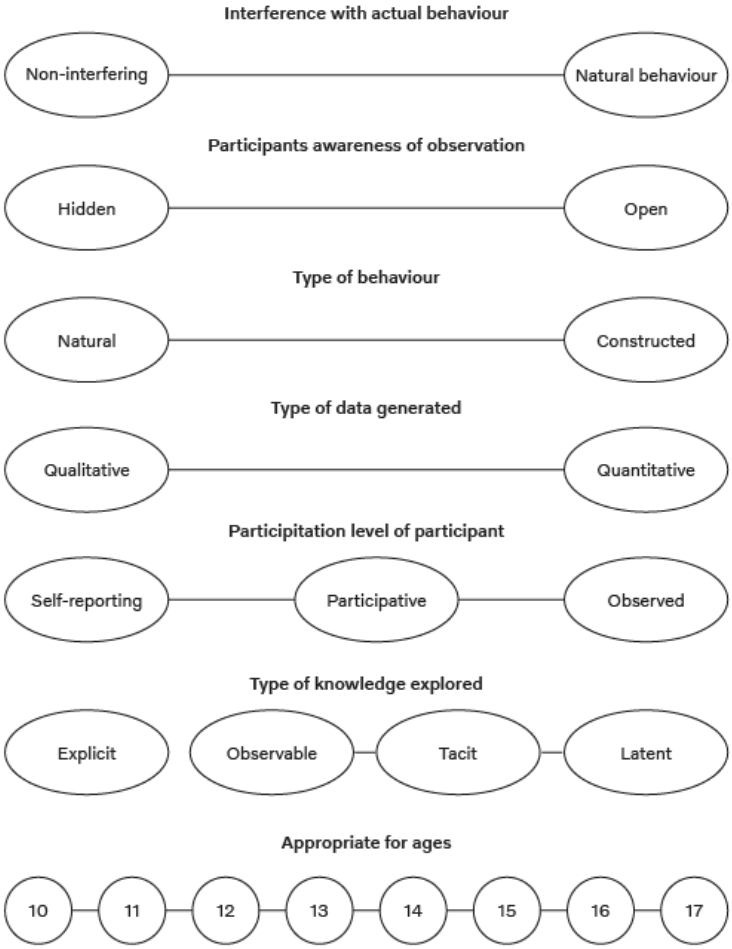
E. APPENDIX – METHODS ASSESSMENT TEMPLATE

Evaluating in relation to how the method works for finding the needs of the target group in a specific context.

Evaluative Scales



Descriptive Scales



Result

What type of data and information do you get out of the method?

For what type of studies does it fit?

When in a project process does it fit?

Suitability on the target group? More appropriate on certain ages?

What was unexpected with the method?

(Anything else we did not cover? In general: What was good and what was bad?)

Discussion

What would we have done differently?

Reliability and validity?

F. APPENDIX – DATA FROM INSTAGRAM

Activity	Age	Type of trip	No. of co-car riders	Co-car riders	Length of trip	No. of siblings
Chilling	12	To sport practise	1	One parent	Short	1
Music	12	Home from sport practise	1	One parent	Short	1
Music - radio	17	To music practise	1	One parent	Short	0
Music	12	Ski trip	2	Two parents, sibling	Long	1
Music - radio	17	To train station	1	One parent	Short	0
Music - radio	10	Home from sport practise	2	One parent, sibling	Short	1
Music - radio	10	To school	1	One parent	Short	1
Music - radio	10	To school	1	Two parents	Short	1
Music - radio	10	To family activity	3	Two parents, sibling	Short	1
Music - radio	10	Home from family activity	3	Two parents, sibling	Short	1
Music - radio	10	To family activity	3	One parent, sibling, friend	Short	1
Music - radio	15	Ski trip	2	Two parents	Long	0
Music	15	To family activity	2	One parent, sibling	Medium	2
Music - radio	15	Home from grocery store	1	One parent	Short	2
Music	15	Ski trip	4	Two parents, sibling, sibling	Long	2
Music - radio	12	Home	2	Parent, sibling	Short	1
Music	11	Ski trip	4	Two parents, two siblings	Long	2
Talking	15	To train station	1	One parent	Short	1
Talking	12	To family activity	4	Two parents, sibling, friend	Short	1
Talking	17	Home from music practise	1	One parent	Short	1
Talking	13	To sport practise	1	One parent	Short	1
Talking	13	Home from sport practise	1	One parent	Short	1

