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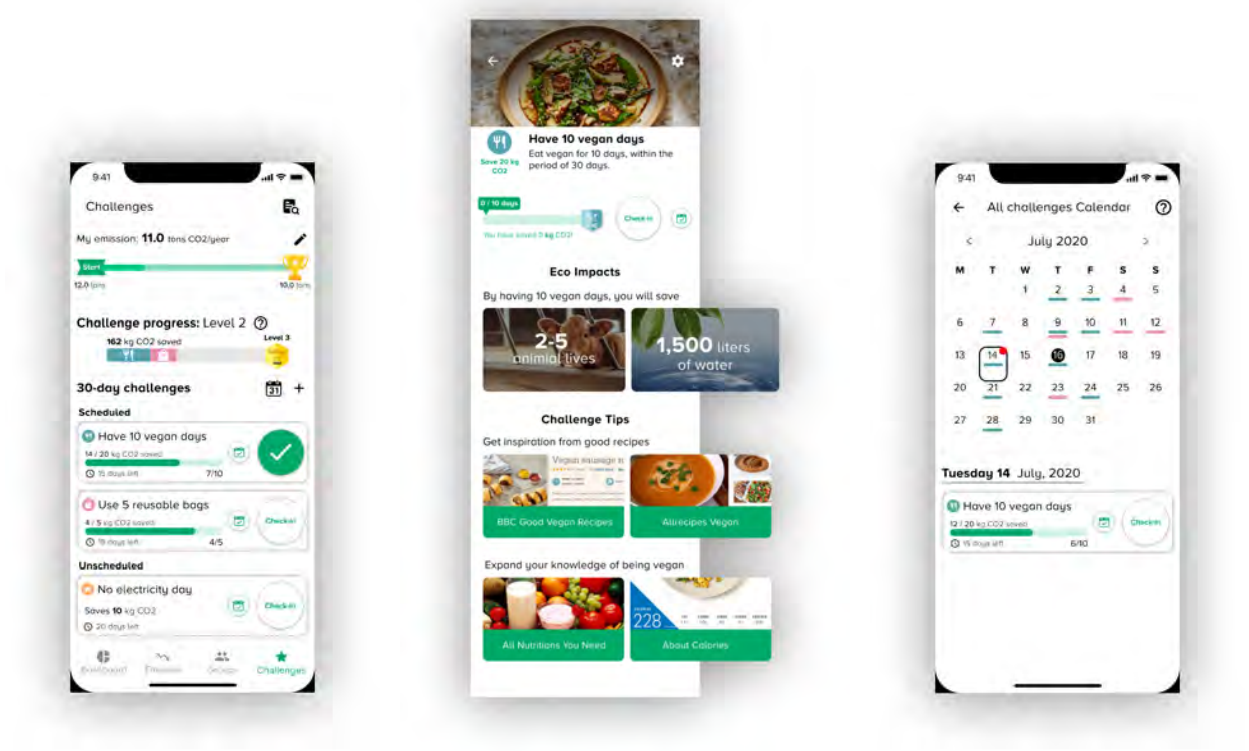

Supporting pro-environmental behavior change with a carbon calculator

The design of user challenges

Master's thesis in Interaction Design and Technologies

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MASTER'S THESIS 2020

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Master's Thesis 2020
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Cover: A selected set of screens in the prototype created, which shows the overview of challenges in a carbon calculator, the details of a challenge, and how challenges have been scheduled.

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Abstract

The purpose of this thesis was to research important factors to consider when designing user challenge in carbon calculators to support behavior change in the users towards a sustainable lifestyle. Therefore, a design in this context was created in order to research and extract important factors for designing the challenges.

In order to create the design and extract the design factors from it, an iterative design process was conducted. This involved researching theory in the field of study, researching users of carbon calculators, designing solutions, evaluating the solutions with users of carbon calculators, and finally, extracting design factors based on analyzing all findings throughout the process.

In the end, this resulted in a design created and important factors to consider when designing challenges in carbon calculators. The design can act as a visual design reference or inspiration for designing challenges in carbon calculators. But more importantly are the design factors, which could be used by others who conduct work in this context.

Keywords: Carbon calculator, pro-environmental behavior change, pro-environmental challenges, interaction design, persuasive technology, sustainability, Svalna

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Martin So & Mengwei Zhou, Gothenburg, June 2020

Abbreviations

GHG - Greenhouse gas

HCI - Human-computer interaction

SHCI - Sustainable human-computer interaction

Contents

1
Introduction

Global warming is causing a range of harmful effects to the earth such as extreme weather events, sea-level rise, crop failure, droughts, and mass extinction (Klein, 2015). Human activities have been seen as one major cause to accelerate global warming through the release of increased amounts of greenhouse gasses into the atmosphere (Michael et al., 2012). Hence the role of humans in helping to alleviate the environmental problems by reducing greenhouse gas (GHG) emissions is undeniable. Reducing GHG emission can also be seen as living a more sustainable lifestyle, where a part of United Nations' 17 sustainable development goals to reach by 2030, involves climate change and environmental degradation (United Nations, 2020). While United Nations also defines other aspects in their goals, such as inequality, peace, justice, and many more, the sustainable lifestyle in focus here will be about the environment-friendly lifestyle. Some concrete examples that the United Nations give involve; (1) avoid wasting food and water, (2) use energy-efficient appliances, (3) be responsible for your consumption and recycle what has been used, and (4) bike, walk or use public transportation to work.

Previous studies have shown various ways of how Human-Computer Interaction (HCI) can be involved in changing people's behavior to achieve smaller GHG emissions. Some of the attempts focus on promoting environmental-friendly behavior on an individual level, such as designing a physical product to encourage domestic energy saving (Arroyo et al., 2005) or developing a mobile application as a tool to support green transportation habits (Froehlich & Consolvo, 2009). Among these attempts, there is one popular tool known as a *carbon footprint calculator* that is used for estimating individual GHG emissions in a quantitative way. According to Birnik (2013), a carbon footprint calculator can play an important role in educating people about environmental impacts, and increasing their awareness in adopting sustainable lifestyles to mitigate GHG emissions.

Svalna is a Swedish company that provides a carbon calculator mobile application for measuring and monitoring carbon emissions based on financial data (Svalna, n.d.). This tool makes it possible for users to know their impact on the environment over time, within the areas of purchases, transportation habits, housing, and food consumption. One of Svalna's aims is to make the users live more sustainably, however, research from Svalna's side has shown that users are not getting enough and concrete guidance on how they can live more sustainably. A specific approach made to provide users with the support on reducing their carbon emission is by making users do pro-environmental challenges, such as *"Eat vegan for a month"* or

"Fly less this year". But Svalna means that the challenges provided are rather vague and do not provide enough support in helping users achieve a more sustainable life. The issues of Svalna can also be described as lacking factors of supporting pro-environmental behavior change in their users. Now Svalna wants to address these issues and introduce a better way of doing challenges in the application that would support pro-environmental behavior change in their users. This thesis will in turn research and explore the issues presented by Svalna, and find solutions in terms of using challenges to support behavior change in users towards a sustainable lifestyle.

1.1 Aim

This thesis aims to explore how user challenges in carbon calculators can be designed in order to support behavior change in users towards a sustainable lifestyle. The result will consist of important factors that need to be considered when designing challenges in carbon calculators, which will be helpful for carbon calculators that are attempting to use challenges to support sustainable behavior change in users. The main approach to this will be by applying *Research through design* (see Section 3.1), where a design needs to be created in order to find the mentioned factors. Therefore, the design created will also be a part of the result together with the design factors. This design will represent how a design approach could look like in a carbon calculator with the factors applied, which ultimately also can act as a visual design reference. Furthermore, Svalna is the one who proposed the problems of using challenges, and therefore they are a potential actor in using the result of this thesis. Additionally, since Svalna potentially could take advantage of the result, Svalna has offered the resources to use their carbon calculator mobile application as a medium for research. This would allow for jumping straight into focusing on researching about challenges within Svalna's already released product. Then it would not be needed to start from scratch, as in creating a carbon calculator from scratch, and all resources can instead be put into the challenges. Additionally, collaborating with Svalna would also facilitate eventual user researches and evaluations where requirements and solutions can be validated, since Svalna already has a user base that can be taken advantage of.

Furthermore, in terms of research context for generating the result, there are several significant steps that need to be focused on. In order to reach the result of potentially changing a behavior, research needs to be made in persuasive designs that attempt to change the behavior of users into a pro-environmental one. This involves investigation within persuasive technology and how pro-environmental behavior change can be achieved by using HCI. Thereafter, for validating whether the design solutions produced have the potential to succeed, prototypes will be created for conducting tests and evaluations with users of Svalna. To summarize this research context, a research question has been defined below.

1.1.1 Research question

What are important factors to consider when designing user challenges in carbon calculators, to support behavior change in the users towards a sustainable lifestyle?

1.1.2 Delimitations

The design factors generated will not make sure that behavior change actually can occur in users. This is because the time limitation of this thesis does not allow for evaluating whether behavior change can occur. But the research that will be made will aim to strengthen the claim of *potentially being able to support behavior change*. In terms of the visual design reference created, this will only be a conceptual digital design, and should not be mistaken with a functional mobile application software.

1.2 Stakeholders

The stakeholders of this thesis will be defined as four conceptual parties according to Wadsworth (2016) in the following sections, which helps specify groups and roles in the research. The first party is *those who it is for*, which in other words is the group that needs to be convinced or influenced when conducting the thesis. The second party is *those it is ultimately for*, where this group is the end-users of the research. The third group is *those who are the researched*, which are those who need to be researched in order to conduct the thesis. The last group is *those who are the researchers*, which are the researchers of the thesis themselves.

1.2.1 Svalna

Svalna is the company that provided the opportunity to research the mentioned research question, thus they belong to *those who it is for* according to Wadsworth (2016). The final result of the thesis is also something that Svalna could make use of if deemed to be suitable which makes it important to satisfy their needs. Therefore they are also arguably within the party of *those it is ultimately for* (Wadsworth, 2016). More about Svalna and their application will be presented in Section 2.4.

1.2.2 Svalna's users

Svalna exists to help people become more sustainable, which makes the users or potential users (people who want to become more sustainable with the help of Svalna), of Svalna one of the stakeholders too. In a user study survey by Svalna in September 2019, it was possible to find out whom the actual users were based on answers from a minor part of 2100 surveys sent out. In terms of answers from 124 users about gender, the majority were women with a percentage of 60% while there only were 35% men. The remaining 5% consisted of other genders and people who did not want to state their gender. These users were mainly above 18 years and the age group of 25-34 years was the major one. Regarding 135 answers on occupation, the

majority were workers while just a small percentage were students or pensioners and even less were *other occupations*. In the end, all of them are the end-users of Svalna. Therefore they will be a part of this thesis' user research and evaluations, which is needed in order to gather user requirements as well as evaluating results. That puts them in the party of *those who are the researched* (Wadsworth, 2016).

1.2.3 External parties

External parties could be researchers or anyone who wants to make use of the result of this thesis. Since this thesis is aiming to provide solutions for designing challenges in carbon calculators as mentioned earlier, anyone who wishes to use the result would be a stakeholder. Therefore, external parties who tries to make use of this thesis' result will be in the party of *those it is ultimately for* (Wadsworth, 2016).

1.2.4 Chalmers University of Technology and Gothenburg University

In terms of academic purposes, this Master's thesis is an academic work for Chalmers University of Technology and Gothenburg University, as a part of a Master's program at the institutes. Therefore it is needed to satisfy their requirements in order for this project to be approved as a Master's thesis and once the work has been approved, the thesis work will be published online by them. Therefore, this puts them in the party of *those who it is for* (Wadsworth, 2016).

1.2.5 The researchers of this thesis

The last stakeholders are the researchers themselves, the authors of this thesis, thus making them *those who are the researchers* according to Wadsworth (2016). Their purpose is first and foremost to accomplish a successful Master's thesis that will yield useful results. By useful results, the researchers wishes that the results potentially could help people become more sustainable and thus make this planet healthier. The second purpose is to have a finished academic work within Interaction design in their career achievements.

1.3 Ethical issues

This project will be accomplished in collaboration with Svalna, therefore it is important to consider both Svalna and their stakeholders when designing the outcome. The stakeholders of Svalna are their users, which means that the final result of this project will affect them if Svalna decides to use it. Therefore it is important to consider how to not cause a negative outcome for users who will come in contact with the final result. Since Svalna's carbon calculator also is rather personal in regards to being able to track users' transaction data, the process of designing within this context needs to be carefully executed in terms of not violating such data in any way.

The users will also be affected when the project group needs to conduct user research and evaluation by involving them personally. It is of high importance to consider the users' rights when involving them, such as asking for consent and not force them to do something that they do not agree with, and they should also be able to withdraw at any time. Preece et al. (2015) emphasizes that when conducting interviews with users, they should be reassured regarding any ethical issues. Furthermore, this will also involve users' data, such as feedback and personal information, and that has to be handled with respect to their integrity. As mentioned before, transaction data of users is something that is involved in Svalna's carbon calculator, therefore it is important to ask for this specific permission before asking about or observing this area. Additionally, the data should be anonymous or deleted if desired by the users.

Furthermore, delivering the result to Svalna as a company could potentially lead to the result being used and implemented into their application if they want to use it. Therefore, the result needs to be considered in terms of usefulness, appropriation, suitability, convenience, and following their view of ethics, as the implementation will involve altering their mobile application and affect their users.

2
Background

In this chapter, the background of the thesis research will be presented. This includes insights into how *sustainable HCI*, *persuasive technology* and *carbon calculators* are involved in the research. Thereafter, Svalna and their carbon calculator are being introduced and how they relate to this thesis.

2.1 Sustainable HCI

Over the past century, the global average surface temperature has increased by 0.6° C (Uprety et al., 2018). This phenomenon known as global warming has caused many severe environmental problems including extreme weather, expansion of deserts, and loss of habitats for wildlife caused by sea-level rise. During past two decades, environmental sustainability has become an increasingly important topic in the Human-Computer Interaction (HCI) community. (HCI can shortly be described as the study of information technology designs, and how humans interact with the technologies (Interaction-Design-Foundation, 2020).) Sustainable HCI (SHCI) has therefore been a nascent sub-field for researchers to explore how HCI can play a role in solving the issues of sustainability. Mankoff et al. (2007) categorizes SHCI into two orientations; *sustainability in design* and *sustainability through design*. The former one focuses on how to take sustainability into account when designing the material design of products regarding energy use, waste reduction and recycling (Mankoff et al., 2007). For example, the design of appliances can help to save energy by enabling users to put machines in an energy saving mode compared to a normal operating mode. The latter design direction pays attention to motivating sustainable behaviors and lifestyles through the design of technology (Mankoff et al., 2007). For instance, EcoIsland is a system designed for tracking users' approximate CO2 emission using sensors and self-report data to persuade users to reduce their emissions (Takayama et al., 2009). In terms of this thesis, the direction will be *sustainability through design*, since the design outcome is supposed to support users through guidance and engagement in living sustainably.

2.2 Persuasive technology

Persuasive technology is defined as *"technology that is designed to change attitudes or behaviors of the users through persuasion and social influence"* (B. J. Fogg, 2003, p.1). Using this technology as a tool, Fogg proposes a set of design strategies

(see Section 3.4) for designing interactive products to change users' attitudes or behaviors.

2.2.1 Persuasive technology as a tool to promote pro-environmental behavior

Tscheligi & Reitberger (2007) argue that persuasive technology can be an important topic of SHCI by designing systems that provide users with information about the environmental impact of their actions and motivate them to behave in a more sustainable way. Regarding utilizing persuasion as a tool to promote pro-environmental behavior, DiSalvo et al. (2010) divided the applied design strategies into two categories; *strong persuasion* and *passive persuasion*. According to DiSalvo et al. (2010), strong persuasion refers to the way of providing information that directly tells whether a user's behavior is sustainable or not. One case of this is a persuasive computer game designed by Bang et al. (2006) to raise awareness of domestic energy consumption among teenagers. In the game, the player can get direct feedback as bonus points once a proper behavior is performed, for example, when the player chooses to use microwave instead of the ordinary electrical oven. The other design direction is providing passive persuasion by presenting broad information such as energy consumption and food waste in an implicit way for suggesting sustainable behavior DiSalvo et al. (2010). One case of this is a physical product that is installed on household taps called Waterbot Arroyo et al. (2005), which attempts to persuade and motivate people to turn off their taps when the water is not being used, by providing positive audio messages every time the tap is closed (Arroyo et al., 2005). Another case is a mobile application designed by Jylhä et al. (2013) that motivates users to make sustainable traveling choices by visualizing the GHG emissions of past traveling activities and provides actionable carbon reduction challenges. The results of the pilot study have shown that the visualization and challenges were positive for affecting awareness of sustainable mobility actions (Jylhä et al., 2013).

2.2.2 Criticism of persuasive technology

In terms of persuasive technology as a tool, Brynjarsdottir et al. (2012) point out many critical points on how persuasive technology has been used towards sustainable behavior change based on previous research involving persuasive technology. One issue is that the evaluation on the effectiveness of behavior change tends to be short-termed and limited evidence has been shown regarding a long-term effect on behavior change. Brynjarsdottir et al. (2012) criticize that the typical duration of a field study lasting for three to four weeks is not long enough to go beyond novelty effects. Even though one study by Broms et al. (2010) that lasted for three months states that behavior change took place, the effectiveness and the frequency of the intended behavior change were still not clear according to Brynjarsdottir et al. (2012). Another issue is that most persuasive products have chosen individual consumer behavior as a design target, which may limit the view to solve complex problems of sustainability as a whole (Brynjarsdottir et al., 2012). Additionally, according to Brynjarsdottir et al. (2012), persuasion has narrowed the vision of

sustainability through its framing of *"users"* as individuals, isolated consumers, which neglects the possibility to motivate behavior change considering community, political, and infrastructural engagement. For example, some pro-environmental behaviors such as recycling and using public transportation can only be performed when the necessary infrastructure is provided (Anja & Julian, 2010). According to Andreas & Axel (1999), political changes such as higher fuel taxes or more strict building codes can be more effective on enhancing pro-environmental behaviors when people are not willing to make sacrifices on changing their behavior.

2.3 Carbon footprint calculators

GHG emissions of a person can also be called a carbon footprint and Johnson (2008, p.1569) defines a carbon footprint as: *"a carbon footprint is equal to the GHG emissions generated by a person, organization or product"*. With growing public concern over climate change, reducing carbon footprint has been seen as an effective way for individuals to take responsibility and action against environmental issues (West et al., 2016). A tool that could be used for facilitating this purpose is carbon footprint calculators. According to Wiedmann & Minx (2008), carbon calculators are tools for measuring the carbon emissions of users' activities, which can play an important role in educating and motivating lifestyle changes.

Carbon calculators can take a variety of forms and features, which has been studied in different ways to better understand the use of existing calculators and to provide suggestions for future development. To reflect on the current use of carbon footprint calculators, Salo et al. (2019) studied the features of ten online footprint calculators and summarized four dominant features of the calculators; *Recruiting users*, *Usability*, *Knowledge*, and *Support*. Moreover, from an evaluative perspective of assessing the effectiveness of carbon footprint calculators, Bottrill (2007) proposed four key criteria to examine the strengths and weaknesses of each calculator; (1) *presentation and usability*, (2) *data and information inputs*, (3) *results, feedback and guidance*, and (4) *context and explanation*. With the same goal to generate insights for designing better carbon footprint calculators, Mulrow et al. (2019) created a set of evaluation categories focusing on input categories (such as home energy, transportation, and food consumption) and user engagement features (such as emission values for each category, carbon footprint comparisons, and advice for lowering emissions). To better understand the current use of carbon footprint calculators with the flow of the expected pattern of use, the following sub-sections will therefore introduce the four key features of the carbon calculators more in detail according to Salo et al. (2019), as well as giving examples of existing carbon calculators.

2.3.1 Features of carbon footprint calculators

2.3.1.1 Recruiting user

The design goal of calculators to raise awareness and motivate behavior change can only be realized if they are used (Salo et al., 2019). Therefore, recruiting users is one

of the features to involves activities to make people aware of their carbon footprint and motivate calculator use, such as campaigns and face-to-face recruiting in public spaces (Salo et al., 2019).