Talking	13	To sport practise	3	One parent, two friends	Short	1
Talking	13	Home from sport practise	3	One parent, two friends	Short	1
Talking	13	To sport practise	3	One parent, two friends	Short	1
Talking	13	Home from sport practise	4	One parent, three friends	Short	1
Talking	13	To sport game	1	One parent	Medium	1
Talking	13	To sport practise	1	One parent	Short	1
Talking	13	Home from sport practise	1	One parent	Short	1
Talking	13	To sport practise	3	One adult, two friends	Short	1
Talking	10	Home from sport practise	1	One parent	Short	2
Talking	10	To sport practise	1	One parent	Short	1
Talking	14	Home from sport practise	1	One parent	Short	1
Talking	10	Home from sport practise	1	One parent	Short	2
Talking	10	To sport practise	2	One parent, friend	Short	2
Talking	15	Home from family activity	2	One parent, sibling	Medium	2
Talking	15	Home from sport practise	1	One parent	Short	1
Talking	15	To grocery store	1	One parent	Short	2
Talking	10	To sport game	2	Two parents	Medium	2
Talking	15	To sport practise	1	One parent	Short	2
Talking	15	Home from sport practise	2	Two parents	Short	2
Talking	15	Ski trip	4	Two parents, sibling, sibling	Long	2
Talking	15	To ski slopes	4	Two parents, sibling, sibling	Short	1
Talking	15	Home from ski slopes	2	One parent	Short	2
Looking out	12	To friend	1	One parent	Short	2
Looking out	14	Home from sport practise	1	One parent	Short	1
Looking out	15	To ski slopes	4	Two parents, sibling, sibling	Short	1

Looking out	12	To family activity	3	Two parents, sibling	Short	1
Looking out	12	Home	2	Parent, sibling	Short	1
Looking out	11	To ski slopes	4	Two parents, two siblings	Short	2
Logging	15	To school	1	One parent	Short	1
Phone - information	17	To train	1	One parent	Short	0
Phone - memes	12	Home from family activity	4	Two parents, sibling, friend	Short	1
Phone - writing	10	To school	1	One parent	Short	1
Phone - youtube	13	To sport game	1	One parent	Medium	1
Phone - shopping	13	Home from sport game	1	One parent	Medium	1
Phone - snapchat	14	To sport practise	1	One parent	Short	2
Phone - snapchat	14	To sport practise	1	One parent	Short	2
Phone - information	10	To sport practise	1	One parent	Short	1
Phone - scrolling	10	Home from sport practise	3	One parent, two friends	Short	1
Phone - instagram	13	To family activity	2	One parent, sibling	Medium	2
Phone - scrolling	10	Home from sport game	2	Two parents	Medium	1
Phone - scrolling	10	To sport game	1	One parent	Medium	1
Phone - scrolling	10	To sport practise	1	One parent	Short	1
Phone - scrolling	10	Home from sport practise	1	One parent	Short	1
Phone - serie	12	To grocery store	3	Two parents, sibling	Short	2
Phone - scrolling	10	Home from sport practise	1	One parent	Short	1
Phone - playing games	15	Ski trip	4	Two parents, sibling, sibling	Long	2
Phone - TikTok	12	To music practise	1	One parent	Short	2
Phone - TikTok	12	Home from music practise	2	One parent, sibling	Short	2

Phone - playing games	11	Ski trip	4	Two parents, two siblings	Long	2
Studying	14	To sport practise	2	One parent, sibling	Short	2
Eating	10	To sport practise	1	One parent	Short	1
Eating	13	Home from family activity	2	One parent, sibling	Medium	2
Nothing - waiting	10	To sport practise	2	One parent, friend	Short	1
Nothing	13	To school	1	One parent	Short	2
Nothing	13	To ski slope	4	Two parents, sibling, sibling	Short	2
Nothing - waiting	10	Home from sport game	1	One parent	Short	1
Nothing - waiting	10	Home from sport practise	1	One parent	Short	1
Nothing	12	To family activity	2	One parent, sibling	Short	1

G. APPENDIX – NEEDS AND DESIRES

Where they sit

- The middle seat should also be comfortable, with enough space.
- There is no need for the fifth seat to be available at all times.
- Being able to be social with the people sitting in the front.
- For longer trips, there is a need to be able to set up the car for activities and to create a cosy setting.
- There is a desire that the seats in the back have the same prerequisites as the passenger front seat.

Devices

- Having (unlimited) access to internet, without using their own phone data.
- Having a charged device (all passengers).
- To be able to entertain themselves anytime.
- Being able to use their phone during a car trip.
- (Using the phone) to be entertained, to make time go by, and to socialise with friends.
- The way they like to be entertained is everchanging, a need is thus varied entertainment that is 'up-to-date'.
- Want to be able to play console or computer games in the car, in the same manner as they do at home.
- Would like to play (digital) games with friends.
- Would appreciate being able to watch/use a (multimedia) screen, that is larger than the screen of a phone.
- Being able to mount/place the device so it is able to stay upright without having to support it.
- Being able to watch what you want on your own premises.

Private vs. Social Space

- To be able to watch videos or movies together with other passengers.
- Appreciate feeling independent.
- Being able to do what they want on their own terms, not based on directions/initiatives from others.
- Being able to make conversation in the car.
- Would like to be able to play games (physical and digital) together with other passengers.
- Being able to socially interact with other passengers.
- Being able to have a private space inside the car.
- Possibility to choose when to be social with the other people in the car.
- Other passengers should not be disturbed by the activity of one passenger.

Music / Listening

- Being able to listen to music and radio together in the car.
- Want to listen to their own music out loud so that the other co-riders can hear it too.
- Playing music out loud should be fairly 'distributed' among the passengers.
- Not disturbing others with sound from devices.
- Being able to privately listen to your own music.

Comfort

- Being able to choose and change how you sit.
- Being able to lean against something for sleep and rest.
- Would like to have their legs up on the seat in different ways.
- Being able to lean devices for a more comfortable viewing angle.
- Would like to be able to put up their feet on something.
- Would like a pillow to stay in place without holding it themselves.
- Being able to tilt chair and to lay down completely.

- Being able to rest comfortably in the car.
- Being able to sleep comfortably in the car.
- Would like to have a bed-like solution in the car.
- The seats should be comfortable and soft.
- The middle seat should be as comfortable as the others.
- Would like to be able to move more when riding in the car.
- Being able to change your sitting posture.
- Having enough leg space to stretch legs and allow comfortable sitting posture.
- Experiencing that the car is spacious.
- Having enough personal space in the car.
- Having seat heating, without compromising air condition on all seats.
- Being able to control your own seat settings.
- Being and feeling safe while being comfortable. The parents should rely on the car and the safety of protecting their children.

Belongings / Set-up

- Being able to store things easily.
- Having your things easily accessible in the car (especially on longer trips).
- Being able to place different drinks vertically without risking spilling it in the car.
- Being able to collect trash in the car.
- Storing your belongings without them moving around while driving.
- Being able to create a cosy set-up in the car, especially on long trips.
- Being able to use a flat surface to put things down.
- Having a surface for both private and for shared use with the other passengers.
- Being able to eat properly in the car without making a mess.

Windows

- Being able to look out, at all times.
- Being able to use different screen devices without being affected by the light from windows (reflections).
- Have as much windows (sight and daylight) as possible but being able to control when and when not.

Endless entertainment

- Being entertained in the car.
- Having different options of activities to choose from.
- Would like to be able to do the same things in the car as they do at home.
- Experience feeling unlimited, despite sitting in the car.
- Being able to perform activities even though sitting still.
- Being able to draw and other more advanced activities that demands more equipment and place.
- Being able to do activities without feeling sick in the car.

Effortless

- A possible solution should not be complex or take time to set-up. It should just be there, available if wanted/needed.

H. APPENDIX - CALCULATION IMPACT MAP

Behaviours	Weight	Needs to have the opportunity to be entertained at all times.	Needs to be able to choose from different alternatives of entertainment.	Wants their things easily accessible in the car without them moving around.	Does not want to be disturbed by nor disturb other passengers.	Needs private space.
1. Fun Seeker	5	1	1	1	0	0.5
2. Solo Rider	4	0.5	1	1	1	1
3. Socialiser	4	0	0	0	0	0
4. Time Killer	4	1	1	0.5	0.5	0.5
5. Set-Upper	3	0	0.5	1	0.5	1
6. Pilot	2	0.5	0	0	0	0
7. Harmony Seeker	1	0	0	0.5	1	1
		12	**14.5**	**14.5**	**8.5**	**12.5**

Needs to be able to make conversation with all the people in the car.	Wants to be able to perform activities together with others.	Wants to feel as a part of a social context in the car.	Wants to pass time and fight boredom.	Wants to be able to do the same things as they do in their home.	Being able to create your own setting in the car.	Wants to sleep in the car.	Wants to be able to eat properly in the car without making a mess.
0.5	1	0.5	1	1	0	0	0
0	0	0	1	1	1	0	0
1	1	1	1	0	0	0	0.5
1	1	0	1	1	0	1	1
0	0.5	0	0	0	1	0	1
0.5	0	0.5	0	0	0.5	0	0
0	0	0	0	0	0.5	0.5	0
11.5	**14.5**	**7.5**	**17**	**13**	**8.5**	**4.5**	**9**