2.3.1.2 Usability

Usability refers to features that support users in completing the calculation (Salo et al., 2019). For example, some calculators have features that help users to estimate their consumption data such as domestic energy use and food consumption. To gather data in a more general way, some calculators may also ask for preferences regarding diet or shopping.

2.3.1.3 Knowledge

Knowledge refers to features that aim to make users aware of their environmental impact by providing knowledge of carbon footprints of different activities and how these activities can affect climate issues (Salo et al., 2019). Typically, carbon footprint calculators can illustrate this relevant knowledge in aspects such as housing, travel, and food (Salo et al., 2019).

2.3.1.4 Support

The support category refers to the features that offer suggestions about how to make one's carbon footprint smaller (Salo et al., 2019). For supporting practical advice, many calculators list tips or pledges on how to generate less carbon emission. In addition, social features like showing the sustainable actions of others are also ways to guide and motivate users toward a more sustainable lifestyle (Salo et al., 2019).

2.3.2 Challenges of carbon footprint calculators

Even though many calculators have features to track users' activities and achievements to increase engagement of calculator usage, involving people to use calculators in a long time is still a challenge (Salo et al., 2019). In addition, Salo et al. (2019) point out that suggestions inside calculators from a carbon emission perspective can be problematic in practice. For example, suggestions to ride a bike instead of driving may be challenged as the quality of routes and infrastructure may not be of equal quality for both of the transportation modes (Salo et al., 2019). Furthermore, the use of carbon calculators to motivate individuals' low carbon action is criticized by Büchs et al. (2018) to be ineffective, based on a long-term study that indicates that more ambitious government and corporate actions are required to accelerate the reduction of carbon emission.

2.3.3 Examples of carbon calculators

There are currently many carbon calculators out in the market, where many of them have been involved in comparison studies that show that they differ in terms of carbon footprint results for individuals (Padgett et al., 2008). However, what

makes Svalna's carbon calculator different from these is the personal transaction data tracking, which provides dynamic personal carbon emission tracking that allows for continuous progress monitoring. Carbon calculators such as the one from WWF (WWF, n.d.) or another one named Klimatkalkylatorn (Klimatkalkylatorn, n.d.), only provide static carbon emission data based on an analysis of your answers of a questionnaire with carbon emission questions. On the other hand, they do give suggestions on how you could potentially be more sustainable, which Svalna does not do. But that is still very static and does not guide you on a personal level on how you can be more sustainable based on dynamic personal progress, thus potentially lacking the ability to change the behavior in terms of pro-environmental thinking. Furthermore, there exist several *personal oriented carbon calculators* that are similar to Svalna, but with more active and clear actions or challenges, which will be described in the following sections.

2.3.3.1 Personal carbon calculators

In this section, several personal carbon calculator applications have been reviewed and will be presented with information on what they are capable of. These calculators have a common similar goal, which is to help users understand their carbon footprints by visualizing them in various ways, as well as supporting their users towards acting environment-friendly. However, each of these applications achieve this in different ways involving different features that can facilitate the achievement of the goal. For a clearer view of what these functionalities mean and are, some descriptions will be presented below on what they mean, as well as a table consisting of the carbon calculators and their specific functionalities.

Carbon footprint profile entry, is an action that users of carbon calculators do the first time they use the application which helps the calculators to calculate the individual carbon footprint of their users. This means that users need to enter how much their carbon emission is in different categories such as transportation, consumption, and shopping, and in the end the calculators can present visualizations on how their users carbon footprints look like. This carbon footprint entry can also be recalculated at any time if users want to refresh their data

Manual activity entry is similar to the *Carbon footprint profile entry* in the sense that data has to be entered manually, however this kind of entry is specific for each activity, with more details. When users want to track something that they have done, e.g. flying to another country or buying clothes, the users can enter this kind of activity and the application will calculate and involve them in the users' carbon footprints. The entry would for example require users to specify what kind of activity that was done, and how much GHG emission it caused.

Bank transaction tracking, is a kind of tracking that tracks users' purchase data which in turn is used for calculating users' carbon footprint continuously. This is a more precise and dynamic calculation compared to the *Carbon footprint profile entry*, since it can actively track the specifics of a user's activity. However, this technique requires users to enter their bank card details in the application and per-

mit transaction tracking.

Social aspects within carbon calculators can involve different functionalities that allow for social interaction with other people that also uses the calculator. This can for example involve the functionality of being able to compare carbon footprints with others and compete, or working together towards an environmental goal as a group.

Donations that exist in some of the reviewed calculators are for donating money to organizations that work toward a sustainable environment. By donating money, users will be able to offset their own carbon emissions. Depending on how much a user donates, the amount of offset will be corresponding to the amount of money, for example, the higher the donation is, the higher the offset will be. However, this is according to the reviewed calculators not a way of covering up users' carbon emission, but more like another way of contributing to a more sustainable environment.

Challenges are tasks within the calculators that asks users to do various activities that contribute to a more sustainable environment. This can for example be; *start eating vegan*, *stop taking the car to work*, *stop flying*, and similar things that involves behaving sustainably, which can be addressed as doing sustainable behaviors. By accomplishing challenges, the users' carbon footprints will also be reduced, which in the end can act as an encouragement to do more sustainable behaviors in challenges to reduce their footprints.

The following table (see Table 2.1) will show the specific functionalities that the reviewed carbon calculators provide according to previous descriptions. The calculators in focus are; **Capture** (Capture, n.d.), **Deedster** (Deedster, n.d.), **Doconomy** (Doconomy, n.d.), **Ducky** (Ducky, n.d.), and **Joro** (Joro, n.d.). The table will also involve Svalna's carbon calculator (Svalna, n.d.) (which will be described with more details in the next section.

	Carbon footprint profile entry	Manual activity entry	Bank transaction tracking	Social aspects	Donations	Challenges
Capture	X	X			X	
Deedster	X			X		X
Doconomy			X		X	
Ducky	X			X		X
Joro	X	X	X	X	X	X
Svalna	X	X	X	X		X

Table 2.1: Functionalities of reviewed carbon calculators

2.4 The Svalna carbon calculator

In the Introduction, (see Chapter 1), Svalna and their carbon calculator was introduced, where it was emphasized that Svalna wanted to improve factors within their application that would better support people into having a more sustainable lifestyle. The following sub-sections will present how Svalna according to themselves currently are attempting to achieve the pro-environmental behavior change by using *intervention techniques* (also described in Section 3.3). This specifically involves the following three main features; *Visualizing emissions*, *Grouping people*, and *Goals and challenges*. The *Goals and challenges* part of the application is what Svalna have emphasized to fail the most in supporting people to have a more sustainable lifestyle. Therefore, the last sub-section will describe the *Goals and challenges* and what *Svalna's proposed problem statement* concerns. This can also be seen as the source of this thesis' purpose.

Figure 2.1: Svalna's carbon calculator (Svalna AB, 2020)

2.4.1 Visualising emissions

The users of Svalna are able to see their GHG emissions in the form of visualisations which should facilitate the understanding, within purchases, transportation habits, housing, and food consumption, as shown in Figure 2.2. Even though these visualizations are just *"mere information"*, Svalna mean that users will get insights on what generates GHG emissions in their consumptions, thus making them more aware in sustainability. The emission data is firstly based on users' carbon emission profiles that they fill in the first time they use the application, which acts as a base for all the data. Secondly, in order to track users' emissions continuously, Svalna will analyze purchases that their users have made, although only if the users allow Svalna to track their bank transactions.

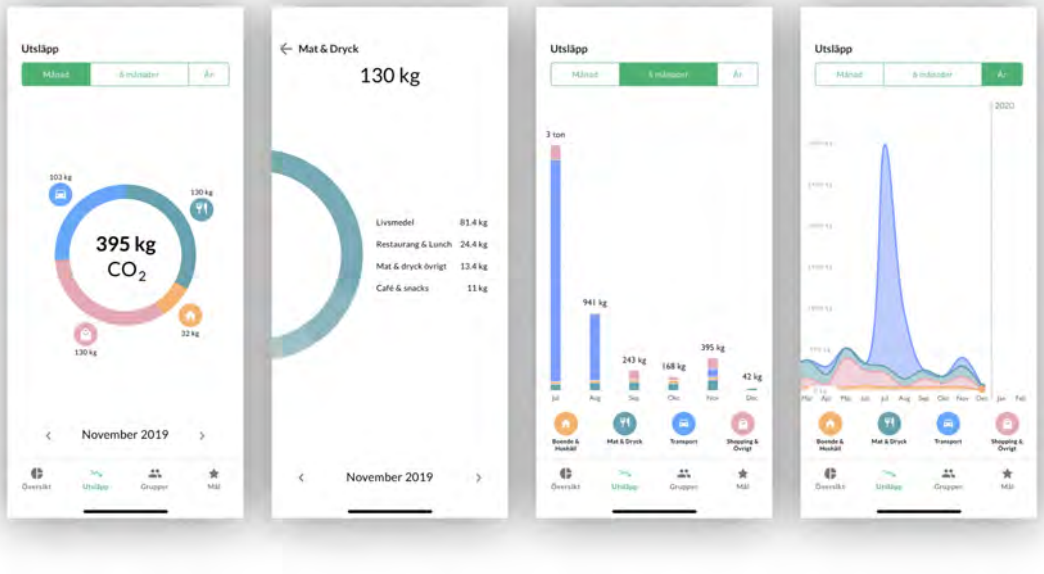


Figure 2.2: The Emission section (Svalna AB, 2020)

2.4.2 Grouping people

Users of Svalna are able to be more active, by participating in communities and groups and as a result of that, reduce GHG emissions together with others. As shown in Figure 2.3, users can create or join different groups with different aims. In the end, Svalna means that the purpose of grouping people is to activate social norms and the social desirability for not causing high emissions, which is a result of being inspired by others.

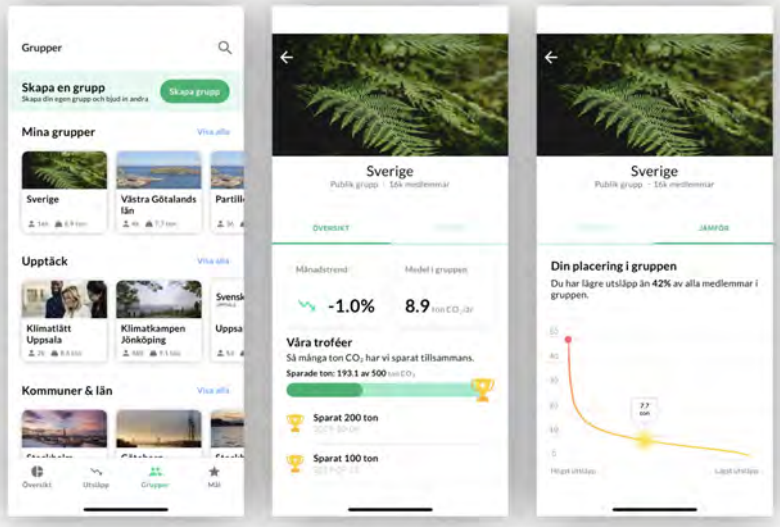


Figure 2.3: The Group section (Svalna AB, 2020)

2.4.3 Failure in using challenges to support pro-environmental behavior change

Users of Svalna are able to take action in becoming more sustainable by setting goals and doing challenges that Svalna provide, as seen in Figure 2.4. However, the way that users attempt to do challenges lacks in encouragement and guidance. When users attempt to take on a challenge, all that will happen is showing what the users' potential reduction will be if the challenge is done. Then it is expected that the users will take this as an inspiration to actually behave according to the challenge's behavior in reality. But research on Svalna's side has shown that the challenges fail to achieve their purposes. The challenges do not provide any support, instructions, encouragement, or motivation to actually make users do the challenge's tasks, that is, the behaviors. This is also the part of the application that Svalna emphasizes more in terms of the failure of engaging users towards a more sustainable lifestyle. Therefore improving the approach of challenges is what Svalna emphasizes, thus inspired this thesis' aim in finding answers for the *research question*.

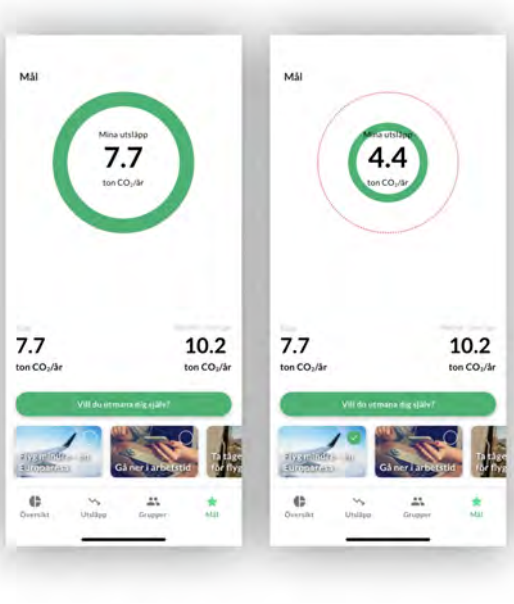


Figure 2.4: The Goals section (Svalna AB, 2020)

3

Theory

In this chapter the theory used for this thesis will be presented, by starting to introduce the core practice that this thesis relies on, called *Research through design*. Thereafter, the theory that is used for supporting the design solutions to the thesis aim will be presented. This involves theories of designing for pro-environmental behavior in HCI and how it can be applied by using a behavior change model, intervention techniques, and persuasive technology.

3.1 Research through design

According to Martin & Hanington (2012), research through design is a way of doing research by using the design process of Interaction design (described in the methodology part in this thesis). This involves both the way of executing the design process and the methods to be used. As a result of the design process, artefacts should emerge ranging from sketches and drawings to models and prototypes. Furthermore, Martin & Hanington (2012) emphasizes that it is the documentation of the design work that is the most important factor, where it acts as a way for contextualizing and communicating the design actions. Gaver (2012) further means that using research through design will tend to produce provisional, contingent and aspirational theory. One of his arguments suggests that practice-based research using annotations, which are concise design principles of realized designs, will convey theory better than trying to develop extensive theories of design.

3.2 Pro-environmental behavior change

Human impact has been considered as one major cause for global warming due to the extensive GHG emissions to the atmosphere over the past 150 years (Michael et al., 2012). According to Kollmuss & Agyeman (2002), pro-environmental behavior refers to behavior that consciously seeks to minimize the negative impact of people's actions on the environment. Taking changing human behavior as a way to address environmental issues, one effective way within environmental psychology is to use intervention to motivate and support people towards pro-environmental behavior change (Linda et al., 2014). To better understand the process of pro-environmental behavior change, a behavior change model created by Geller (2002) will be introduced, which clearly illustrates the different stages of pro-environmental behavior change and the relationship between the stages and types of interventions. Based

on this model, specific intervention techniques will then be presented in the coming sections, with examples that explain how they can be used in practice.

3.2.1 Pro-environmental behavior change model

In the field of environmental psychology, Geller (2002) introduced a pro-environmental behavior change model which focuses on the process of behavior change and relates three types of intervention approaches (*instructional*, *motivational*, *supportive*) to the four behavior change stages (*unconscious incompetence*, *conscious incompetence*, *conscious competence*, *unconscious competence*) of the target individuals. To better understand how different types of interventions cause behavior change in the next section, a simplified Geller's model adapted by Yun et al. (2013) (see Figure 3.1)) will be introduced in this section.

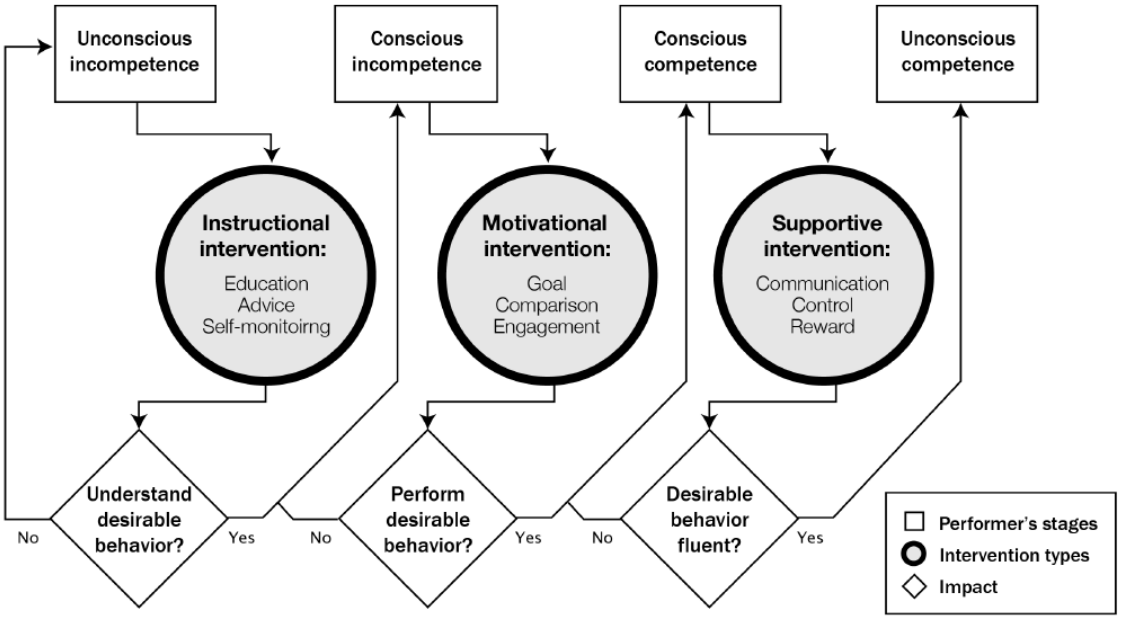


Figure 3.1: Behavior change model for sustainability (Yun et al., 2013, p.257)

In this simplified behavior change model, *unconscious incompetence* is the stage where people are unaware of the desired pro-environment practice (Geller, 2002). In this stage, people need repeated *instructional intervention* (such as education, advice, and self-monitoring) until they understand what they could do and/or why it is important (Yun et al., 2013). When people know how to protect the environment but do not do it, they are considered to be *consciously incompetent*. This is the stage where people need *motivational intervention* (such as goal, comparison, and engagement) to motivate them to adopt the pro-environmental behavior more easily and then be able to move to the next stage, *conscious competence* (Yun et al., 2013). In this stage, the person has now acquired enough environmental knowledge and performed a target behavior at least once (Yun et al., 2013). Since the end goal of behavior change is to make a habitual behavior, *supportive intervention* (such as communication, control, and rewards) therefore can aid people in repeatedly

performing the behavior and move to the goal stage, *unconscious competence*, where the pro-environmental behavior has become a habit or part of a regular routine (Geller, 2002).

3.3 Intervention techniques to promote pro-environmental behavior

Based on reviews made by Froehlich et al. (2010) and Yun et al. (2013), this section will cover some of the most commonly used intervention techniques for encouraging pro-environmental behavior and offer examples that show how they have been applied in practice. These intervention techniques are categorized into three types of intervention identified by Geller (2002); *instructional intervention*, *motivational intervention*, and *supportive intervention*.

3.3.1 Instructional intervention

Instructional intervention is an activator used for getting people's attention through providing instructions, which will be more effective when these instructions are specific and personalized (Geller, 2002). The specific techniques for instructional intervention are education and advice described below.

3.3.1.1 Education

According to Geller (2002), education intervention is a technique that allows people with no background information about sustainability (*unconscious incompetence*) to understand why they should perform sustainable behaviors (*conscious incompetence*). In the context of carbon calculators, education can teach people why they should decrease their carbon footprint and what behavior can be helpful to make it smaller.

3.3.1.2 Advice

Advice is an intervention that offers people suggestions about what they can do to reduce environmental impacts (Yun et al., 2013). To make advice more effective, Harrigan (1994) argues that making individualized and customized advice can be helpful to motivate and guide pro-environmental behavior. In addition, advice can make better persuasive effects if it can based on the opinion or behavior of others to affect people's behavior (Steg et al., 2013). For example, Goldstein et al. (2008) conducted two experiments to examine the effectiveness of signs requesting pro-environmental participation in the hotel. The results showed that using signs with information about how many other guests were reusing towels was more effective than signs with traditional messages that solely reminded on environmental protection (Goldstein et al., 2008).