Wants to be able to move and stretch their legs.	Want to be able to lean/mount a (brought) device in order to create a good view angle.	Wants control over different settings and adjustments of the passenger environment inside the car.	Needs control of the speakers in the car.	Wants a clear overlook both inside and out of the car.	Wants to be able to adjust the amount of daylight that is let in.
0	1	0	0.5	0	0
0	1	0.5	0	0	0.5
0	0.5	0	0.5	0.5	0
1	0.5	0	0	0	0
0.5	1	0.5	0	0.5	1
0	0.5	1	1	1	1
0.5	0	0.5	0	0.5	1
6	**17**	**6**	**6.5**	**6**	**8**

I. APPENDIX - REQUIREMENT SPECIFICATION

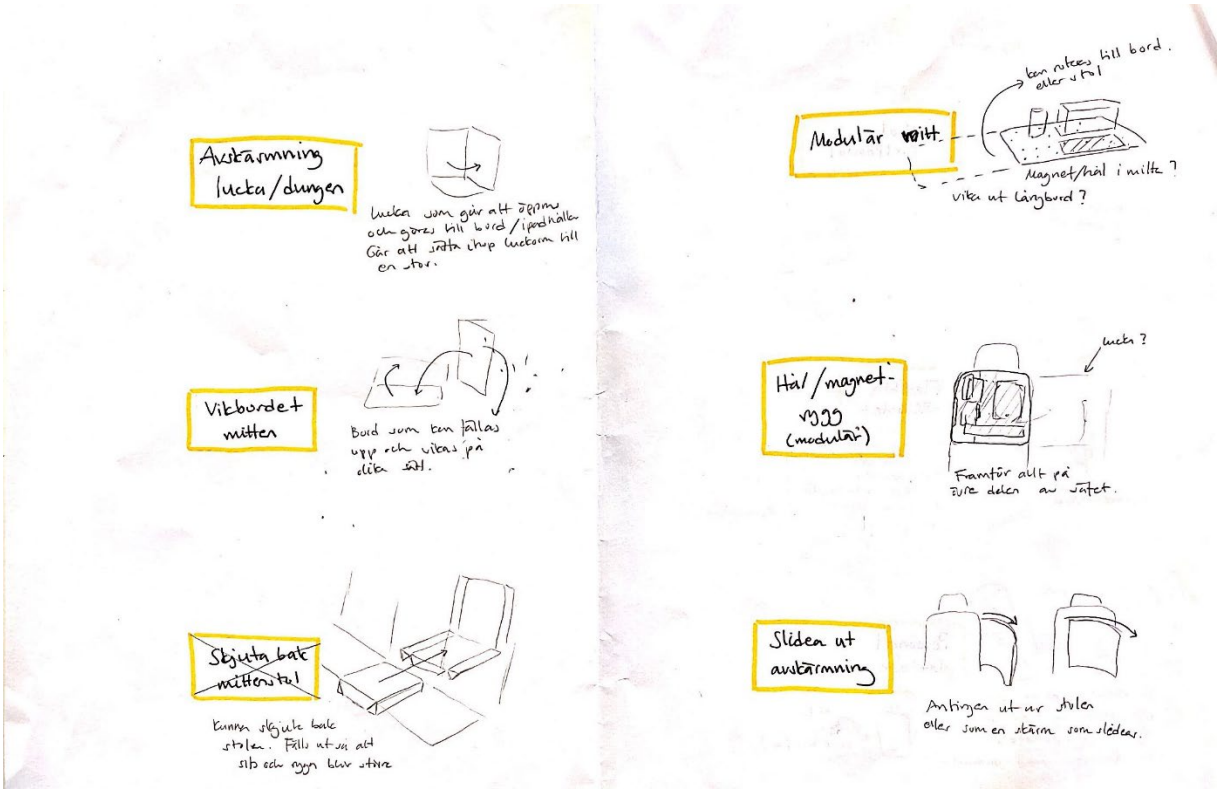
NO.	REQUIREMENTS & DESIRES	R/D	JUSTIFICATIONS	WEIGHTING (1-5)
1. Safety				
1.1	The solution should support a natural sitting posture*	R	Safety factor	
1.2	The solution should not affect the positioning of the belt negatively	R	Safety factor	
1.3	The solution should not directly distract the driver	R	Safety factor	
1.4	The solution should encourage a behaviour that is suitable** for the driving context	R	Safety factor	
1.5	The solution should be surely fastened, and not move around inside the car	R	Safety factor	
1.6	The solution should not be in the way of any airbags or other safety systems	R	Safety factor	
1.7	If other products are used together with the solution, the solution should nudge a usage of those, not being in the way of any airbags or other safety systems	D	Safety factor	2
1.8	The solution should raise trust in parents/guardians regarding safety aspects	D	User studies	4
1.9	The should not have any sharp edges, radius above 2 mm	R		
1.10	The solution should not increase the risk of injury during a crash	R	Safety factor	
1.11	The solution should lower the risk of injury during a crash	D	Safety factor	5
1.12	The solution should not hinder the sight of the driver	R	Safety factor	
1.13	The solution should be experienced as safe for all car riders	D	User studies	5
1.14	Using the solution should be experienced as safe	D	User studies	5
2. Comfort				
2.1	The solution should support sitting comfortably	R	User studies	
2.2	The solution should allow varying the sitting posture while maintaining a safe belt position	R	Safety factor	
2.3	The solution should be experienced as comfortable	D	Ergonomics	3
2.4	The solution should be ergonomically suitable for youths' between the ages 10-17	R	Ergonomics	
2.5	The solution should be ergonomically suitable for all above 10 years	D	Ergonomics	2
2.6	All seats should be equally comfortable	D	User studies	2
3. Satisfaction				
3.1	The user should feel that there are no unnecessary or irrelevant interactions	D	Usability	4

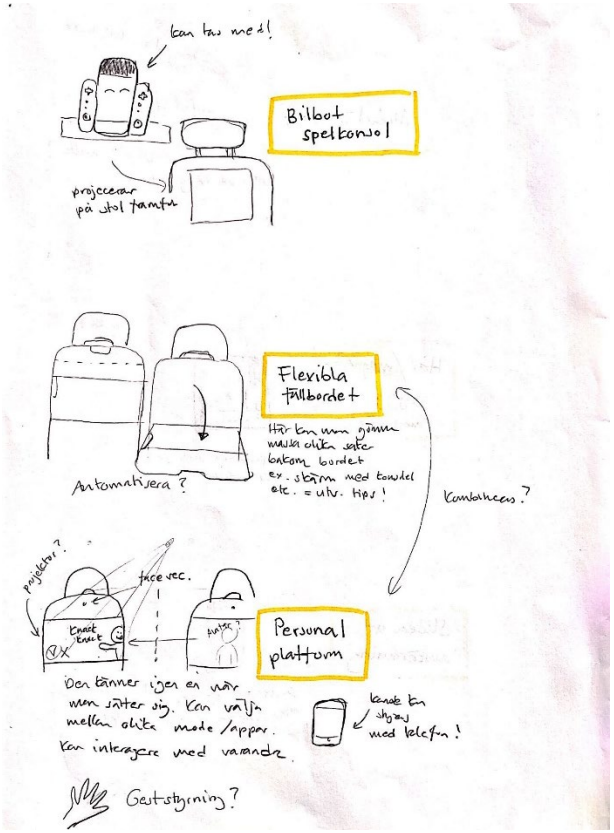
3.2	The user should feel that completing a task is efficient	D	Usability	4
3.3	The user should be able to predict the result of their key actions	D	Usability	5
3.4	The user should feel haptically satisfied when interacting with the solution	D	User Experience	3
3.5	The user should feel visually satisfied when interacting with the solution	D	User Experience	3
4. Space				
4.1	The solution should enable having a social space	D	User studies	5
4.2	The solution should enable having a personal space	D	User studies	5
4.3	The solution should not limit the experienced spaciousness	D	User studies	4
5. Usage				
5.1	The first time using the solution, it should be possible to understand how to use it within 20 seconds	R	Usability	
5.2	The solution should take less than 20 seconds to set-up	R	User studies	
5.3	Using the solution should be experienced as effortless	D	User studies	5
5.4	The solution should enable the users to fulfill their goals effectively	D	User Experience	5
5.5	The solution should be usable both during short and long trips	D	User studies	4
6. Material				
6.1	The material should be possible to clean	R	User studies	
6.2	The material should induce the feeling of quality	R	User Experience	
6.3	The material should not attract dirt	D	User studies	2
7. Freedom				
7.1	The solution should not limit the experienced freedom inside the car	D	User studies	3
7.2	The solution should be experienced as controllable	D	User studies	4
7.3	All car riders should be able to look outside	R	User studies	
7.4	The solution should be experienced as eligible	D	User studies	5
7.5	The solution should be flexible/adjustable	D	User studies	3
8. Fairness				
8.1	The solution should be experienced as fair	D	User studies	3
8.2	The solution should make it possible to listen to music, both privately and together	D	User studies	3
9. Storage				
9.1	The solution should enable having brought belongings easily accessible in the car, without them moving around	D	User studies	4
10. Social				