3.3.2 Motivational intervention

Even though people are aware of negative environmental impacts due to their behavior and know what to do through instructive intervention, it is still difficult for people to actually take pro-environmental actions. In this case, the motivational intervention can aid in stimulating people to make pro-environmental changes. The techniques for this type of intervention include goal-setting, engagement, and comparison.

3.3.2.1 Goal-setting

This intervention technique builds on a goal-setting theory which claims that individual behavior is goal-oriented and people will be motivated through the expectation to achieve an attractive goal (Steg et al., 2013). However, Shiraishi et al. (2009) argue that too challenging and long-term goals may make people unmotivated. Therefore, goals should be made achievable and preferably reachable within a short period of time without risking to lose people's motivation.

3.3.2.2 Engagement

Engagement refers to a strategy that considers emotional aspects for attracting people and raising their curiosity, by making pro-environmental efforts more engaging (Yun et al., 2013). For example, virtual characters (e.g. a polar bear (Froehlich & Consolvo, 2009)) can make users feel empathy and perform desired behaviors to keep the character alive or happy. However, regarding the end goal to achieve long-term behavior change, engagement intervention alone may be inadequate. Yun et al. (2013) suggest that this intervention can be combined with supportive intervention to motivate users continuously.

3.3.2.3 Comparison

Comparison is an intervention technique to motivate pro-environmental behavior by comparing behavior performance to others (Yun et al., 2013). A comparison between individuals or groups can be more effective in motivating a purpose when combined with feedback (see Section 3.3.3.1) about performance (Froehlich et al., 2010).

3.3.3 Supportive intervention

The supportive intervention aims at aiding people in repeatedly performing the target behavior once people have been stimulated through motivational intervention and moving to the goal stage, *unconscious competence*, where the pro-environmental behavior has become a habit or part of a regular routine (Geller, 2002). According to Geller (2002), a good habit is an outcome of long-term implementation of a motivational intervention combined with consistent supportive intervention. The specific intervention techniques for supportive intervention are feedback, rewards and penalties, and commitment.

3.3.3.1 Feedback

Another technique to support long-term behavior change is to provide feedback on people's actions. According to Froehlich et al. (2010), the feedback has two forms: low-level feedback providing details about how to change or improve a specific behavior, and high-level feedback which is summative and can help in improving performance towards a goal or in comparison to others.

3.3.3.2 Rewards and penalties

Unlike other intervention techniques that are designed for promoting behavior change before the desired behavior happens, rewards and penalties occur after the target behavior happens. Kohlenberg et al. (1976) showed that monetary payment can help to promote behavior such as reducing energy usage. In persuasive technology and HCI, virtual and game-like rewards such as points and levels were introduced (Froehlich & Consolvo, 2009; Shiraishi et al., 2009).

3.3.3.3 Commitment

A commitment is a technique where people make promises to change their behavior. The way for people to express commitment increases the probability that they will take action (Gonzales & Aronson, 1988). Froehlich et al. (2010) proposed three factors that impact behavior through commitment: the type of commitment, the person or group to whom the commitment is made, and whether the commitment is public or private.

3.4 Applying Persuasive technology according to Fogg

As the background of Persuasive technology was introduced in Section 2.2.1, this section will go into details on how persuasive technology can be applied according to Fogg's *Behavior Model for Persuasive Design* and *seven types of persuasive technology tools*.

3.4.1 The three factors of Fogg's Behavior Model

The Fogg Behavior Model is a model defined by B. Fogg (2009) that is used for understanding the behavior of users as well as asserting that a target behavior can be achieved in users. The model makes use of three factors that must be present in users at the same moment in order for a target behavior to take place; *motivation*, *ability*, and *triggers*. The aim to achieve a target behavior in users is to make sure that motivation and ability are high for the behavior to be made. An example B. Fogg (2009) makes is; solving a puzzle can be difficult, therefore there will be a low ability in the user. However, the prize is one million dollars, which makes the motivation high, and as a result, the behavior to do this can still go through. The same goes for a low motivation, e.g. buying a car when you do not need it. The motivation will

be low, however the cost of the car is one dollar, which highly will make you buy it in the end, due to having a high ability to buy it. In terms of the third factor, *trigger*, it helps to achieve a behavior in the sense that it tells the user to do it. An example B. Fogg (2009) gives is that, even though a person likes to play the ukulele and knows how to play it, the person will not necessarily play it. Even though the motivation and ability are present, there is nobody to tell that person to play. Therefore, triggers are a way for triggering a person to perform a target behavior. B. Fogg (2009) further mentions a factor in terms of triggers, which is *timing*. He means that a trigger of behavior needs to happen at a suitable time, which is when motivation and ability are high. The following sub-sections will go more into detail on what useful motivators are, what increases ability and three types of triggers.

Furthermore, the model with the three factors can also be used for analyzing and designing persuasive technology (B. Fogg, 2009). The model can help researchers and designers in finding new potentials for persuading users as well as assisting in thinking more clearly about behavior. It can also identify existing issues in persuasive designs that fail to achieve the intended outcomes, by systematically following the model with the three factors.

3.4.1.1 Useful motivators

Two motivators that have been known to be powerful in persuasive technology are *hope* and *fear*, where *hope* is seen as the most ethical and empowering motivator (B. Fogg, 2009). Two examples of *hope* and *fear* that B. Fogg (2009) give are; Joining a dating website motivates *hope*, and *fear* can motivate a person to update their anti-virus software on their computers. Two other growing motivators are *social acceptance* and *social rejection*, which are closely related to social media. B. Fogg (2009) mentions that Facebook uses the social motivators for motivating their users by making them desire for social acceptance by sharing personal updates, and if they do not do that, they risk social rejection. Furthermore, if a designer has the aim of achieving an escalation of motivation, *pleasure* and *pain* are two powerful motivators according to B. Fogg (2009). Even though a designer should have these motivators in mind, they should be used with caution as they might not be ideal, especially pain.

3.4.1.2 Increase in ability

Products that generally require users to learn new things usually fail to do so due to the natural laziness of humans (B. Fogg, 2009). Therefore, B. Fogg (2009) argues that instead of increasing the ability in a user, the increment should instead be made in the products, as in making the target behavior easier to achieve. An example of simplicity in terms of making people buy products, Amazon provides a 1-click shopping experience for users, which indeed lets a user buy a product in one click (B. Fogg, 2009). As a result of this, people will buy more because of how easy it is to buy things, and B. Fogg (2009) means that simplicity changes behaviors. In terms of achieving a persuasive design with motivation versus ability, focusing more on simplicity in achieving the behavior tends to succeed faster than piling on motiva-

tion (B. Fogg, 2009). Furthermore, B. Fogg (2009) defines six elements of simplicity that need to be linked and if not, there will be no simplicity; *time*, *money*, *physical effort*, *brain cycles*, *social deviance* and *non-routine*.

Time is important in the sense that people will not do certain things if they do not have time to do it. When a target behavior requires a lot of time, e.g. filling in a very long questionnaire, it will be difficult to achieve since users might prioritize other things. *Money* in the sense of being able to afford to do a target behavior is also a factor that determines whether or not it is doable. However, money as a factor is also different from person to person, as a kid might not have money to buy a video game, whereas a billionaire almost can afford anything. *Physical effort* is another deciding factor whether or not a person can do certain things such as traveling to different places. A trip to Las Vegas with an airplane is easy whereas walking there is not simple. *Brain cycles* involve the ability of your brain. If a task is too hard for your brain to solve, then the task is not simple. Following the social norm and the rules of the society is what *Social deviance* is about, where breaking those will make the target behavior difficult. For the last element of simplicity, *non-routine* is wanting to do things that you are used to doing. If you start a new routine, it might get difficult.

3.4.1.3 Three types of triggers

In terms of triggering a target behavior, B. Fogg (2009) proposes three types of triggers; *sparks as triggers*, *facilitator as triggers* and *signal as triggers*. Sparks are used for triggering the motivations described in 3.4.1.1. Therefore, the triggering should be made with care as it is not suitable to motivate someone when they do not plan to do something. Facilitators as triggers on the other hand are for triggering when the motivation already is high, but the ability is low. Therefore the trigger should not only trigger the user to do the target behavior but also make it easier. An example of this is social media where you want to add contacts. Instead of manually adding a user by user, it should trigger for uploading all contacts from the mobile phone contact book. The last trigger is the signal which acts as a plain reminder, and does not need to involve motivation or facilitation. All it does is signaling when a behavior is suitable to do, however, it does require high motivation and ability to begin with.

3.4.2 Seven types of persuasive technology tools

In this sections the seven types of persuasive technology tools defined by B. J. Fogg (2003) will be presented. These tools are useful for designing interactive products that should change attitudes or behaviors of users and in the end, making the target behavior easier to achieve.

3.4.2.1 Reduction: Persuading through simplifying

Reduction according to B. J. Fogg (2003) is about reducing the complexity of an activity in an interactive product by bringing the steps down for achieving a task,

where the ideal scenario would be one single step. The reasoning of reduction is that it makes the task easier for a user to accomplish which in turn makes the task more beneficial to do in terms of cost, and as a result the motivation to do the target behavior will be increased. Furthermore, by simplifying a target behavior, users will feel that it is easy to achieve that behavior and thus boost the users' confidence in their ability to perform the behavior. The attitude that users have towards the target behavior will also be more positive and as a result of that, they will put more effort into adapting the behavior and performing it more frequently. A concrete example that B. J. Fogg (2003) gives is buying products on Amazon.com with a "one-click" feature which lets customers buy a product with just on click. This reduction strategy would in turn make customers more motivated to buy things.

3.4.2.2 Tunneling: Guided persuasion

Tunneling is about making a process for users easier by guiding them through a controlled environment, which involves a sequence of actions that users have to follow step by step. Their user experience is controlled by the designers, such as content and pathways, and the users must confront the assumptions and values in order to achieve the goal. However, caution needs to be made in terms of always allowing users to exit at any point. Some concrete examples of tunneling are when people want guidance through changing themselves, such as hiring a personal trainer to guide them towards a healthier body or going to a drug rehab clinic to become drug-free.

3.4.2.3 Tailoring: Persuasion through customization

Tailoring a product involves customizing the information for the users in a way that would make them change behaviors. If a word processing application would remind you every day to learn new words based on what you already know, you might not follow this suggestion. However, if the information that the application provides you involves stating that your vocabulary is limited and also below other people of your profession, then you might want to follow the suggestion more. What B. J. Fogg (2003) also means is that the information does not necessarily have to be personally relevant, but just appear to be personal. If users just believe that the information is made for them, they will care more about the information and really take it in, and as a result of this the information has more potential to persuade the users.

3.4.2.4 Suggestion: Intervening at the right time

In order for a target behavior to take place, the timing of it needs to be on the right time. Therefore a product needs to know when to suggest the target behavior and for example when a person has a good mood, that person tends to be easier to persuade. Using a car speed tracker sign is a way to change people to not drive faster than what they are allowed to do. It does so by making the drivers aware of the recommended speed. This will in turn trigger their consciousness in terms of risking to cause an accident or simply being afraid of being fined for speeding.

3.4.2.5 Self-monitoring: Taking the tedium out of tracking

Self-monitoring in terms of persuasive technology is when users can monitor their actions and thus change their behaviors to achieve a goal target behavior that they have decided upon. This kind of monitoring can for example be ongoing data of their physical states or any other progress, where the goal is to improve their state by continuously making sure that they are on the right track. A heart rate meter can for example monitor your heart rate and as a result of this, you will be able to keep a healthy rate at all times by increasing it or decreasing it whenever needed, using different means. Another example is a jump rope with a tracker that can track users' burned calories and the number of jumps. This will both act as a tracker and a tool for motivation, as the feedback of the exercising effort can motivate them to continue exercising.

3.4.2.6 Surveillance: Persuasion through observation

Surveillance on users will make them behave differently according to the observer's desires, and as a result of that the users will change into a behavior that the observer wants. This is through the effect that the observer can reward or punish the user being monitored and thus, the user needs to live up to the behavior in order to be rewarded or fail and get punished. A more concrete example of this is a company that monitors if employees wash their hands. If the employees do not wash their hands, they will risk being punished by their boss, but if they do wash their hands they might get a bonus payment. B. J. Fogg (2003) further emphasizes that the monitoring must be known to the users being monitored. If the users do not know this, then they will not give the effort to perform exceptionally well since they are not aware of potential rewards or punishments. However, a risk of using surveillance is that the boost in performance towards a behavior will only happen during the monitoring and if removing it, the users will not maintain the behavior.

3.4.2.7 Conditioning: Reinforcing target behaviors

Conditioning technology is in other words a way of changing the behavior of users by rewarding them. Some concrete examples can be for example when your kid is doing a good action, a praise to the kid will reinforce that the action will be repeated. The same goes for a dog that listens to your commands and a snack as a reward will make sure that the dog will listen again next time. This can also be seen in gamification, where the reward or reinforcement of behavior can happen through gathering points, advancing through levels or competing for high scores. B. J. Fogg (2003) also means that this technology can shape complex behavior where an example he gives is training dolphins to jump out of the water. By rewarding the dolphin for swimming over a rope, the dolphin will do it over and over again in order to get more rewards. But at the same time, this rope will slowly rise until it is above water, and eventually the dolphin will have learned how to jump out of the water.

4
Methodology

This chapter will describe the intended methods to use for accomplishing the aim of this thesis. The workflow will follow the *Design process* by Preece et al. (2015) within Interaction design, which involves four activities; Establishing requirement, Design alternatives, Prototyping and Evaluating, and each of these activities will in turn contain relevant methods for use. The *Design process* and the four activities will be presented as sections while the methods within each activity will be presented as sub-sections.

4.1 The Design process

The design process is a process within Interaction design for designing interactive products that should enhance and augment how people work, communicate and interact, by creating user experiences (Preece et al., 2015). Preece et al. (2015, p.21) also define a more concrete definition of Interaction design as:

> *"designing interactive products to support the way people communicate and interact in their everyday and working lives."*

Within the design process itself, Preece et al. (2015) mention four activities; Establishing requirement, Design alternatives, Prototyping and Evaluating. Each of these activities acts as a phase within the process, where relevant use of different Interaction design methods can be used, depending on the circumstances. In this thesis, a digital prototype in the context of a mobile application will be designed, therefore the methods to be used will be selected with the mentioned context in mind.

The first activity in a design process of Interaction design described by Preece et al. (2015) will be *Establishing requirements*, since it is a fundamental step in user-centered approaches for understanding who the target user is and what they would need in the design. Followed by forming a basis of the product's requirements that can lead the designers to understand how to support people with the design, the next step would be Designing alternatives, which Preece et al. (2015) describe as the core activity of designing. This is the part of the design process where ideas and designs based on the user requirements are being generated using different ideation methods described later. When ideas and designs have been generated, it is important to turn them into interactive designs, by Prototyping. Preece et al. (2015) means that by

having an interactive design, users are able to evaluate the design in the most sensible way due to being able to interact with the design. Furthermore, they mention that there are different prototyping techniques depending on the circumstances. A working piece of software is a kind of prototype, however that kind of level in terms of functionality is not always necessary, especially if there is not enough time or competence to produce such a prototype. Preece et al. (2015) proposes paper-based prototypes as a quicker way of prototyping, which is cheap to build and can identify problems effectively, and will be described more later. The last activity of the design process is Evaluating, where Preece et al. (2015) argues that users need to be highly involved in Interaction design and this activity has the room for it. The Evaluating activity is essentially the process that will evaluate the usability and acceptability of the design, where different methods described later will be able to evaluate different criteria, such as usability problems and user experience. Therefore, involving users of the design will enhance the chances of delivering a satisfied product, since they ultimately are the end-users.

In the following sections, each activity with relevant methods will be presented in an order that could represent a chronological order of execution. However, this order of execution will firstly not necessarily be the final order and secondly, there will probably not only be one iteration of the process. Throughout the design process, there is a term called *iterative design* which essentially means that the design process will involve iterations. Preece et al. (2015) mean that the four activities are intended to inform each other and allow for each activity to be repeated. A scenario of an iteration within the context of this thesis could for example be: After the execution of all the methods according to the order of this Chapter, the design turns out to not satisfy users' needs. Then it is needed to iterate the design again and find out more about users' needs. The goal in the end is to produce a design that satisfies the users and the number of iterations to be made to achieve that is up to the designers themselves, although limited to resources (Preece et al., 2015). Furthermore, even though the order of execution is not strict, the final step before delivering a product is to ensure that the product satisfies users, therefore Preece et al. (2015) argue that the design process needs to end with the Evaluating activity. However, they also argue that evaluation does not replace quality assurance and testing for making sure that the final product fits the purpose, but that the evaluation only complements and enhances the design. For this thesis, the design process' flow will be flexible in terms of execution order and iteration, where a model of the process can be seen in Figure 4.1.

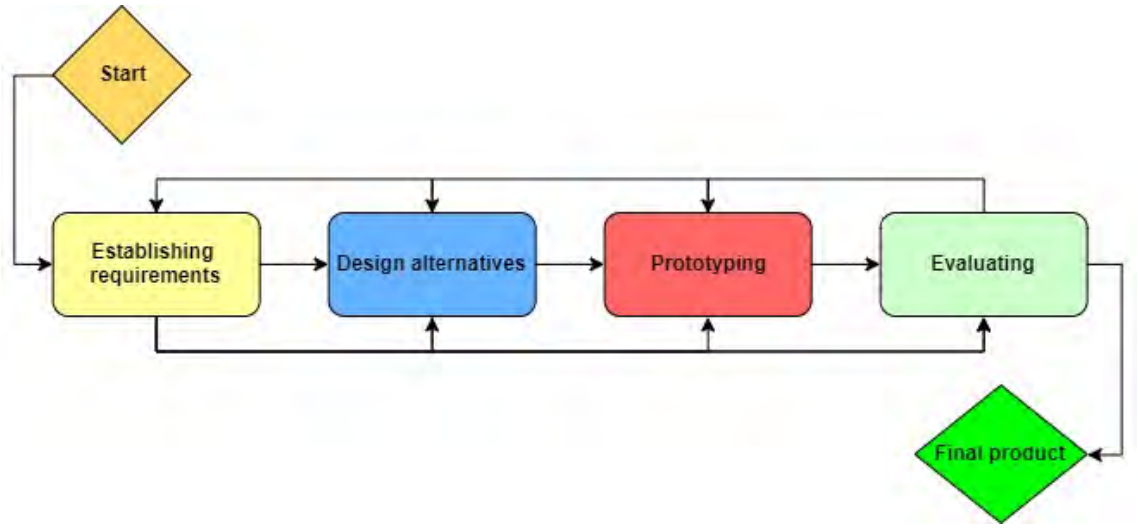


Figure 4.1: The design process for this thesis

4.2 Establishing requirements

In this section, the intended methods to use for establishing requirements will be presented, which are needed in order to produce a design that this thesis aims for. This involves background and theory literature research in order to get a better understanding of the field of study, followed by user research methods that will support forming a better understanding of user needs.

4.2.1 Domain and Context research

Domain and context research in the field of the thesis' aim is a fundamental step in order to better understand what is to be researched and designed. Martin & Hanington (2012) call this *Literature reviews*, where they argue that capturing already discovered information can be useful for informing the current project. They also mention that the Internet can be used as a tool for finding literature since it allows for accessing online libraries around the world. However, one critical factor that Martin & Hanington (2012) point out is that the sources must be selected with caution, both in terms of irrelevance and credibility. Within this context, Martin & Hanington (2012) also mention a method called *Secondary research* or *Desk research*, where it not only emphasizes literature review, but also previous related work. Researching and reviewing related work can provide a better understanding of what has already been done, which can help define the scope of the project better and thus make it unique. The related work can additionally provide inspiration to your design, such as visual guidelines on how to approach different design problems.

4.2.2 Interviews

Conducting interviews with stakeholders of the design is a survey research method for collecting firsthand data, which is a fundamental part of the research according to

Martin & Hanington (2012). They also argue that conducting the interview face to face will allow for personal expression and body language being conveyed, however, remote interviews electronically are not to be omitted. According to Preece et al. (2015), interviews can be categorized into four types where each of them has its own benefits and use cases; *Unstructured interviews*, *Structured interviews*, *Semi-structured interviews*, and Group interviews, better known as *Focus groups*. The following sub-sections will describe these different interviews and point out when one type of interview fits the interview's purpose best.

4.2.2.1 Unstructured interviews

The purpose of using unstructured interviews according to Martin & Hanington (2012) is for exploratory purposes, due to the unstructured format and flexibility. When conducting unstructured interviews, the questions to be asked are not strict, thus allowing for flexibility and the session can be interpreted as conversational, which allows for more depth in the interview hence resulting in rich data (Preece et al., 2015). The questions that the interviewer asks should be open, in the sense that an exact answer from the interviewee should not be expected in terms of content or format (Preece et al., 2015). The answers that the interviewees give should be up to themselves in terms of the extent of the content, where they for example can steer the interview on their own and give input on something else than what was asked at first. However, if the interviewer is not satisfied with the answer, the interviewer can probe the interviewee for more details, for example by kindly asking more about the topic. Although the interview is unstructured, it is still needed to have a guiding set of topics that the interviewer wants to address (Martin & Hanington, 2012), and Preece et al. (2015) also argues that some sort of agenda is important to follow so that the desired information can be extracted from the users. However, due to the openness of the answers, the result will not follow a common format among all interviewees due to the inconsistent answers, therefore Preece et al. (2015) argue that unstructured interviews can be time-consuming to analyze.

4.2.2.2 Structured interviews

Structured interviews according to Preece et al. (2015) require the researchers to have clear goals and know exactly what to ask, since it is supposed to generate quick and straight forward answers. The structured interviews are the opposite of unstructured interviews, where Martin & Hanington (2012) argues that they should be perceived as formal and impersonal. As a result of the conditions, the interviews will be easier to control in terms of questions and time management. Preece et al. (2015) mention that the questions to be asked need to be short and clear and more importantly is that every interviewee should be asked the same questions. This would in turn make the analysis of the data easier (Martin & Hanington, 2012). Martin & Hanington (2012) also means that by asking the exact questions according to a script to every interviewee, the introduction of bias or altered interpretations by the researchers will be prevented.

4.2.2.3 Semi-structured interviews

The semi-structured interview is a combination of the structured and unstructured interviews where both opened and closed questions can exist (Preece et al., 2015). There will still be a script with questions that should be followed similar to the structured one, but after asking the interviewee each question, the interviewer can probe for more information just like in the unstructured one. For each question, the probing can go on until no new relevant information is available.

4.2.2.4 Focus groups

The focus group, also interpreted as interviewing people in groups, is when the interviewer interviews several interviewees at the same time, from three to ten people (Preece et al., 2015). A purpose of interviewing in this way is that diverse or sensitive issues can be raised easier due to the method assuming that such opinions are developed in social contexts by talking to each other. As a result of the interview being in a group, Preece et al. (2015) mean that focus groups are not meant for researching individual experiences, but rather researching community issues. The interviewee will act as a facilitator in order to guide the interviewees' discussion in the right direction of the interview's purpose. It is also important for the facilitator to give room for unanticipated issues raised, as they could support the research in ways that were not considered. Another important duty of the facilitator is to find a balance between every participant in terms of talking, for example more quiet people should be given the chance to talk while people who are too vocal need to be slowed down.

4.2.3 Questionnaires

Preece et al. (2015) describe a questionnaire as a technique for collecting data such as demographics and user opinions, by involving questions that are open or closed, similar to interviews, depending on desired results. According to Martin & Hanington (2012), open-ended questions provide depth in the response while closed-ended questions provide data that are easier to numerically analyze. Furthermore, Martin & Hanington (2012) means that the questionnaires are simple to administer and produce, but how the questionnaire is formed needs careful attention, in terms of wording and response options, length, layout, and design. However, achieving a well-designed questionnaire will secure a good response rate. Martin & Hanington (2012) proposes to use *Likert scale* questions since they allow users to respond in a way that will convey their strength of agreement or disagreement in a scaling manner rather than in a *yes or no* way.

An advantage of using questionnaires over interviews is that there is no need to put time into having conversations and planning appointments. The questions can instead simply be distributed to a large number of participants online, where the sample size of 20 is an acceptable number for interaction designers (Preece et al., 2015). However, this technique will lack the ability to extract a deep understanding of users, which conversational face to face interviews will provide.

4.2.4 Personas

Writing personas is a way of producing a rich description of the target users in a realistic way rather than describing the real users (Preece et al., 2015). The personas are typically written in a way that combines a number of real users that have been involved in the user research. The description itself is a narrative that involves life situations, goals and behavior of the users related to the design, which then can act as a guideline to design for the target users by the designers (Martin & Hanington, 2012). Martin & Hanington (2012) further argues that understanding what users exactly want is important in order to design a product. However, trying to design for everyone can introduce incoherent and unfocused design solutions. An argument that is made by Hartson & Pyla (2012) is to fully satisfy a small part of the target user group rather than trying to satisfy everybody. Attempting to satisfy everybody would end up in only a half-satisfied group whereas attempting to satisfy a small part of the group would make sure that each of them is fully satisfied. Hence in terms of personas, it is important to define them with concrete characteristics based on a small number of users rather than characteristics based on many other users with different opinions, which would result in an averaged persona.

The use of personas can also act as a tool for preventing future debates on what exactly the design needs since the persona is a clear proof of what users' need which is based on user research (Hartson & Pyla, 2012). In terms of designers attitudes, there is a difficulty for them to not design for themselves, therefore the persona can act as a reminder for designers to know what the users actually need (Hartson & Pyla, 2012).

Covering the target user group with only one persona is a difficulty with regards to a persona needing to focus on a smaller part of the group rather than everybody as mentioned previously. Therefore, Hartson & Pyla (2012) mean that it is necessary to produce as many personas as needed in order to fulfill the requirement of the users. However, Martin & Hanington (2012) argues that defining too many personas would result in not being able to manage the design focus and risking targeting extreme outliers. A more reasonable number of personas according to them is between three and five.

4.2.5 Storyboard

A storyboard according to Hartson & Pyla (2012) is a story of how users will use the design, illustrated as graphical sketches. They further argue that the sketches are not only drawings, but dialogues and annotations can also be involved where the result can be thought of as a comic book. This altogether should illustrate emotional perspectives such as deeper user experiences involving fun, joy, and aesthetics. The storyboard as a tool can be used to provide a role-play experience to stakeholders, where they can step through the series of illustrations by themselves (Preece et al., 2015). Martin & Hanington (2012) further emphasizes that storyboards are not only for designers with artistic capabilities, and simple and abstract drawings sometimes can be better than too detailed drawings as they could distract the purpose that

the storyboard should convey. Typically when designing storyboards, experts tend to use between three to six panels for just communicating one concept (Martin & Hanington, 2012). If more than one concept is to be conveyed, multiple storyboards need to be created where each storyboard portrays one concept.

4.3 Design alternatives

This section will present the intended methods to use for generating design solutions to the thesis' aim based on findings in the previous section about Establishing requirements.

4.3.1 KJ technique

The KJ technique is an idea-generating method that facilitates idea and information organizing (Martin & Hanington, 2012). Another factor that makes this method beneficial is that it gets rids of problems of traditional meetings, where it is known that only one person speaks at a time. According to Martin & Hanington (2012), this way of practice is time-consuming when it involves generating ideas. In the KJ technique, all the participants will instead simultaneously and silently generate ideas on sticky notes followed by posting them on a board that everybody can see. This will in turn provide a bigger perspective of the problem, by being able to get inspiration for what others have in mind and relate them, thus being able to generate even more ideas. Furthermore, when carrying out this session, it is important to have in mind that everybody's ideas are of equal representation where decisions are made democratically and not by the power of someone with a higher profile.

4.3.2 Affinity diagram

The qualitative analysis technique called Affinity diagram, is a way for organizing ideas or insights into a hierarchy of groups, which in the end should result in themes of concrete findings (Preece et al., 2015). The groups are formed based on the content of the ideas or insights that are to be grouped, rather than predefining groups in the start. Martin & Hanington (2012) calls this way of grouping *bottom up*, where the specific and small details are first formed as groups, which then gives the inspiration to form more overarching themes.

4.3.3 Sketching

Hartson & Pyla (2012) define sketching as a rapid way of expressing preliminary design ideas by freehand drawing with a focus on the concept as a whole without emphasis on the details. This method is not to be confused with prototyping, and instead it is a tool for exploring design possibilities. Neither is sketching a way for documenting a design by drawing, but rather a medium to facilitate the conversation of designers and the artifact. It can also act as a tool for retaining the understanding of designers while they are developing the concept further later on in the Prototyping

activity. Furthermore, sketching is not just about providing visual results, but it also supports the more important aspect of sketching, which is invention through embodied cognition Hartson & Pyla (2012). By sketching, you will embrace your hands, mind and all the senses into thinking, which will aid your ability to solve design problems and Hartson & Pyla (2012, p.286) gives a clear definition of this as: *"Designers invent while sketching"*.

4.4 Prototyping

This section will present the intended methods to use for producing prototypes that will support the research of the thesis. The prototypes will be based on the design solutions generated in Design alternatives. Furthermore, this section is divided into low-fidelity prototyping and high-fidelity prototyping, where the former is used in the earlier stages of the design process and the latter will be used in the later stages. But in general for the two forms of prototypes, Martin & Hanington (2012) describe them as a physical representation of a design concept generated in previous stages, which is essential for testing the concept in a tangible way with the stakeholders and the design team itself.

4.4.1 Low-fidelity prototyping

Low-fidelity prototypes are good for the early stages of the design process, where the design concept can be tested early on in order to get an evaluation from stakeholders, where this is an act of iteration between the Prototyping and Evaluating activities (Martin & Hanington, 2012). One thing that is important to have in mind is that a prototype of this fidelity will not come close to the final product in terms of looks and functionality (Preece et al., 2015). However, the strength lies in the simplicity, quickness, and cheapness of producing the prototype, which makes this option a good idea for producing it early in the design process. One way of producing a low-fidelity prototype in the context of a mobile application is paper prototyping proposed by Martin & Hanington (2012). This can be achieved by creating pages of the interface screens which then can be presented to the users as part of the evaluation. As the screens are static paper versions of a software, the users will have to indicate themselves on what they want to do in the design, while the designers will have to act as the *"computer"* by swapping screens in order to simulate the software. This kind of activity is also described by Preece et al. (2015) as *Wizard of Oz*.

4.4.2 High-fidelity prototyping

High-fidelity prototypes are compared to the low-fidelity prototypes much more refined in terms of representing the final product in functionality, look and feel (Martin & Hanington, 2012). Their potential lies in the later stages of the design process, where evaluation on them will provide feedback from stakeholders on aesthetics, form, interaction, and usability. Preece et al. (2015) also describe high-fidelity prototyping as a useful way of identifying technical issues and to sell ideas to people.

One way of producing high-fidelity prototypes in the context of mobile applications is by using the online tool Figma (Figma, 2020), which allows for effective collaboration in creating the interactive prototypes that are identical to final products in terms of look and feel.

4.5 Evaluating

This section will present the intended methods to use for evaluating the produced prototypes, which in turn will result in potential improvement changes in the concept and design. This is also the activity where stakeholders will be highly involved.

4.5.1 Heuristic evaluation

Heuristic evaluation is a technique that is used for detecting usability problems in a design before users of the design will be involved, by using a set of usability best practices (Martin & Hanington, 2012). Instead of involving actual users, the evaluation will involve members of the team ranging from expert designers to novice programmers in terms of user experience, where the aim is for these evaluators to detect the usability problems as a preparation for the *Usability testing* later. By fixing the baseline usability problems as preparation, the later usability testing will be more effective, and as a complementary effect, practicing this evaluation will improve the ability to detect usability problems.

The method is an invention by Jakob Nielsen and his colleagues, where they also have developed a set of best practices or usability principles that should be followed in the evaluation (Preece et al., 2015). These principles are also called Nielsen's heuristics (see A.1), where the evaluator should look at each of these heuristics when evaluating the design in focus, in order to judge whether there are usability problems in the aspects that the heuristics describe. A session according to Nielsen (1994a) should be one or two hours, where the evaluator goes through the design several times and comparing it to the heuristics, and a general recommendation is at least twice, or as Preece et al. (2015) also says, until the evaluator deems that there are no more problems to be found. In terms of the number of evaluators needed in evaluating a design, Nielsen (1994a) means that although one evaluator can detect usability problems, that evaluator will only find 35% of all the problems. Therefore, Nielsen recommends between three to five evaluators, which is the optimal number of evaluators according to a study of his.

The result of finding usability problems can be many, and even potentially more problems that you have time to solve. Some problems might be crucial to solve first, whereas other problems might be smaller and would not affect the design very much. Therefore, Nielsen (1994b) describes a technique where the usability problems found can be rated in terms of severity. The higher the severity of a problem is, the more time it should be given in order to be solved. By rating every problem found with a severity level, there will be a structured plan of what needs to be fixed first by the designers. Nielsen (1994b) means that the problem with the highest severity

level should be resolved first whereas the lowest ones even can be left for later stages if there is time. In terms of level definition, a problem can be rated from zero to four, where four indicates an urgent need of fix whereas a zero indicates that there actually is no problem with it.

4.5.2 Usability testing

Usability testing is the method where users of the design will be involved in order to evaluate the design (Martin & Hanington, 2012). This is accomplished by having the users complete certain tasks within the system, and the designers can then find usability problems based on the users' actions and feedback. The tasks given to users in the context of digital applications involve for example attempting to search for information or trying to navigate through screens. Based on the actions of the users, it is possible to get quantitative data by measuring performance time and errors made (Preece et al., 2015). For more qualitative data collection, the Think-aloud Protocol can be applied, which is described in the following sub-section (see Section 4.5.2.1). In terms of the number of participants for the usability testing, Preece et al. (2015) argue that an acceptable number is between five and twelve, which will provide the best result of the evaluation.

4.5.2.1 Think-Aloud Protocol

Applying the Think-aloud Protocol to the usability testing will provide qualitative feedback from the users, by making them talk their thoughts out loud to the designers (Martin & Hanington, 2012). While the users are performing tasks as mentioned earlier, they should describe every action they are doing as well as expressing their feelings. As a result of this, the designers can evaluate what is frustrating and confusing with the design and later be able to resolve these qualitative usability problems. Preece et al. (2015) also argue for this method that users must not complete tasks without verbal feedback, as this would leave the designers guessing what the users think. Martin & Hanington (2012) further mentions another variant of this method, called *Retrospective Think-aloud*, which instead of requiring users to give verbal feedback while performing tasks, they should give a retrospective of the tasks in the end.

5
Planning

This chapter describes how the research of this thesis is planned over 20 weeks where the end-goal is to achieve the *aim* described in Section 1.1, by employing *Research through design* (see Section 3.1). Additionally, a Gantt schedule is used for complementing the description of the plan by giving a better visual overview of all the activities (see Figure 5.1 below). The plan follows an *iterative design process* proposed by Preece et al. (2015), also described in Chapter 4, with a selected set of suitable Interaction design methods that have been chosen to be used based on literature studies and previous experiences.

Figure 5.1: The Gantt schedule of this thesis

5.1 Planning, report writing and presentation

The beginning of this thesis will start with reviewing Svalna's carbon calculator and other related work, and researching academic literature in order to get a better understanding of the field of study. Reading academic literature acts as a way of analyzing results of the research area that has already been attempted or proven by other researchers. The research of other researchers can then be used to strengthen the research of this thesis, but it is important be source critical and study papers that are trustworthy. In terms of the literature, this firstly involves the background and theory needed for understanding the context of the thesis and secondly, methodology in Interaction design. These foundations of knowledge will support the planning and execution to reach the thesis' aim.

Furthermore, there needs to be continuous report writing so that a final report can be delivered in the end. Continuous writing is an important act, as it basically will store the freshest memory of the process in an arbitrary medium, which in turn will provide an accurate thesis process and result in the end. Towards the end of the

thesis work, the final report needs to be close to complete, and a presentation of the thesis work needs to be done. Once the thesis has been presented, the thesis needs to be completed as well, based on final feedback from both opponents and supervisor of the thesis work, before being able to submit the thesis and eventually graduate.

5.2 Research

As mentioned in the previous section, it involved researching the context of the thesis in terms of background, theory, and methodology, however, there needs to be more research done. This will specifically be in user research, which is needed in order to understand who the users are and what they desire in potential challenges within carbon calculators that can support pro-environmental behavior change. The intended plan is to use *Semi-structured interviews* and *Questionnaires* described in Sections 4.2.2.3 and 4.2.3, as the methods for finding user requirements. In general, the content that is to be extracted from the users will involve pro-environmental behavior change in Svalna's carbon calculator with focus on challenges. In the end, the interviews and questionnaires will provide data of users' thoughts which will be used for defining user requirements that will control the direction of the process towards the result. For a better summary of the data in another form than a table of users' answers, *Personas* and *Storyboard* described in Sections 4.2.4 and 4.2.5, will be used for summarizing the user requirements which will facilitate the later stages of finding design solutions. In terms of finding users for research, Svalna will be able to provide a contacting network to their users. Therefore, finding users for researching content in a carbon calculator will not be an issue.

5.3 Ideation

After gathering data from the users, design solutions will be designed using *KJ technique*, *Affinity diagram*, and *Sketching*, described in Sections 4.3.1, 4.3.2, and 4.3.3. These methods are useful for generating concrete ideas both in text and visual form, which gives a bigger perspective of the solutions. The *KJ technique* will be a session where the thesis researchers will generate ideas with both the user data and theory as support, such as *pro-environmental behavior change* and *persuasive technology* described in Chapter 3. In the end, the design solutions will have more potential to answer the *Research question* due to the support of theory and user research. *Sketching* will in turn provide ideas in the form of visualizations which are further developments of the ideas generated previously. This will both provide new ideas and more concrete ideas, which can be used in the *Prototyping* activity.

5.4 Design, Prototyping and Evaluation

This section will involve both *Prototyping* and *Evaluation*, described in Sections 4.4 and 4.5, since there will be iterations of these steps multiple times, in order to pro-

duce user satisfied design solutions. Firstly, *Paper-prototypes* of the design solutions will be created as early phase prototypes. This will serve as a way to secure that the design solutions developed are in the right direction, by involving evaluations with stakeholders. In terms of evaluating the prototypes, discussing the solutions with experts within carbon calculators, as a form of a *Semi-structured interview*, will be a fast and effective way to evaluate whether the solutions are in the right direction. Due to Svalna being closely connected to this thesis' work and are experts in the field of carbon calculators, they will be the perfect targets to involve. Although, involving users of carbon calculators, such as Svalna's users, this early on is by no means a bad decision. However, the time constraint is a factor and involving users of Svalna might not be suitable due to the need of very time-consuming meeting planning and execution, especially since it still just is a paper prototype of low quality. On the other hand, people that are easier to find, such as Interaction design students at Chalmers, will be involved in the same way as the experts in Svalna. This will save time and also prevent too much bias from people at Svalna, which might happen if they are too focused on what they desire in their product.

After the low-fidelity prototyping phase, a higher fidelity prototype can be created in Figma (Figma, 2020) where improvements from the previous evaluations have been made. This is also where users of Svalna will be involved for evaluation using *Usability testing* with the *Think-aloud Protocol* (see Section 4.5.2), where users will be able to evaluate the experience of using the prototype. In the same session after the testing, users will also be asked questions regarding the design solutions in the form of a semi-structured interview. This will involve a range of questions regarding how the design solutions have potential in supporting behavior change towards a sustainable lifestyle. There could be a risk that users might not feel confident in giving their true feedback on a high-fidelity prototype, since the prototype might look too good to be changed. Therefore it is important to emphasize to the users that they are free to give any opinions that they want. The number of users involved will be as many users as possible within the time constraint as well as how many users that can be found. But following Preece et al. (2015), a number between five and twelve is preferable. Svalna will again be able to provide a contacting network to their users, which can be taken advantage of. However, before the evaluation with users of Svalna, a *Heuristic evaluation* with the researchers themselves, as well as experts from Svalna as a company will be conducted. This will, as described in Section 4.5.1, act as a preparation for the testing with actual users. In the end, the number of iterations of usability tests and prototype improvements depends on how much time different factors will take, and also how many users that can be reached. But the goal in the end is to deliver a result as good as possible to answer the research question and satisfy the stakeholders.