10.1	It should be possible to make conversation with all the people in the car	R	User studies	
10.2	It should be possible to perform activities together with others, inside the car	D	User studies	4
11. Miscellaneous				
11.1	The solution should enable using a tablet or similar in a safe way	D	User studies	5
11.2	The solution should enable using a smartphone in a safe way	D	User studies	5
11.3	The solution should be experienced as meaningful	D	User studies	4
11.4	The solution should be experienced as robust	D	User studies	5

DESIRES / CONCEPT	WEIGHT	CAR CORNER	FOLDABLE TABLE	BACKSEAT HUB	FOLDABLE TABLE	BACKSEAT HUB	CAR CORNER	BACKSEAT HUB	CAR CORNER	FOLDABLE TABLE
If other products are used together with the solution, the solution should nudge a usage of those, not being in the way of any airbags or other safety systems	2		0	0		0	0		0	0
The solution should raise trust in parents/guardians regarding saftey aspects	4		0	1		1	0		-1	1
The solution should lower the risk of injury during a crash	5		-1	1		1	1		-1	-1
The solution should be experienced as safe for all car riders	5		0	0		0	0		0	0
Using the solution should be experienced as safe	5		0	0		0	0		0	0
The solution should be experienced as comfortable	3		1	1		0	-1		-1	0
The solution should be ergonomically suitable for all above 10 years	2		-1	0		1	0		-1	-1
Should not affect the person sitting in the third seat negatively	2		-1	-1		1	1		0	-1
The user should feel that there are no unnecessary or irrelevant interactions	4		0	0		0	0		0	0
The user should feel that completing a task is efficient	4		0	0		0	0		0	0
The user should be able to predict the result of their key actions	5		0	0		0	0		0	0
The user should feel haptically satisfied when interacting with the solution	3		0	-1		-1	0		1	1
The user should feel visually satisfied when interacting with the solution	3		0	0		0	0		0	0
The solution should enable having a social space	5		0	0		0	0		0	0
The solution should enable having a personal space	5		-1	-1		1	1		0	0
The solution should not limit the experienced spaciousness	4		-1	1		1	1		-1	-1
Using the solution should be experienced as effortless	5		0	1		1	0		-1	-1
The solution should enable the users to fulfill their goals effectively	5		0	0		0	0		0	0
The solution should be usable both during short and long trips	4		1	1		1	-1		-1	-1
The material should not attract dirt	2		0	1		1	0		-1	-1
The solution should not limit the experienced freedom inside the car	3		0	0		0	0		0	0
The solution should be experienced as controllable	4		0	0		0	0		0	0
The solution should be experienced as eligible	5	Reference	0	0	Reference	0	0	Reference	0	0
The solution should be flexible/adjustable	3		0	1		1	0		0	0
The solution should be experienced as fair	3		0	0		0	0		0	0
The solution should make it possible to listen to music, both privately and together	3		0	0		0	0		0	0
The solution should enable having brought belongings easy accessible in the car, without them moving around	4		-1	-1		-1	1		1	1
It should be possible to perform activities together with others, inside the car	4		1	1		1	0		-1	-1
The solution should enable using a tablet or similar in a safe way	5		0	1		1	0		-1	-1
The solution should enable using a smartphone in a safe way	5		1	1		1	-1		-1	0
The solution should be experienced as meaningful	4		-1	1		1	1		-1	-1
The solution should be experienced as robust	5		0	-1		-1	0		1	1
Other factors										
Fun (user perspective)	5		-1	1		1	1		-1	-1
Innovative	5		-1	-1		0	1		1	0
Implementable	3		-1	-1		-1	1		1	1
Cool (user perspective)	2		0	1		1	1		-1	-1
Frequence of use / usefulness - short trips	3		0	1		1	0		-1	-1
Frequence of use / usefulness - long trips	5		0	1		1	0		-1	-1
Cost	1		0	-1		-1	0		1	1
Effortless	4		0	0		0	0		0	0
Longterm UX	4		0	0		0	0		0	0
Amount of activities it supports	2		1	1					-1	-1
Total +			5	17		18	10		6	6
Total 0			27	17		18	28		19	21
Total -			10	8		5	3		17	15
Net		**0**	**-21**	**37**	**0**	**53**	**27**	**0**	**-43**	**-34**
Rank		2	3	1	3	1	2	1	3	2
Total		**-16**			**-55**			**90**		
Total Rank		2			3			1		

K. APPENDIX – SKETCHES OF NINE CONCEPTS





L. APPENDIX – EXPERT EVALUATION

Technical Implementation

- Starting up the system and app should be effortless and seamless. That can be achieved without creating accounts as viewed in the presentation of the concept.
    - Example: Sonos system that only uses Wi-Fi.
    - Use BLE (Bluetooth Low Energy) which could be used for letting the system know which phone that should be connected to which screen.
- Including cameras in the concept creates different possibilities. But must be aware of legal restriction regarding picture motion in the front seat.
- Possible with face recognition to identify the user to the system, but it increases complexity and price.
- Might be unnecessary to send request for interaction with other passengers (games etc.) through the system, when it can be done "physically".
- Complex to solve a blend of native apps, the connection between screens, and the cars' functionality. But it should be possible.
    - Have to solve APIs (Application Programming Interfaces) to the car to blend it.
- Get inspiration from existing systems and use common ways of solutions to ensure users are familiar with it. E.g. could be like taking Apple CarPlay to next level.
- Might be possible to create the solution with a "dumb" screen, and that the functionality and software is based in the phone. The issue to be investigated is whether Wi-Fi-connection can provide enough bandwidth for heavier applications, such movie streaming.
    - Technically achievable, just a question about how the architecture is designed.
- Recommends to not go too deep with a technical solution on this level of the concept development, but instead explain what is wanted to achieve.
- Cost will decide what implementation should be used. Decide who the buyer is, and adjust the solution based on that.
- It is possible to control the car climate. Solved in Volvo S90 Excellence Ambience.
- If wanting to lower the cost for the physical parts of the concept, it should not be adjustable.
- Digital technical challenge is to provide the APIs for this type of solution.
- Create a unique selling point, in comparison to other game platforms. E.g. Volvo games.
- Open up for the possibility to involve third party of developers.
- Recommends screen instead of projection. Because of the problem with light, which increases cost and complexity.
- Possible with the wireless charging surface, just make it big enough.
- Possible to adjust the screen based on eye tracking, but it requires a motorised mount.
- Headphones should connect to phone and not to the screen.
- Clear target group to decide cost and complexity.
- Involve experts from architecture.
- Include cameras, e.g. for gamification.

Positive aspects

- Being able to play games together and share your screen with other passengers.
- That you can view how far it is until the goal of the trip.
- The screens are mounted i.e. not loose objects in the car.
- Open up for playing games together with the family.
- Positive effect on the sitting posture.
- Controlling the car climate could create individual solutions.

Ergonomics

- Small children have a small shoulder width, and they are therefore relatively "far away" from the door, which could result in them leaning towards the door. In that case, the armrest would not have its intended function and it would be worse in a safety point of view. You want them sitting as symmetrical as possible.
- The armrest on the door and in the middle have different height based on the distance to the person.
- Would be good if the screen could be rotated downwards from its upright position.
- Important to think about reflections from the sun, from all different angles. This can result in incorrect, resulting in negative sitting postures.
    - The light from the side window is probably the worst problem.
- The seats in the front are not entirely centred in front the side backseat positions, should bare this in mind when deciding the placement of the screens on the back of the front chairs.
- Think about the third seat in the middle, it is good if it can still be used.
- Depending on the position of the seat in front, the distance can vary. This can result in the screen being close or further way, which can affect the interaction with the screen in its upright position both positively and negatively.
- The door should have an even and flat surface, to not increase risk of injury during side collisions.
- If the armrest is too far away, and they lean towards it – there is a risk of the belt being uncomfortable against the neck. This can create misuse of the belt, since they want to find a comfortable position. General rule for the best belt comfort is to have as upright position as possible.
- Might be possible to only have support for the upper wrist when interacting with the phone on the armrest, which might not lead to the same level of leaning towards the door. But this must be tested, in order to find out how the target group behaves.
- Even better to have eye tracking to adjust the height but makes the solution more complex.
- Adjustability can be negative since the target group does not always know what positions are better in terms of ergonomics and safety.
- Not necessary that this concept has specific measures in this stage of the design process.