6
Process

In this chapter, the process of the research execution will be documented in a chronological order. Each section will describe in detail how different methods from Chapter 4 have been used for achieving a result that the *Research question* asked for.

6.1 Domain research & Planning

The thesis research started with reviewing related products in focus, specifically Svalna's carbon calculator mobile application, where the analysis of the products can be seen in Section 2.3.3.1. This involved using the products and analyzing all the elements in detail, with focus on how the designing of challenges is approached in terms of supporting sustainable behavior. Furthermore, by reviewing the products, it not only provided a good understanding of the medium that was to be worked on, but it also provided early insights on what could be improved. Having an early understanding of the products facilitated the later stage when doing user research, such as knowing what to specifically ask users. It also facilitated the later stage of ideating design solutions, since insights on what could be improved would always be in mind, due to a continuous problem solving happening in the brain.

To better understand the area of research, relevant academic literature was important to study. In terms of the academic papers that were studied, they were mainly within the area of; *carbon calculators and sustainability*, *pro-environmental behavior change*, *persuasive HCI and technology*, and *methodology in Interaction design*. How the papers were found was mainly with the help of Google Scholar (Google, n.d.), where doing a simple search on the previous mentioned terms provided many relevant papers to read.

With the extensive knowledge of background and theory in the field of research, it was possible to create the plan of the thesis execution. This plan was carefully thought through in order to fit in the important stages of the Design process described in Chapter 4, where the goal in the end was to answer the research question of this thesis.

6.2 User research

Even though the domain research described previously covered a large part of the thesis research, there needed to be research done on the actual users of carbon

calculator in order to understand who the result should be designed for and what requirements they have. If there is no user research, then it will be difficult to find design solutions that satisfies users' requirements. As a result of that, it will be questionable whether the design solutions can support behavior change towards a sustainable lifestyle, as asked by the research question. In terms of finding users of carbon calculators, Svalna were able to provide a contacting network to their users, as a resource of help in doing this thesis. Therefore, the user research mainly consisted of interviewing Svalna's users, and then questionnaires as a complement to the interviews were also sent to users of Svalna. The data gathered would then be analyzed and turned into personas and storyboards for better summaries of the target users, which would become helpful for understanding the users throughout the design process. The data would also be the center of the ideation in the later stages, where ideas generated would consider the user requirements.

6.2.1 Interviewing users of Svalna

Interviewing users of Svalna was a crucial part of the research since it provided a deep understanding of user requirements which let the researchers know how solving design problems could be approached with the users in mind. The interviews were semi-structured (see Section 4.2.2.3), which meant that there was a predefined agenda on what questions that were going to be asked, but it was also possible to probe for further information based on how a potential discussion developed. The main goal of the interview was to ask users what they felt about Svalna's approach on challenges. But firstly, it was important to ask some background questions such as what makes the users sustainable, and how Svalna helps them to become sustainable. This gave the interviewers a better understanding of the interviewees' mentalities, which would helped to differentiate how different individuals with different mentalities look at the challenges. Furthermore in terms of the main questions, it was important to ask the interviewees why they would want to do challenges, and whether and why they are dissatisfied with the challenges. Finally, a crucial question was to ask how challenges could be improved in terms of supporting users more towards a sustainable lifestyle. In the end, this provided a good understanding of who users are and what they require in challenges that attempts to support sustainability in users. In B.2, all the predefined questions that were asked can be seen.

Interviewing face to face was a prioritized request which would mean that the users for the interviews had to be in Gothenburg, due to the thesis being researched in Gothenburg. However, some of the users who were willing to participate did not live in Gothenburg, therefore phone interviews had to be conducted too. In the end, there were two interviews face to face in Gothenburg, and four phone interviews with users in other parts of Sweden. In conclusion of face to face versus online interviewing, the difference in outcome was not very significant, but it was noticeable that the face to face interviews resulted in a bit more data gathered. However, this also depends on who the user is, such as being talkative or comfortable with interviews, and some people may even feel more comfortable to talk behind a phone.

Conducting each interview took between 40 to 50 minutes, which matched the estimation done by the researchers. Each interview started with an introduction of the agenda and it was also emphasized that the interview was anonymous. The interviewees also had to sign a consent form (see B.1) where they had to agree that the data from the interviews could be used in this thesis. However, interviewees were not forced to do anything that they did not want to do and cancelling the interviews was allowed at any time. They could also permit the interviewers to audio record the interviews, which all interviewees allowed. The recordings were valuable to the researchers, since it was possible to listen to the interviewees thoughts in detail after the interviews. Once the recordings had been analyzed, they were deleted. The actual findings of the interviews and how they had been analyzed will be presented later in Section 6.2.3.

6.2.2 Unsuccessful attempt in using questionnaires to support the interview data

Using questionnaires is a flexible and time efficient method for gathering data from users and can be distributed to many users effortlessly by using online tools. However, it is difficult to get deep and detailed answers from users for the purpose of this user research, which an interview can provide. Therefore, this questionnaire acted more as a complement to the interviews, rather than a research on its own. In terms of finding users to answer the questionnaires, the contacting network to Svalna's users could once again be utilized, with approval from Svalna. However, Svalna also wanted to find answers to their researches at the same time, but did not want to send out too many questionnaires to their users (one for this thesis and one on Svalna's side). Because this could potentially damage their image as a company, due to *"spamming"* their users. Therefore, it was agreed to collaborate and create one merged questionnaire together. In spite of that, the questionnaire still had a consistent theme in favor of the thesis group, and it definitely did not turn into two different questionnaires inside one. But it has to be noted that some questions would not be useful for the research of this thesis, but those could easily be filtered out. The main questions that were asked by this thesis group were all quantitative questions and revolved around; *how often Svalna is used*, *whether Svalna is of any help*, *what users think of Svalnas approach on challenges*, and *whether users needed motivation and concrete suggestions to reduce emission*. Additionally, the questionnaire also involved some lower profile questions about comparison within social aspects, and gamification. This would then provide an understanding of how these factors would play a role in designing challenges. For full set of questions, see B.3.

Unfortunately, due to certain errors made when Svalna gathered all the answers in the end, the questionnaire results became faulty and could not be used. Therefore, the analysis of the questionnaire data had to be left out from this research. But since this questionnaire acted as a complement to the interviews rather than a research on its own, the quality of the final outcome of the user research was not worsened. The interviews on their own were in fact capable to capture insights

that the questionnaires asked for, however the downside was that the interviews could not capture the bigger quantity. Furthermore, creating questions for the questionnaire required a thorough analysis of the research field in this thesis in order to generate meaningful questions that could yield useful data. Therefore, by creating this questionnaire, the understanding of the research in focus became stronger.

6.2.3 Analysis of the user research

The analysis of the interview findings was made with the help of using the Affinity diagram (see Section 4.3.2) which provided data structuring and in the end facilitated finding themes in the data. The themes could thereafter be used to provide crucial concrete insights of users in the personas and storyboards, as well as in the later stage of ideation. The process of building the affinity diagram resulted in what can be seen in Figure 6.1, which shows the themes of users' feedback. The findings will be summarized in the next section, but a clearer result of the affinity diagram can also be seen in B.4.

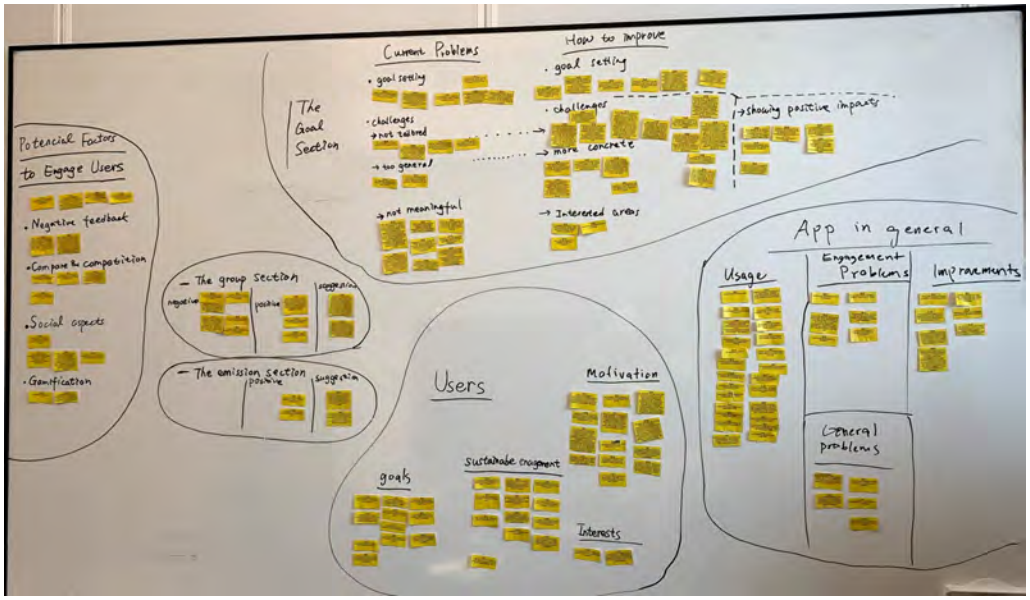


Figure 6.1: The result of using affinity diagram

6.2.4 Result of the user research

The result of the affinity diagramming will be presented below as summaries based on the full result, which can be seen in B.5 as a list of concrete findings. Furthermore, since the research of this thesis focused on the aspect of challenges in carbon calculators, the focus point of the following results will be on challenges, even though the full result covers other parts of a carbon calculator.

Users mentalities in acting sustainably

The mentalities of the users extracted from the research, were all focused on try-

ing to achieve a more sustainable lifestyle. However, the capability in achieving a sustainable lifestyle with the help of the carbon calculator differed. Some users understood clearly what sustainability meant, but the carbon calculator did not provide the extent of encouragement to these users to actually commit to behave more sustainable. Then there were users who were quite willingly in behaving sustainable, however, these users lacked the knowledge to fully understand how to act sustainably. The carbon calculator did either not provide such knowledge to the extent to really become more sustainable. But in the end, the importance in these users' mentalities was that they all strived for becoming more sustainable.

Problems in challenges
In terms of challenges, the users meant that the challenges were not tailored for their needs, and further meant that challenges should be meaningful, motivating, applicable, and suitable for users' situations. A user was very frustrated about the fact that the carbon calculator recommended a challenge about driving less, when the user did not even use or own a car. Another user meant that a recommended challenge regarding *"working less"* did not make sense. Because this user worked within striving for improving sustainability, therefore working less according to this user mean less contribution to better sustainability. Furthermore, it was also emphasized by users that the challenge were not concrete and clear enough, in terms of providing support on how challenges could be done. If the challenges did not provide information on how to behave sustainably, then the users would not do the challenge.

6.2.5 Personas for describing the target users

Based on the user research findings presented previously, two personas were created (see B.6 and B.7) which represent the main user target group that should be designed for. In short, *Persona 1* is about a user who is knowledgeable in sustainable behavior and knows what is required to act sustainable, however, there is a huge lack of engagement to do so. *Persona 2* is the other way around, which is lack of knowledge in sustainability but has the willingness and engagement to become sustainable. The two main factors, *knowledge* and *engagement*, can also be related to the theory of persuasion and behavior change described in Chapter 3. Knowledge can refer to Fogg's theory of needing *ability* in order to achieve a certain behavior, or according to Geller's behavior change model, which is *instructional intervention*. *Engagement* can on the other hand refer to Fogg's theory of needing *motivation*, or *motivational intervention* according to the behavior change model.

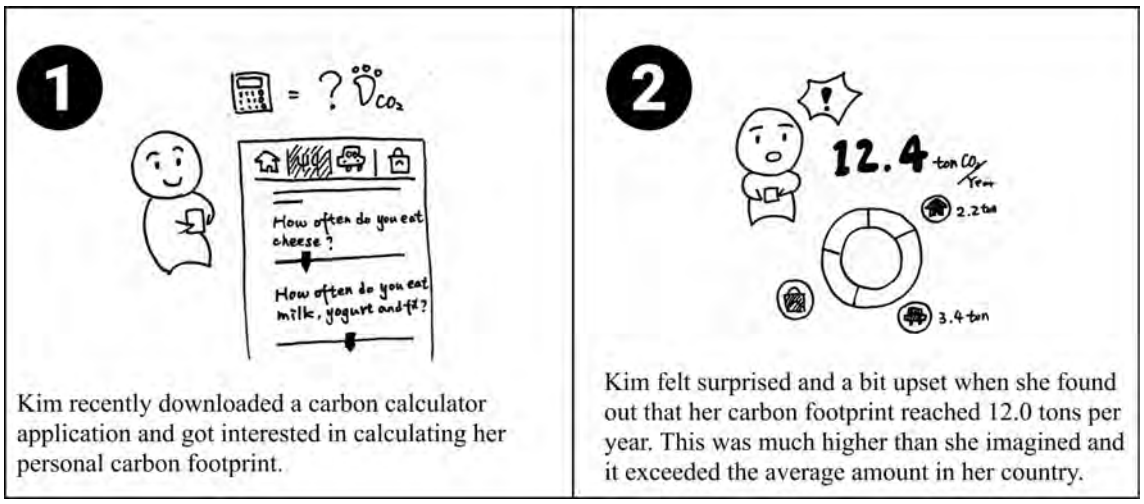
6.2.6 Storyboards for conveying user experience

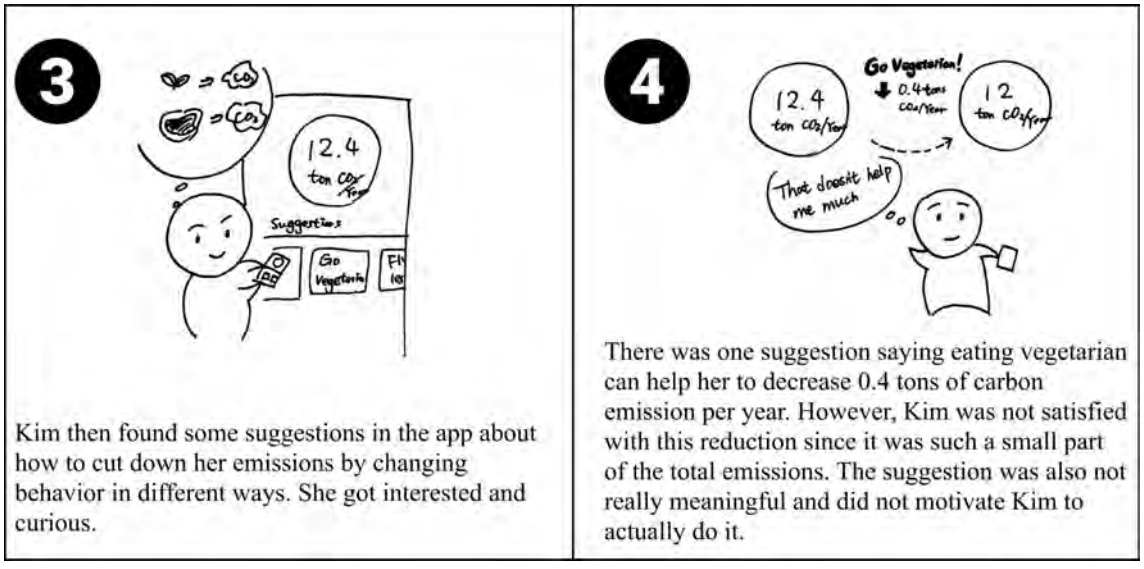
Based on user research findings presented previously, four storyboards were created based on different scenarios of users. The storyboards were useful for expressing users' experiences of what they were lacking in carbon calculators, specifically Svalna's carbon calculator. In contrast to the personas, the storyboards convey an experience through simple scenarios with pictures whereas personas involve a de-

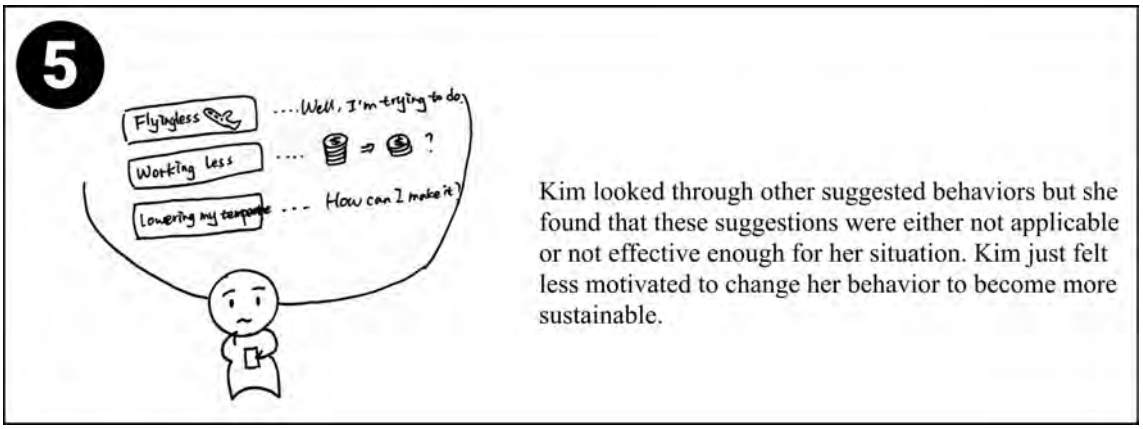
scription that is more detailed but requires more focus in order to understand. The following will first present the main storyboard created. Then three other ones will be presented as short descriptions and the full storyboards can instead be found in B.9, B.10, and B.11.

Storyboard 1: Current problems of the challenges in the Goal section

This storyboard expresses the experience of a user who attempts to do challenges within a carbon calculator, in order to lower the emission. However, it turns out that the challenges are not tailored to users' situations. They are not meaningful, motivating, applicable, or suitable enough.







Storyboard 2: Current Problem of the Goals
This storyboard demonstrates how setting a goal in a carbon calculator lacks in supporting the user to actually achieve the goal. Once the user sets a goal, there is neither motivation nor instructions on how to reach the target goal set. See B.9.

Storyboard 3: To create more engagement by involving social aspects
This storyboard shows how a social aspect can support in learning more about sustainability, via knowledge sharing. See B.10.

Storyboard 4: To create more engagement by showing potential effects
This storyboard explains how showing potential effects of user actions can affect the decision of the user. The potential effects presented to the users can play a huge role in preventing the users to not cause too much emission, before they actually attempt to do so. See B.11.

6.3 Ideating design solutions

After the user research, it was deemed that the information provided by the users was enough for starting to produce design solutions for this thesis. For producing design solutions, it was needed to have an ideation session, consisting of two main steps; generating many ideas using the KJ technique and Affinity diagram (see Section 4.3.1 and 4.3.2), and then making the ideas more concrete by Sketching (see Section 4.3.3), which will be presented in the following sections.

6.3.1 Generating ideas based on user data and theory

The ideation session was started off by generating ideas silently by following the KJ technique. For supporting this idea generation, the concrete findings from the user research were used and placed on the board for continuous reminding of what users were requiring. Additionally, to make use of the theory of this thesis, keywords from *pro-environmental behavior change* (see Section 3.2), *intervention techniques to*

promote pro-environmental behavior (see Section 3.3), and *Fogg's persuasive technology* (see Section 3.4), were also placed on the board for making sure that the ideas generated were supported by theory. The total support in ideating using the KJ technique resulted in the concrete findings from the user research analysis (see Section 6.2.3), and 27 keywords based on the theory. On top of that, the personas and storyboards that were created earlier were of great use in terms of providing a summarized understanding of users, which helped steering the researchers' mindsets towards the users' requirements. Furthermore, the way this KJ technique was carried out was by using a digital board online, Google Sheets, instead of going by the traditional way of using a physical whiteboard. This digital medium for ideating was experienced to be more flexible than what the physical way would be (which was used in the user research analysis, see Section 6.2.3). Because the digital one allowed for quick note writing and movement, as well as being able to transport it instantly, in case it was needed to move location. It also allowed for remote ideation, which was important when it was not ideal to meet physically due to risks and restrictions (see Section 8.4). In the end, the digital board was still a board that could serve the same purposes as a physical whiteboard (if not better, according to the thesis group), that is, writing, placing notes, and providing an overview of all notes. As a result of using the KJ technique with the user research findings and theory, there were many ideas generated, which can be seen in B.12.

Afterwards, the ideas were analyzed by creating an Affinity diagram where it was possible to group the ideas and form more concrete ideas, which can be seen as themes in the findings. This was made digitally and the reason behind making it digitally, was the same as mentioned earlier in the KJ technique. In the end, it resulted in 23 concrete groups of ideas, within six umbrella themes, and the affinity diagram can be seen in B.13. The themes found could be defined as; (1) *user centered design*, (2) *tips/education, feedback, and how they are communicated to users*, (3) *goals*, (4) *challenges*, (5) *gamification*, and (6) *social aspects*. These concrete ideas were then used in the following section for further idea development.

6.3.2 Elaborating the ideas by sketching

The 23 concrete groups of ideas within the six umbrella themes were further developed by Sketching (see Section 4.3.3). The thesis researchers individually sketched elaborated ideas for each of the 23 concrete groups of ideas, where Figure 6.2 shows a small selection of the many sketches generated. For the full set of sketches from researcher one and researcher two, see B.14.

By making these sketches, the ideas were not only getting more developed, but more new ideas were generated based on the original ideas. The sketching also allowed for attempting to actually start to create concrete interfaces of design solutions, instead of only describing ideas with words. This gave an early feeling of whether certain design approaches actually were suitable design solutions and had potential to solve the issues of inadequate challenges as seen in Svalna's carbon calculator. After each researcher of this thesis had sketched ideas based on the 23 concrete groups from

the affinity diagram earlier, as well as having the personas and storyboards created earlier in mind, the ideas were presented to each other. This acted as idea sharing for further inspiration and ideas could be discussed even further. After discussions and further sketching, it was decided to merge ideas that the researchers considered had potential. This merge was represented as a table of design solutions and how to approach them, which can be seen in B.15. The table then acted as a crucial source on how creating prototypes could be approached, which will be presented in the next section.

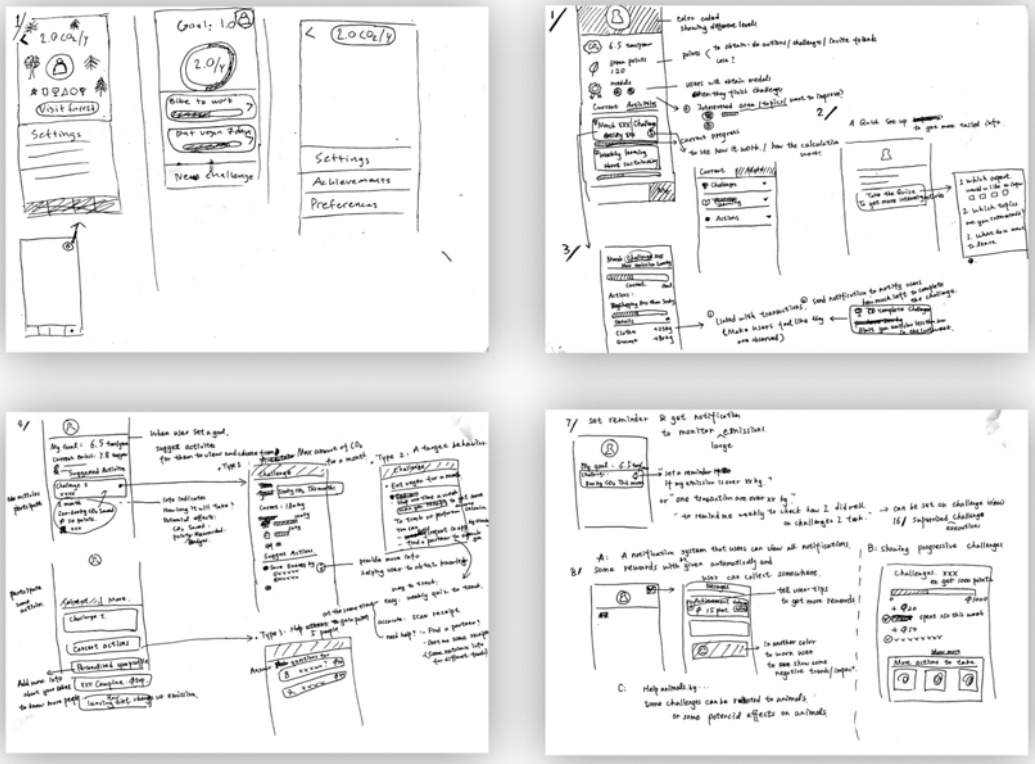


Figure 6.2: A selection of sketches, based on the 23 concrete groups of ideas from the Affinity diagram (see B.13).

6.4 Low-fidelity prototyping

With a clear vision towards making prototypes with the help of results from the previous ideation session, it was decided to start off by making quick paper prototypes of low fidelity. The quickness and simplicity of making prototypes made out of papers allowed the researchers to evaluate the design solutions early on by involving stakeholders. Because the earlier a design can be evaluated, the more time there will be afterwards to improve it. The paper prototypes were also capable enough for conveying a clear understanding of the design solutions, since this was not about colors and graphics, but rather about how the concept of the design worked. Whenever the prototype was to be presented to stakeholders, they would be

able to evaluate whether the design solutions were going into the correct directions in terms of having the potential to satisfy the end users.

The following sections will present the produced low-fidelity paper prototypes and the evaluations of them with stakeholders, in two phases. The first phase will be about creating paper prototypes and evaluating them with Svalna as a company. The second phase will be about creating an improved version of the first one based on the feedback from Svalna, and then conduct evaluations on it with Interaction design students at Chalmers. By evaluating the prototype with other people than employees at Svalna, it will provide more perspectives than what Svalna as a company might be able to give, as well as potential bias from Svalna will not be the only evaluation that can be analyzed. Furthermore, people with Interaction design backgrounds are also able to provide expert feedback since they are evaluating something that they are experienced in. Although, conducting these evaluations with actual users of Svalna would have been ideal since they are the end users, but time constraints hindered that option. Finding Interaction design students on the other hand, was quicker and more flexible, due to the researchers of this thesis having close connections with them.

6.4.1 First phase of the paper prototyping

The creations of the first phase paper prototypes were made individually by each researcher so that the result would end up in two different prototypes. By ending up in two types of prototypes, there would be more aspects that could be evaluated. However, it could also be argued that it would be better to create even more prototypes, but the time constraint only allowed for two. The following two prototypes approached the idea of doing challenges quite differently. The first one used gamification to engage users to do the challenges, whereas the second focused on creating a tailored user experience when doing challenges. But in the end, they both aimed to create concrete, informational, and encouraging challenges.

6.4.1.1 Paper prototyping version 1a

Figure 6.3 shows a set of selected screens of the first prototype of phase one, and for the full prototype, see B.16. This prototype had the focus to use gamification for engaging users to be more engaged in acting sustainably. The idea was to make users do challenges as part of a game, where doing more pro-environmental challenges would make users progress further and become better in the game. The game was to build a virtual forest, and the more GHG emission the users reduce by doing challenges, the healthier and better looking would the forest become. Then doing challenges would both be fun and tempting to do, where users would strive for the best looking forest. The challenges had also been improved from Svalna's carbon calculator. They were made more concrete, instructional, and had the potential to create more engagement in sustainability. This was achieved by showing instructions, progress, and concrete facts of benefits of doing the challenges. In the end, this prototype tried to support users to adapt to an environment-friendly lifestyle

by doing challenges that potentially could support and teach users to achieve a sustainable behavior in a fun way.

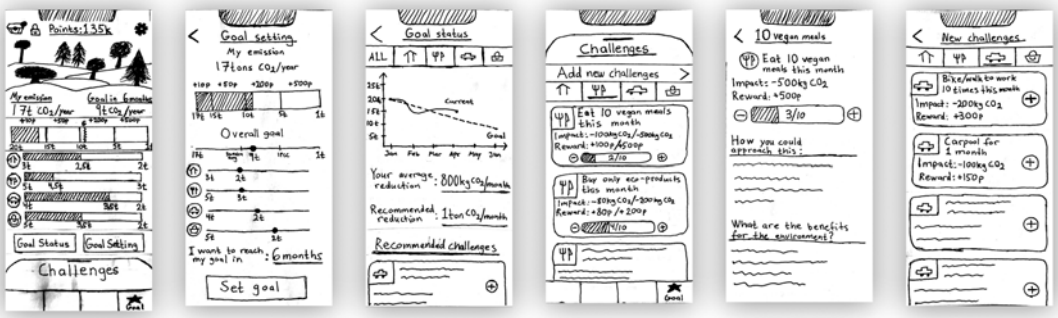


Figure 6.3: Paper prototype version 1a

6.4.1.2 Paper prototyping version 1b

The second prototype which can be seen in Figure 6.4 (for full prototype, see B.17), focused on supporting the users to achieve goals and complete challenges in a simplistic and user focused approach. Firstly, in order to tailor the challenges for the users, the users would have to go through an onboarding process. The process would allow the users to provide preferences and interests in terms of acting sustainably. In the end, the users would be served with perfectly tailored challenges that the users really would like to do. After the onboarding, the users would have their plan ready and they could start working on completing their challenges. Furthermore, the tracking and completion of the challenges were created in a way that would give the users supportive progressiveness and would provide senses of achievement when doing challenges. For every challenge that the users would complete, they would earn a badge which represented their achievement, and acted as an engagement factor of willingness to keep up with doing challenges. Lastly, looking at the details of a challenge, it would show proper instructions on how the challenge could be approached as well as showing the benefits of doing the challenge in terms of being sustainable. The users would also be given the freedom to customize when to do the challenges, as a form of a scheduling system, where users would be notified to keep up with the challenges. In the end, this prototype tried to give the users a tailored and simplistic user experience that potentially could support users towards behavior change in sustainability.

Figure 6.4: Paper prototype version 1b

6.4.1.3 Evaluation on the paper prototypes with Svalna

After creating the two prototypes, they had to be evaluated so that it could be known whether the prototypes were suitable for going forward, and which prototype that was going to be focused on. This evaluation was conducted together with an employee and the CEO of Svalna, and it had to be in the form of an online meeting due to the circumstances described in Section 8.4. The evaluation was like a discussion, where the prototypes first were presented to the two participants from Svalna and thereafter the participants could give feedback on each of them. The feedback and analysis for each prototype will be summarized in the following paragraphs.

Feedback on paper prototype version 1a
The evaluators from Svalna liked the overall idea of having gamification as a way of engaging users to keep up with behaving sustainable. However, this game was deemed to be too complex and difficult to understand, therefore it was recommended to not go with this approach. Although, it was still a possibility to involve gamification, but then the game should be made more simplistic in terms of being able to understand it. Regarding the challenges, the people from Svalna thought that it was a big improvement from the ones that Svalna provided at the time of writing. Making the challenges concrete with important information and guidance to users was encouraged by the evaluators. Overall, the evaluators recommended to keep the design simplistic, but still being able to support users with supportive challenges.

Feedback on paper prototype version 1b
This prototype was favored a bit more than version 1a according to the evaluators from Svalna, due to its simplicity and user focused challenges. The onboarding process was a big plus since it could let the system learn more about the users and tailor content for them. The way of presenting the challenges and letting users schedule their challenges was seen as a good approach for making the users keep up with their sustainable behavior. However, the evaluators emphasized that making the challenges too complex in terms of information layout and customization should be reconsidered. The reward system of getting achievements for completing challenges was a good approach since it was not overpowering like a gamification would be,

but still being able to encourage users to strive for doing challenges. Using less text overall was also recommended, which also is a key to keeping the design simplistic. Overall, the prototype had a good direction in creating a good user experience for users in doing challenges and it was recommended to keep on focusing on simplicity for the users.

6.4.2 Second phase of the paper prototyping

In conclusion of the feedback on the two prototypes, it was determined to create a second phase paper prototype which was going to be based on the positive aspects extracted from each previous prototype. The aspects involved overall simplicity, user focused challenges, simplistic yet engaging rewarding system, and an onboarding process in order to tailor the content for the users. The following will present a selected part of the prototype created, for showing the crucial parts of the solutions. For the full prototype, see B.18.

The onboarding process
The onboarding process in Figure6.5 allows users to setup their preferences the first time they are using the goal section, which makes it possible for the system to tailor content for the users and thus give them a good user experience.

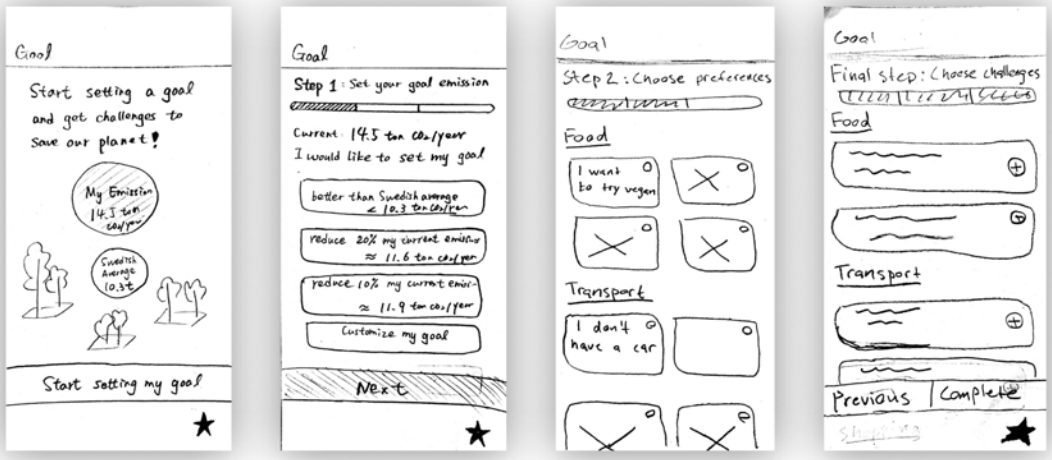


Figure 6.5: Paper prototype phase two: Onboarding screens

Overview of challenges
The main screen consisted of two parts, the goal and progress of doing challenges on the top, and the active challenges underneath (see Figure 6.6). The progress is simplistic which shows how the users' are progressing forward by doing challenges and behaving sustainably. The challenges part on the other hand contains a list of users' active challenges, and an overview of how challenges are planned in the form of a calendar view. The list of challenges shows and reminds the users of what they currently need to do, according to the challenges' behaviors. Once the users have

completed them they can tap on a complete button for each challenge that they complete. The presentation of the challenges will engage and remind users to keep up and do the challenges, and the way users can complete the challenges by tapping on the complete button is supposed to give the users a sense of achievement. In the calendar view on the other hand, the users can see an overview of how their current challenges are scheduled. This should act as a schedule to remind users when challenges should be done. Overall, the challenges part should give the users a good user experience when attempting to do challenges. As a result of that, the users would be able to potentially achieve a sustainable behavior in the end.

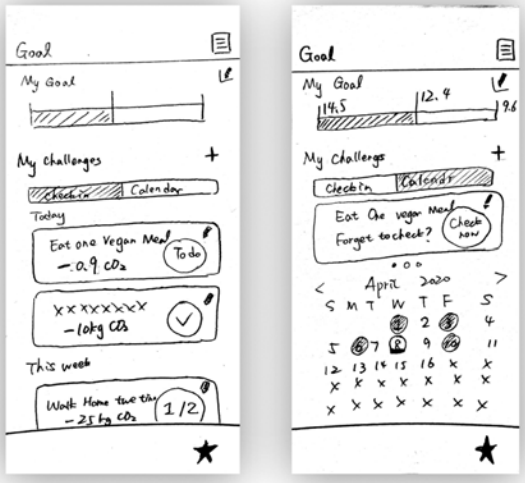


Figure 6.6: Paper prototype phase two: Main screens

Overview of accomplishments

In order to improve the engagement in users for doing more challenges, the prototype provides possibilities where users are able to explore more about what they have achieved, which can be seen in Figure 6.7. Firstly, there will be a place where users can see how they have progressed by doing challenges, such as how much GHG emission they have been reducing. By making users see positive progress of doing challenges, the users might get more motivation to keep on doing challenges. This approach was inspired by one of Fogg's seven persuasive technology tools, *Reduction: Persuading through simplifying* (see Section 3.4.2.5), where being able to monitor oneself will help in going towards the right direction. Secondly, there will be a place where users can see what they have been awarded for doing challenges, which can be seen as achievements. By awarding users with rewards for doing challenges, users might feel more motivated to keep on doing challenges so that more achievements can be collected. This was also inspired by one of Fogg's seven persuasive technology tools, *Conditioning: Reinforcing target behaviors* (see Section 3.4.2.7), where awarding users for doing a task will make them more likely to do the task again next time.

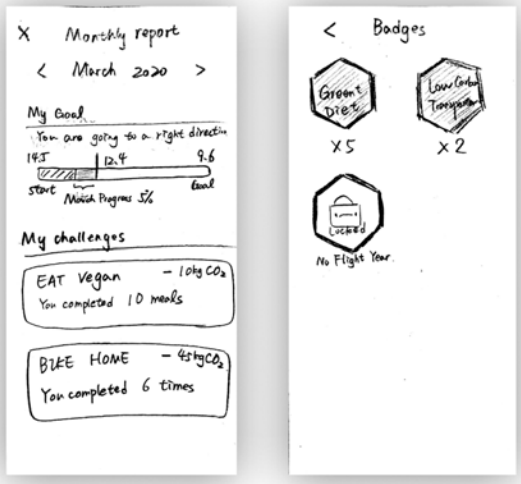


Figure 6.7: Paper prototype phase two: Monthly report of personal progress to the left. Achievement system to the right.

6.4.2.1 Evaluation on the paper prototypes with two Interaction design students

The evaluators in this evaluation consisted of two Interaction design students, where each of them participated individually. Before the evaluations, the participants were asked to sign the consent form seen in B.1, so that it could be made sure that the feedback from them could be used anonymously with permission in this thesis. Furthermore, the evaluations were carried out in the same way as the one in phase one due to same reasons, which was in the form of an online meeting. The prototype was demonstrated to the participants and after that, a discussion started where the participants could give feedback freely. However, the participants were not users of Svalna or any carbon calculators, and therefore, Svalna's carbon calculator had to be explained. Although, this was done without any comprehension issues at all. The following will present a summarized feedback of the significant findings regarding challenges in the prototype from the two participants. For more details on what the participants said, see B.19, where a structured table shows the participants' feedback on different parts of the prototype.

General thoughts

According to the evaluators, the prototype in general had a clear flow that would motivate them to use the application more often. The approach of the pro-environmental challenges and how they had been designed would make the evaluators feel good about themselves if they were to do them.

The overview of challenges
In terms of how the challenges were being presented to the evaluators, they thought that the design was simple and intuitive. However, there were some aspects that could be improved according to them. The evaluators wanted to see encouraging feedback for completing challenges so that they could know whether they had accomplished something meaningful. Regarding the calendar view of the challenge scheduling, the evaluators found it useful since it gave an overview of all the challenges so that they could track what had been done and not done. But one significant issue noted was that too many active challenges at the same time would crowd the view. However at the same time, the evaluators still wanted more functionality in the calendar view that could enhance the user experience, therefore, managing and getting the most out of the space is crucial.

The challenges
The evaluators also reacted on the complexity of having to customize the challenge too much apart from the scheduling, before getting to start the challenge. They meant that the challenges should be more predefined so that users can start immediately without having to configure too many settings. For the content within a challenge, the evaluators would want to see more concrete information, benefits, and instructions of doing the challenge, as well as improving how they were presented to the users. One critical aspect that was brought up to the evaluators was regarding whether showing suffering animals to the users was a good idea for encouraging them to become vegan. However, there were mixed feelings about this, where one evaluator thought it was useful whereas the other one thought the opposite.

6.5 High-fidelity prototyping

The high-fidelity prototyping (see Section 4.4.2) in this thesis was used for producing a product that was close to a final product in terms of look and feel, however without being a functional mobile application software. This prototype would be used for finding out the answer to the research question, where being able to present the design created in a realistic looking way was more important than having it functional in the field. Because the most important factor in the end was for the users to be able to understand what had been created so that they could evaluate whether the design solutions satisfied their needs or not.

The following sections will go through how the high-fidelity prototype had been created, which was based on the low-fidelity prototype and evaluations presented earlier. This involved the creation of the prototype in a design framework called Figma (Figma, 2020), as well as evaluating it both internally, and externally with Svalna's users, so that the prototype could be improved further.

6.5.1 Prototyping in Figma

In order to create a product that is identical to a final product in terms of look and feel, the design framework Figma was used. The low-fidelity prototype created previously was replicated as a more refined version in Figma with the previous evaluations in mind. In terms of design element choices and themes, Svalna was able to provide their design library, where design elements and themes could be used for designing the concept created in this thesis. The design library from Svalna facilitated the process of making design decisions in terms of for example what colors and design elements to use. However, being able to use Svalna's library did not mean that the thesis group did not create their own design elements, or not make their own design decisions. In other words, Svalna's design library facilitated the process, but was not a requirement for achieving the produced prototypes. The following will present a selected set of the most important screens from the full prototype created, with explanation of how they could be used by users.

6.5.1.1 The onboarding process

The concept developed in this thesis named the *Challenges section*, is the recreated and improved version of how Svalna attempts to use challenges to support behavior change in users. When the users enter the *Challenges section* for the first time, they will have to go through an onboarding process, which can be seen in Figure 6.8. This process serves the purpose of preparing the users so that they will get a better experience when doing challenges. This involves tailoring challenges for users so that they only will experience challenges that they truly enjoy to do. It is important that the users get a comfortable and understandable start, because this is where users ultimately can change behavior into a more sustainable one.

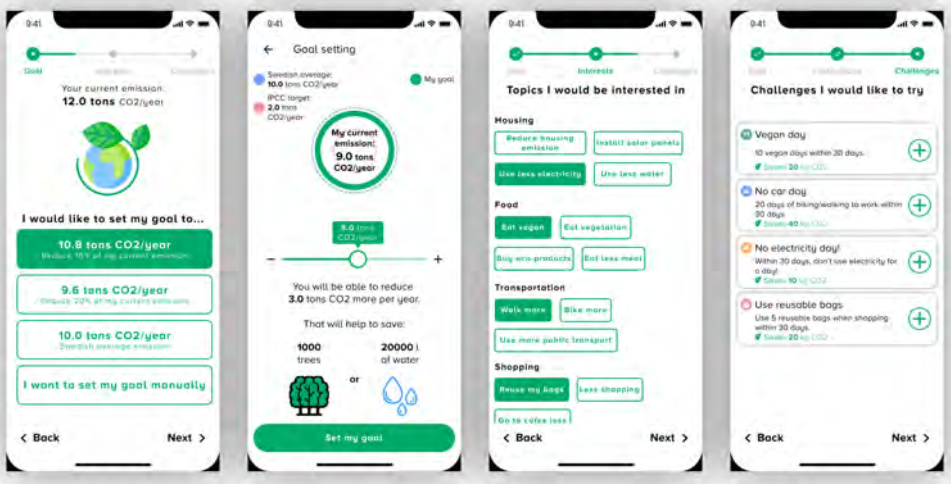


Figure 6.8: High-fidelity prototype version 1: Onboarding

6.5.1.2 The challenges

Figure 6.9 shows the main screens of the *Challenges section*, which are essentially the more important screens in the concept created. The leftmost screen is the actual main screen of the *Challenges section*, which shows the overview of users' challenges. It also shows progress of doing challenges, in terms of reducing GHG emission based on what is needed to be done in a challenge's behavior. Regarding tracking the progress of doing challenges, the users can tap on a challenge's check-in button for each time the task of a challenge has been done. The check-in of a challenge also gives direct feedback to the users on what they have achieved in terms of reducing GHG emission.

The screen shown in the middle of the figure, shows how the details of a specific challenge looks like. Here, users can see progress and information about the challenge. What is more important in this screen is the facts regarding environmental impact and guidance on how to approach the challenge. The environmental impact should act as encouraging factors, whereas the guidance information should facilitate users in actually doing the challenge.

Lastly, the rightmost screen in the figure shows how challenges have been scheduled by the users, in the form of a calendar view. The scheduling should facilitate the users in knowing when to do the challenges, and also make users more committed to do the challenges since the the planning of challenges can be seen as promises being made.

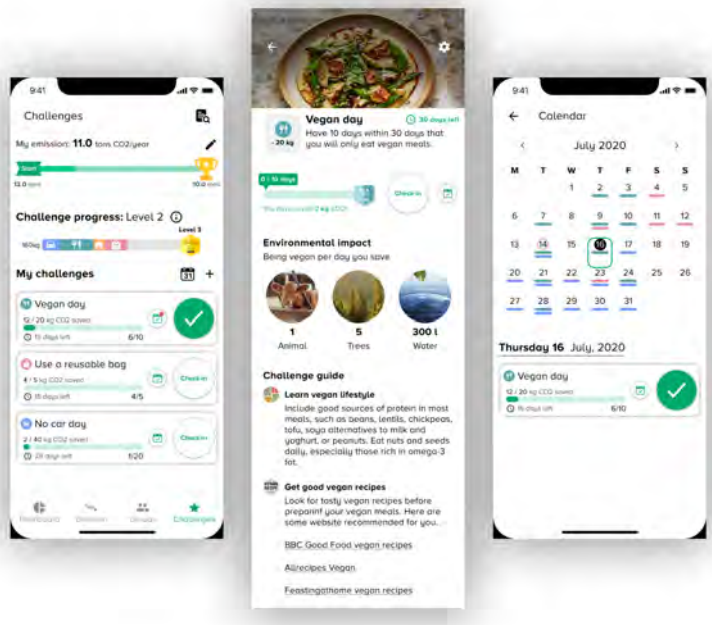


Figure 6.9: High-fidelity prototype version 1: Main screens of the prototype

6.5.1.3 The process of adding a challenge

Adding challenges can be done by tapping on the plus button in the main screen shown previously. This will navigate the users to a screen (see leftmost screen in Figure 6.10) with lists of challenges in the different categories. This provides a simplistic and effective way for users to find suitable challenges. When adding a challenge, the users can choose between scheduling a challenge or not. In the three rightmost screens in Figure 6.10, it is presented how a user can schedule a selected challenge, by tapping on multiple different days in the calendar view. There is also an option to receive notifications for reminding users whenever a challenge is due.

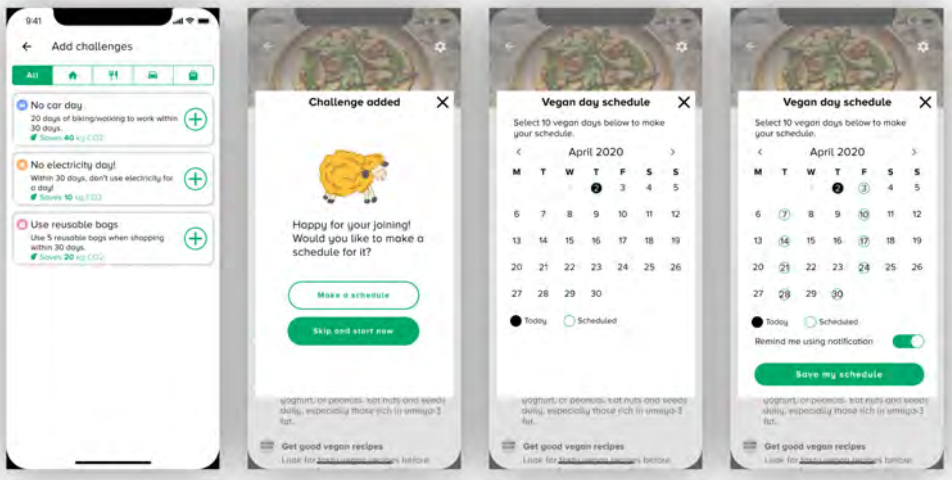


Figure 6.10: High-fidelity prototype version 1: The process of adding a challenge

6.5.1.4 Providing information of users' progress

The last part of the prototype is about presenting progress of what the users have achieved. In Figure 6.11, the two leftmost screens presents history of how the users have progressed in previous months as well as showing previous challenges done, which can be navigated to by tapping on the top right icon in the main screen. This serves as a way for users to review and explore what they have achieved so far and let them understand their progress so that there is both motivation and data on how to keep on behaving sustainable. On the other hand, the rightmost screen in Figure 6.11 shows achievements in the form of badges that the users have collected by doing challenges. This is purely for motivating users to keep on doing challenges since the rewards that users get should let them know that they have done something good.

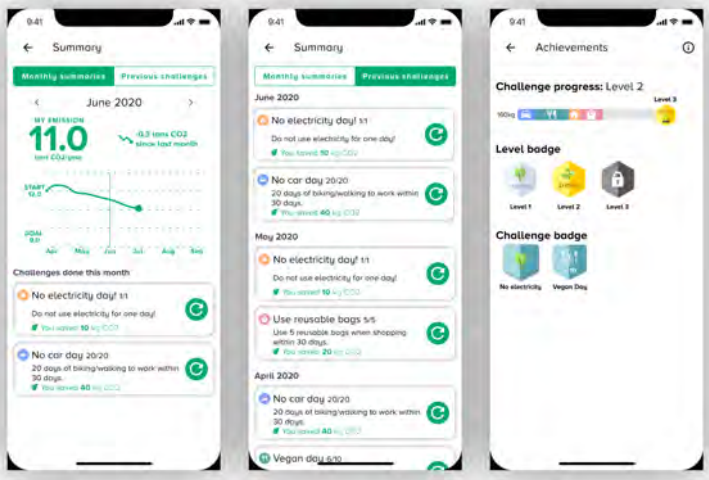


Figure 6.11: High-fidelity prototype version 1: Presenting progress to the users

6.5.2 Conducting heuristic evaluations to find usability problems

The evaluation method Heuristic evaluation (see Section 4.5.1) was used in order to find usability problems of the prototype presented previously, without having to involve users of Svalna. The ultimate goal was to prepare a prototype with as few problems as possible before involving users of Svalna in the usability testing later on. Then the users would be able to focus on finding complex problems in the usability testing, instead of obvious ones that could be captured by the researchers themselves. Furthermore, the researchers of this thesis were the only evaluators of this evaluation, which was not according to the plan since it had been planned that an employee of Svalna would participate. At the start, the heuristic evaluation task was sent to the employee for doing it independently remote rather than requiring a supervised online meeting. This was because time could be saved for both parties and the evaluation could be made without the affection of the researchers' presence. However, due to certain circumstances, the evaluation feedback could not be delivered on time. By the time this was known, it was already too late because the researchers had to move forward due to the strict time plan of this thesis, therefore the evaluation with this employee was cancelled. It was also not a possibility to find and involve another evaluator, due to the time limitations. Nevertheless, the final outcome was still a satisfied result due to being able to find and resolve a large amount of usability problems.

The start of the researchers' evaluations were made independently, which involved finding usability problems of the entire prototype based on Nielsen's ten heuristics (see A.1). The findings from both researchers were then merged together into one list of problems, so that similar problems could be put together in order to eliminate redundancy and in the end get a cleaner result. To further analyze the list of

findings, the researchers decided to together rate the problems based on severity (see Section 4.5.1), which facilitated the process of knowing what was most critical to improve first, in case time was a limitation. In B.20, a table is presented with all the usability problems found and their ratings, as well as what had been resolved in the prototype. Due to time limitations, only the problems rated *4* and *3* were resolved, however, these represented the major part of the problems.

6.5.3 Evaluating the high-fidelity prototype with Svalna's users

After the heuristic evaluations, the prototype had less usability problems, and was deemed ready to be tested by users. The user evaluations conducted were sessions containing two parts; finding usability problems and evaluating how challenges should be designed in order to support behavior change in users towards a sustainable lifestyle. The usability testing part was conducted with the Think-aloud protocol whereas the second part consisted of asking users questions regarding the approach of designing challenges in the way it was done in this thesis. This helped to evaluate what kind of content that was important and should be present when designing challenges that support users towards a sustainable lifestyle. Regarding finding users of Svalna, the thesis group once again made use of the contacting network that Svalna had provided. In the end, the researchers were able to find six users to involve via email invitations and the meetings were all conducted online due to circumstances described in Section 8.4. Before each of these meeting sessions, it had been confirmed by each participant that the data gathered within the sessions would be used for this thesis' research only, as well as being anonymous. The consent of each user was confirmed via the email invitation, where it was clearly defined that by participating in the research, the data gathered could be used for the thesis anonymously. It was also specified that in order to accept the invitation and participate, the users had to specify that they agreed to the agreement by replying that they consent, which all of the participants did. The approach of asking for consent via the email invitation was something new for this thesis, and it was decided that this method of asking for consent was the most convenient for the users. If the research instead asked for an electronic signing of the consent, there could be issues where some people would not be able to sign online due to lack of tools.

In terms of the actual online meetings, the online tools used were Zoom, Skype, and normal phone calls, depending on what the users requested to use. Regarding whether to use a video call or not was also up to the users' decisions, and in terms of the meeting's goal, a video call was not a must. The time for each meeting varied from one hour to one and a half hour, which depended on how much input a user gave.

6.5.3.1 Usability testing with the Think-aloud protocol

The usability testing with the Think-aloud protocol (see Sections 4.5.2 and 4.5.2.1) provided a way for the researchers to evaluate whether the users experienced a usable

prototype. In the end, this would help the researchers to resolve the problems that were found by the users. Other than finding usability problems, the users were also encouraged to talk about the design solutions in general and how the solutions fulfilled the aim of supporting behavior change towards a sustainable lifestyle in users. How the users were able to evaluate different parts of the prototype was by giving users tasks to perform on the prototype. In terms of providing a realistic experience of a mobile application, the prototype had been made interactive in Figma, which meant that users could interact with the prototype in a similar way as a real mobile application. Then the prototype in Figma was sent to the users, and it was possible for the researchers to observe the users' actions on the prototype remotely with the help of Figma's functionalities. The tasks given to the users involved actions where the users eventually would go through the entire prototype and testing the most significant parts of the prototype. The tasks mainly tested; *the onboarding process*, *tracking challenges*, *adding challenges*, and *using the scheduling*. When a task was given to the users, the users could read it for themselves and then start to perform it on the prototype. While doing the tasks, the users also had to talk out all thoughts so that the researchers could take notes on what was experienced by the users, all according to the think-aloud protocol. The researchers also observed quantitative data in the background, which involved counting the number of errors made by the users. After each task, there was a small break where the researchers probed the users to fill in on areas that the researchers wanted to find out more about, which involved questions both about usability problems, and thoughts on the concept itself. At last, the users were also asked to give difficulty ratings on the tasks, based on how easy or difficult it was to do each task. In terms of the error counting and the task difficulty tracking, this quantitative data would be used for evaluating what areas of the design that had the more severe problems and needed to be resolved first. In B.21, the eight tasks given to the six users can be seen, as well as result on number of errors committed and the difficulty levels given.

6.5.3.2 Improving the prototype based on the usability testing

From the usability testing, it was possible to extract a large amount of usability problems from the six involved users. This showed that the prototype still was quite far from being a foolproof design. Therefore, these problems had to be resolved in order to provide a better visual design reference in the end to complement the eventually extracted design factors. However, due to the large number of problems found, it was quickly decided that these had to be rated according to Nielsen's severity ratings (see 6.5.2). This would facilitate the process of knowing what to resolve first. It was also already known at this time that the remaining time for this thesis would not allow for resolving all of the problems. Therefore the rating of the problems was of big importance since the most critical problems could be resolved first, and in the end, a better design reference could be delivered. Additionally, for facilitating the problem rating, the result from the task completion (see B.21) was also used. This would make it clearer on what parts of the design that were more problematic. In B.27, the rating of all the usability problems found can be seen. This table is structured in the same way as the prototype' design structure, which makes it easier to see which problems that relate to what part in the prototype.

In the end, the problems that could be resolved in the prototype, resulted in the problems with rating *4* and *3*. These were the most critical problems according to the scale of Nielsen's ratings. Even though resolving the problems with rating *2* would improve the prototype significantly due to the large numbers of problems that had this rating, the time remaining just did not allow for that. The final result of the prototype will then be presented in the next chapter.

6.5.3.3 Design solution evaluation by interviewing users

After each usability test in the meetings with the users, semi-structured interviews (see Section 4.2.2.3) were conducted with the users in order to evaluate the design solutions further. This helped to evaluate what kind of content that was important and should be present when designing challenges that support users towards a sustainable lifestyle. The questions firstly asked about the users' backgrounds in terms of how supported they were in having a sustainable lifestyle. Then questions were asked regarding how the design solutions had the potential to support users in having a sustainable lifestyle. The reason behind firstly asking the background questions was to see how the design solutions potentially would affect people with different backgrounds in sustainability. For example, how the prototype would affect someone who had no prior support to a sustainable lifestyle, versus how the prototype would affect someone with full support in being sustainable. In B.22, the full set of questions asked in the interviews can be seen. The feedback received from the users was then summarized in the next section.

6.5.4 Findings from the evaluations with Svalna's users

The following will present the findings from the interviews with the six users of Svalna. Additionally, the findings in the usability testing will also be involved, that were not about usability problems but rather about thoughts on the design solutions. All the findings would in the end make it possible to draw conclusions on how to potentially design challenges within carbon calculators that aims to support behavior change in users towards a sustainable lifestyle. In the end, this played a huge role in defining the design factors that the research question asked for.

6.5.4.1 General thoughts on the challenge design solutions

The users were all in agreement that the design solutions had a promising potential in supporting behavior change in the users towards a sustainable lifestyle. They emphasized that the user focused challenges and the system of handling the challenges were what showed the potential in succeeding with the thesis' aim. This approach would provide the support in making users take actions to become more sustainable, by making them do the pro-environmental behaviors in the challenges.

Simplicity in usage of the approach on challenges was a highly prioritized factor for succeeding in making users wanting to continue to use the concept and adapt to new behaviors. The users meant that the design of the entire system of challenges were considered to be at the edge of becoming too complex, and it was not encouraged to

add more functionality. Reducing functionality or making the current functionality more simplistic was instead encouraged since it would provide a clearer and more understandable user experience and thus, make users want to do challenges. This also involved making the actual user interfaces more straight forward to understand, and not just the understanding of the challenge concept.

6.5.4.2 The challenges

Going into the actual challenges, the idea of having to check-in a challenge in order to track the progress, was a very liked concept. The users felt that checking-in a challenge was like an accomplishment and the way the check-in button was designed, tempted users to just want to accomplish the challenge's task and check it in. The users further mentioned that in order to start with and commit to the challenges, the challenges must be useful and interesting for the users. If a challenge is not meaningful and tailored for the users situations and interests, they would straight up not do it. No matter how good the scheduling system is, or how well the design looks, the user would not be interested in doing something that they were not comfortable with or liked. Some users argued that in order to make people commit to doing a behavior, it must be enjoyable and fun to do. Challenges should not only challenge the users, but also act as an activity that the users enjoy to do. In the end the users concluded that behaving sustainably should be natural rather than forced, otherwise, the behaviors would not be done thus habits would not be formed.

In terms of what information that the challenge provided played a big role in helping users to decide whether to do a challenge or not. The users were fond of the idea of showing environmental impacts and tips on how the challenge could be approached. The environmental impacts would make the users understand why it was important to do the challenge in terms of saving the environment, which also acted as an encouraging factor. The tips presented in the challenge acted as a knowledge source for facilitating the accomplishment of the challenge since the users would be given concrete information on how to do the challenge. This would especially be important when users wanted to try something that they had not done before.

6.5.4.3 Seeing the progress of doing challenges creates engagement

The biggest source of encouragement according to the users came from the challenge progress, as in how the progress of doing challenges shows the impact of each challenge done. By seeing the direct feedback of challenges done, the user would feel a sense of achievement and they would just want to keep on doing more challenges so that more GHG emission could be reduced. It was seen as something satisfying and that it felt like something valuable had been accomplished in terms of helping the environment.

Furthermore, by completing challenges, the users would also be awarded with unique virtual badges as achievements of what they had done. This would act as the encouragement factor for making users continue to do challenges so that even more badges could be earned. Although this was a good approach to many users, they also

meant that the excitement of getting badges was not present and they would either not know what that could be done with them. As a conclusion, the users expressed that encouraging users by awarding them with rewards was a good approach, but the type of rewards to use should be be researched further. The users were also asked if a social factor would change the way the saw at badges as a reward, such as, if profiles with badges and level progression could be shared with others. To some users, sharing their profile with their progress seemed to have potential because then they could both encourage others or get encouraged, by being able to see comparisons. However, some users also emphasized that sharing progress might cause a negative effect. It may make a user feel bad if that user is behind others in number of badges or levels, which in turn might cause the user to quit due to feeling bad. A user also mentioned that social aspects simply was not an interest at all in the daily life. Therefore as a conclusion, progress sharing might be a suitable approach, but it should be optional for each user.

Lastly, there is the part of the concept that shows users' summaries of how they have been progressing in previous months and what challenges that they have done. This was a highly liked part by the users since the information it provided gave users a better understanding of what they had achieved. The trends they could see in doing challenges for the previous months acted as a motivator to make them keep on doing challenges and behave sustainably.

6.5.4.4 The potential in scheduling challenges

The idea of scheduling challenges was emphasized to be a crucial factor for supporting users in doing the challenges. The users meant that by scheduling a challenge, they would be committed to doing it. It would also have the potential to become a habit in their daily life if a behavior of a challenge was practiced and repeated over a longer time, such as a month. The way the design solutions require users to be more active in the application due to the continuous scheduling and tracking, was also seen as something that would make users more aware of sustainability. It would basically continuously remind users and make them aware of the importance of acting sustainable. Some users also meant that they did not always have sustainability in their minds, but the scheduling system would make them reminded to accomplish the behaviors of the challenges.

However, there were also users who expressed that scheduling challenges in their life was not preferred. A user was not interested in adding one more scheduling system into an already fully packed personal and work schedule since it would be too much to handle. But the user also pointed out that the concept of scheduling and repeating behaviors actually would be the key to adapting to the behaviors. On the other hand, another user wanted the overall concept of challenges to also focus on users who wanted to be less dependent on actively using the application to track activity. A suggestion was that a user maybe could use the application once a week or month, to track activities that had been done. Even though the concept created allowed for non-scheduled challenges that can be tracked at any time, the user meant that the concept still was too focused on an active tracking habit. It

would instead be better to format challenges so that they could be tracked once a week or month. The user also insisted that tracking on a weekly or monthly basis would not make it less encouraging since it would still be possible to see positive progress forward. But the user also expressed that this way of tracking challenges is based on personal interests, and that the current design solutions would be great for people who liked a more active scheduling.

Furthermore, whether following a challenge's schedule should be strict or flexible throughout the challenge's period, had mixed point of views among the users. Some users meant that the way a challenge should be accomplished should be more strict. If failing to fulfill the requirements of a challenge or missing to do a challenge's task on a scheduled day, then there needs to be some kind of punishment. Otherwise, a user meant that there would be no point to follow a schedule, because doing the challenge on another day is permitted. Therefore it could lead to users making too many exceptions which in turn would cause an inconsistent routine and the change of behavior might fail. On the other hand, some users emphasized that flexibility should always be an option, because if a user is not comfortable with doing something, then the user should not have to do it. Forcing users to do something they do not want to do might make them quit in doing the challenges.

6.5.4.5 Adding challenges should be encouraged

Regarding making users add challenges and continuously adding more challenges as the previous ones are completed, the users felt like this aspect was too passive. There was no actual encouragement in the concept that would motivate the users to add more challenges to do according to them. The way of adding challenges was too passive and might only fit users who already have an aim for what challenges that they would want to accomplish. A user criticized that, if a user does not have enough initiative to actually add and start a challenge, then this concept of designing challenges would not work for this user because there would not really be any temptation to start any challenges. The user instead pushed for an approach to advertise challenges so that users will be served with challenges, instead of users having to chase for challenges. Otherwise there will be no trigger to make users start a challenge.

6.5.5 Evaluating the challenge details screen

The challenge details screen presented earlier in Section 6.5.1, had a specific important purpose in the entire approach of designing challenges, which was to encourage and teach users to behave sustainably by providing such information. Therefore, how this information was conveyed to the users played an important role according to the researchers of this thesis. So it was decided to evaluate this specific screen further, by making three design alternatives of this screen in total in order to find the best design approach, which can be seen in Figures 6.12, 6.13, and 6.14. However, it could be argued that other parts of the design concept also would need the same treatment of evaluation in order to create a product that supports users the best in having a sustainable lifestyle. But the time frame of this thesis only allowed

for exploring different design alternatives of the challenge details screen, as well as evaluating them. Nevertheless, the three design alternatives differs in how information is conveyed to the users, while the actual information output in the end stays the same. The first design (the original one which was presented earlier) utilizes a lot of text, all summarized together for the users to take in. The second design utilizes curiosity to make users commit to take in information. The design starts with showing interesting questions to topics about the environment, and in order for users to find the answers, they have to commit and explore what the answers are by interacting with the design. The third design only utilizes videos to convey information.

Figure 6.12:
Design alternative 1

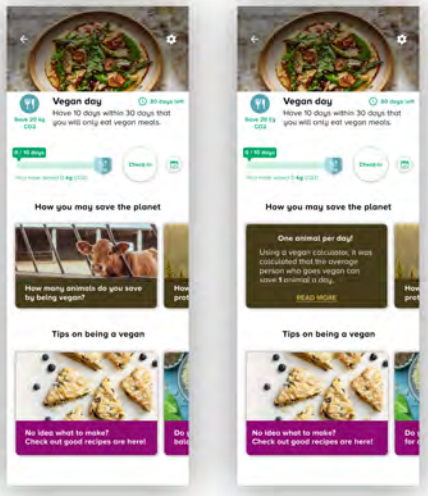


Figure 6.13:
Design alternative 2

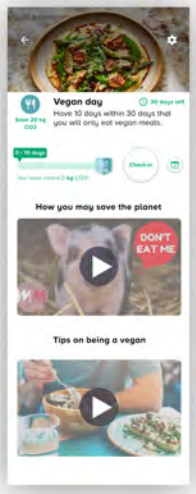


Figure 6.14:
Design alternative 3

Regarding how the design alternatives were evaluated, it firstly happened during the interviews mentioned earlier. There the six Svalna users were asked to rate the designs on which one that supported them the most in terms of becoming more sustainable. However, if this research only relied on the findings from the interviews, it could potentially end up in a biased decision from the six users interviewed, which was not desired. Therefore, at the same time as the evaluation sessions (the usability testing and interviews mentioned earlier) were conducted, questionnaires regarding the challenge details screen were also sent out. The questionnaire aimed to get more insights on which of the design alternatives that was preferred and that could provide the most support in making people become sustainable. For each design alternative, it was also asked how much the design would engage and provide knowledge in terms of acting more sustainable. The questionnaire was firstly sent out to users of Svalna but the researchers wanted a bigger sample size, therefore the questionnaire was also sent to people who were not users of Svalna. Even though these people were not expected to be familiar with Svalna's or any carbon calculator, the researchers deemed that it would not be an issue for them to be able to provide their insights.

This was because the questionnaire had been formulated in an abstract way so that anyone would be able to give insights on the three design alternatives presented. (Even without having to understand the entire design concept created in this thesis.) Therefore, the non Svalna users involved in the questionnaire varied from friends of the researchers, to Interaction design related people, and even people with unknown backgrounds. But the questionnaire asked for the sustainable backgrounds of the people involved, and thus conclusions could be made regarding how much the design alternatives actually affected the people involved in terms of providing support to live a sustainable lifestyle. In B.23, all the questions for the questionnaire can be seen. At the end of the evaluation period, the total number of questionnaire answers received ended up in 32, where the result will be presented in the next section.

6.5.5.1 The conclusion of the challenge details screen

The evaluation of the challenge details screen in the end came both from the 32 questionnaire answers, as well as what was mentioned about this screen in the interviews with the six users. They were put together so that all the data could be seen as one, where both qualitative and quantitative data had been gathered. It has to be noted that the qualitative data not only came from the interviews, but also from the questionnaires' open questions. Nevertheless, in terms of the quantitative data from the evaluations, the design that showed to have the most potential in supporting people to behave sustainably was *design alternative two*. *Design alternative one* was not too far behind, but *design alternative three* could be seen as the design with least potential, as seen in Figure 6.15.

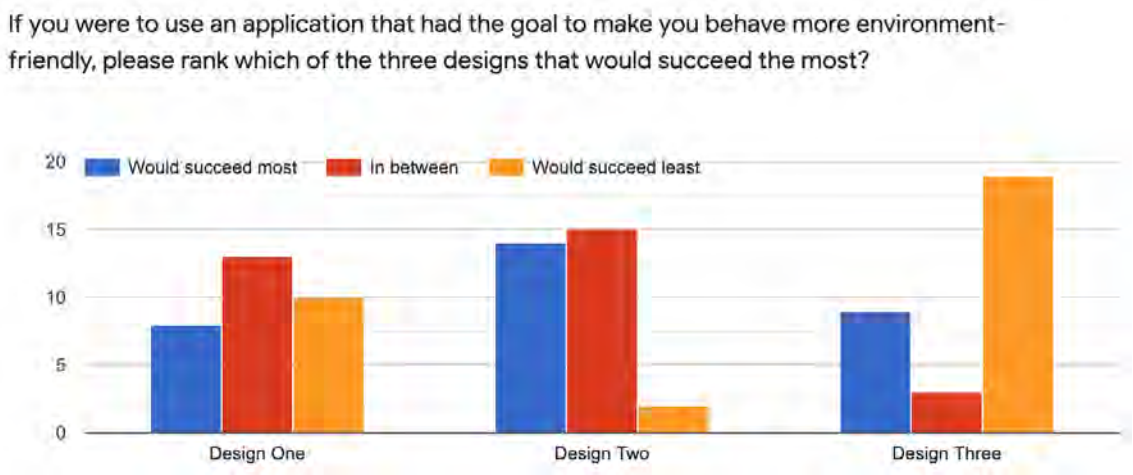


Figure 6.15: Questionnaire result of choosing between the three design alternatives

Regarding which of the three designs that showed most potential in terms of providing engagement and knowledge in sustainability, *design alternative two* was again regarded as the one with most potential according to the participants. The questionnaire's quantitative results in B.24, B.24, and B.24, show that *design alternative three* was by far the least promising one, whereas *design alternative two* had a bit of advantage over *design alternative one* in terms of providing engagement. Moving on

to the more qualitative data collected, *design alternative two* was still regarded as the one with most potential. The participants meant that the attractive visualizations and possible interactions in the design showed a promising potential in making them want to explore and learn more about the environment. *Design alternative one* on the other hand was both liked and disliked. Showing static and straightforward information was liked by participants who preferred a place with summarized information where nothing more had to be done other than reading. But some other participants meant that the passiveness of this design did not provide engagement in the topic and the use of too much text was not of interest. Lastly, *design alternative three* was once again shown to be the worst out of the three different designs. Watching videos was not desired at all and some participants also meant that it was not a time-efficient way of gaining knowledge. As a conclusion of both the quantitative and qualitative data, the majority of the participants preferred *design alternative two*, thus this design would be the chosen one for the final result.

7
Results

This chapter will present the final result of answering the research question. The research question specifically asked for finding out what important factors are for designing user challenges in carbon calculators to support behavior change in the users towards a sustainable lifestyle. To find such factors, *Research through design* was applied, where a prototype called *The Challenges section*, was created in order to find and extract the factors throughout the process presented in Chapter 6. The following sections will firstly present an overview of the prototype created, with illustrations and complementary descriptions. After that, the design factors for answering the research question will be presented.

7.1 The prototype: The Challenges section

In this section, the prototype created in this thesis will be presented, which was the result of applying *Research through design*. This prototype was created according to the *Design process* described in Chapter 4, where the full process of how it was created is presented in Chapter 6. Therefore, the prototype is essentially based on theoretical findings in the field of study, as well as user evaluations. In the end, the main reason for creating this prototype was to find the design factors to answer the research question. However, the prototype itself can also be used as a visual design reference for external researchers who have similar aims as this thesis. Furthermore, the numbers and facts shown in certain parts of the prototype are just based on rough estimations from the researchers, due to not having the time to actually research exact facts. Therefore the information seen in the prototype should not be perceived as real.

The prototype created can be described as an approach to use pro-environmental challenges to support behavior change towards a sustainable lifestyle in users of carbon calculators. Therefore, the central focus of this prototype will be around challenges, how to make users do the behaviors in the challenges, and how the behaviors can become habits. Because when a user is able to turn the pro-environmental behavior in a challenge into a habit, then a behavior change in the user can be seen as achieved. Furthermore, since Svalna's carbon calculator has been used for developing the prototype, the prototype is considered to be a part in Svalna's carbon calculator. More specifically, the approach is created to entirely replace Svalna's approach of using challenges, as a form of an improvement in terms of supporting behavior change in users towards a sustainable lifestyle by doing challenges. This

improvement was decided to be called the *Challenges section* because the main content of the prototype revolves around challenges. The following list gives a quick overview of the prototype's different part, before explaining the prototype more in details in the sections to come:

- Onboarding process:
  - Creates a more user adapted start in doing challenges
- Viewing progress of doing challenges:
  - Provides encouragement through positive progressive feedback
- The challenges' content:
  - Provides encouragement and knowledge to support doing the challenges
- Adding and scheduling challenges:
  - Plan newly added challenges whenever suitable
- Presenting the scheduling in calendars:
  - See how all challenges are scheduled
- Achievements and history:
  - Learn more about what has been accomplished

7.1.1 Starting a challenge

In order to give users a comfortable start in doing challenges, the situations' of the users must be known. This could involve having to know what the users' preferences and interests are when it comes to behaving sustainable. If such information is known, the system of a product would be able to provide the users with customized and suitable challenges to do, exactly according to users' likings. This in turn would make the users more committed to actually start and do challenges. Therefore the prototype of this thesis lets users go through a simple onboarding process, which gathers requirements about the users in order to recommend them with suitable challenges to do. Firstly, the users would need to select a goal to aim for (see Figure 7.1), which will act as the overall goal in terms of reducing GHG emission by using Svalna's carbon calculator. The aim then is for the users to try to reduce their GHG emission by behaving more sustainable, where this goal set will act as a continuous reminder of what the users actually are aiming for. Thereafter, the users can choose interests based on what they are prepared to do in order to achieve a more sustainable lifestyle (see Figure 7.2). These interests can range from anything within sustainable actions, such as *"I want to start eating vegan"*. Lastly, the users will be able to select challenges that they want to do (see Figure 7.3). These challenges are recommended to the users based on what they previously have selected in terms of goal and interests. Therefore, every challenge recommended to the users will take into consideration what the users are aiming for and what they want to do. When the onboarding process is finished, the users will be navigated to the main screen of this section, and be able to start doing the selected challenges, which will be presented in the next section. Furthermore, this onboarding process will only appear for the first time when the users approach this prototype, so that users will get a comfortable start in doing challenges.

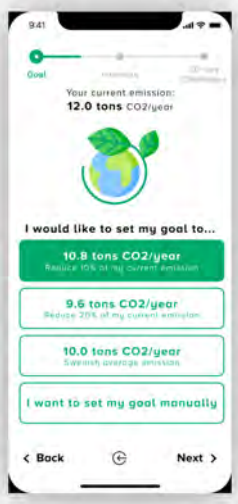


Figure 7.1: Onboarding: Set a goal to reach

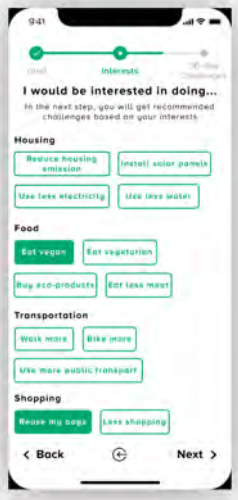


Figure 7.2: Onboarding: Select interests in sustainability

Figure 7.3: Onboarding: Recommended challenges to add

7.1.2 Viewing progress of active challenges

Figure 7.4 shows the main screen of the *Challenges section*, which is the screen that users will see when navigating to this section, taking into account that the onboarding has been completed previously. This screen acts as an overview of the current challenges that users have in their progress. In the top part of the screen, there is a goal progress based on what Svalna has calculated users' current GHG emission to be. Then the aim for the users is to reach the target that they set in the onboarding process, but it can also be edited at any time. This goal progress in itself is independent from the challenge progress placed below, which will be presented next. But the goal progress acts as a motivator where it continuously tells users what they are trying to reach, in terms of using Svalna's carbon calculator as a whole.

Positioned below the goal progress, are the challenge progress bar and users' active challenges. The challenge progress bar acts as an encouraging factor for making the users want to keep on doing more challenges. The bar shows the potential GHG emission that is being reduced when challenges are being done. Whenever the amount of reduced emission reaches a certain point, e.g. 100 kg, the users will increase their level. This level is supposed to be the representation of users' sustainable lifestyle, as in, the higher level a user is the more sustainable that user is regarded to be. Therefore, this progress bar's aim is to make users want to do more challenges to reduce their emission, so that they can reach higher levels.

Moving on to what challenges that users currently would be doing, these would be presented in the list of active challenges below the challenge progress bar. Whenever

users add challenges, they would appear in this list, which ultimately should give the users a clear overview of what they are committing to and continuously remind them to accomplish their desires. The challenges in the list are presented as tappable cards with information about the progress of the challenge. Tapping on a card will lead to a navigation to a detailed screen of the challenge with more information, which will be presented in the next section. Furthermore, in order to track the progress of a challenge, the users have to tap on the *check-in* button to the right in the challenge cards. Then the progress of the challenge will increase, and users will be able to see the potential GHG emission reduced in the challenge progress bar above. In Figure 7.6, the check-in and change in progress can be seen. In the next section, more details on what information the challenges contain and how they are supposed to work will be presented.

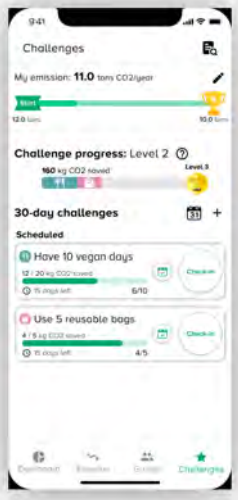


Figure 7.4: The main screen

Figure 7.5: Information

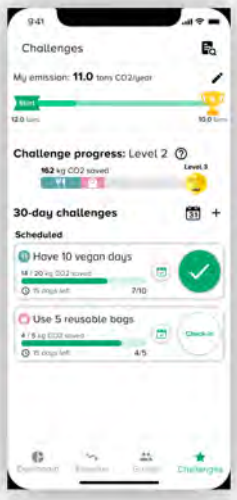


Figure 7.6: Challenge checked in

7.1.3 The challenges' content

The challenges' purpose is to make users do the pro-environmental behaviors in the challenges. Therefore, it is of high importance that the challenges both can support users in accomplishing the behaviors, as well as encourage users to do them and become committed. As seen in the previous section, the challenges were presented in the main screen as an overview of users' progress. But the challenges can also be explored more in details, where more information about each challenge can be seen. In the prototype created, the specific challenge used as an example was a vegan challenge, where the aim was to have a certain number of days where only vegan food could be consumed. Then this challenge can be regarded as promoting a vegan behavior to users. Furthermore, figures 7.7 and 7.8 show how the challenge details screens look like in the prototype. This is where the crucial information exists for making users committed to a start to do a challenge. The crucial information in

the challenge details screen mainly consists of two factors; providing encouragement and providing knowledge. In terms of encouragement, the users will be presented with what it would mean to the environment if the challenge were to be done, which can be called environmental impacts. Regarding providing knowledge, the users will be able to learn more about the challenge in terms of how the challenge can be approached, where tips and knowledge about the topic can be explored.