Positive aspects:

- Incentive to place the phone in the safe place because of the offered charging there.
- That it is flexible and adjustable, since their body size varies a lot.
- Good to use the support on the armrest to steady the hand for interaction with the phone.
- Great and important that the height of the screen is adjustable, to suit each persons' sight height.
- Good that the screen can be closer, so you can reach it.
- Good that the phone is on the side, so someone can sit in the middle seat and it also creates a higher level of privacy.
- Because that the car is a moving object which can create bumping, it is good that the game control has large interactions areas.
- Good that it is possible to change your sitting posture, to enable small movements.
- That the supported posture is upright. Looking in the direction car is good for car sickness. Might be good to be able see the road from the screen.
- Important aspect of this concept is the ability to either do things alone and sometimes together with the others in the car.

Safety

- Important that the door is even and flat, since that has been developed thoroughly to be safe during side collisions.

- Children have a narrow shoulder width, which can result in that they have to lean to reach the armrest. Might want the armrest to be adjustable towards the passenger. But that would require the armrest to fold towards the door to not become an object sticking and creating a risk for injury. Could be possible to solve.
    - A study showed that woman with a small body frame, tend to not use the support surfaces in the front seat today.
    - Unwanted symmetry with the belt towards the neck if they lean towards the armrest.
    - The surfaces must be collision friendly and e.g. collapse.
- It is important that the armrest is stable, but still unstable enough to collapse during a collision. E.g. having a mechanism which makes it "limp". It is possible to solve, but complex.
- In earlier studies, she cannot recall that any (younger) children used the armrest.
- During a frontal collision, the head moves towards the knees when using a seat belt. This would mean a risk with the screen solution, that the head would hit the screen when it is used in its extended position. To solve that, the screen should either be further away, be soft or completely collapse during a collision.
- There are requirements for surfaces regarding collisions with e.g. heads. The screen in this concept therefore must be tested based on this.
- It is better than a loose object in the car, but when offering a built-in solution, it is important to ensure the safety of it.
- Suggests that the touch should be disabled when in the upright position, to prevent the user from leaning forward to use the screen.
- Might be good with a specific spot for earphones and their cases as well.
- Regarding privacy, not wanting to show each other what they are looking at.
- That the armrest is adjustable, makes it complex to make it safe. Might want to find a more universal position of the armrest, difficult to have a wide range in height.

Positive aspects

- In general, a great concept.
- That the armrest is placed on the door, because of the belt position and the privacy aspect.
- That the screen is mounted and thus secure, and not possible to loosen. Also, that it is not possible to rotate it around its z-axis.
- The phone as a loose object (when it is used as a game control) is better than a big tablet.
- Good that it is possible to share e.g. YouTube videos with each other, to prevent them from leaning towards the other.
- Good with a specific spot for the phone to encourage putting it away in a safe place.
- Enable communication without leaning towards each other.
- The needs are fulfilled, and it has potential to have a safe construction.
- Appreciated the remote control, functioning like a computer mouse.

User Experience

- Sceptical to the use case of the remote control, since the target group are used to touch screens.
- Recommends rethinking the use cases for the upright position of the screen.
- Notifications, that they can pop-up e.g. when watching a movie. How should they cope with that?
- Comfort wins over reason, especially when it comes to children. Children would not choose a safe option just because it is safe. User Experience overrides safety, in the way that you would not naturally choose safety because it is safe.
- Important to prioritize parts of the concept. What will make the most impact.
- Important that the use cases are tested with users.

- Important that it is effortless and fast to achieve intended goals, especially for kids.
- Difficult with precision when interacting with the remote control.
- Missing the inclusion of the Solo Rider behavioural archetype, the privacy aspect.
- Might not want to show others their notifications, might be possible to include some sort of confirmation.
- A challenge to make the users put away their phone.
- Rethink the starting and connecting to the system, to make it effortless.

Positive aspects:

- That the screen can be adjustable to be close to the passenger. Also support the privacy need.
- To create nudges and incentives for putting away your phone, the charging and the "phone widget" in the interface supports that.
- Using the phone as a game control gives the phone and solution increased meaningfulness.
- Great behaviours.
- Good that the system enlarges the interface.
- Good that it is possible to charge and use the phone at the same time.
- Likes how the interface divides the phone in different levels, showing notifications, widgets and applications at the same time. Unique.

DEPARTMENT OF INDUSTRIAL AND MATERIALS SCIENCE
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY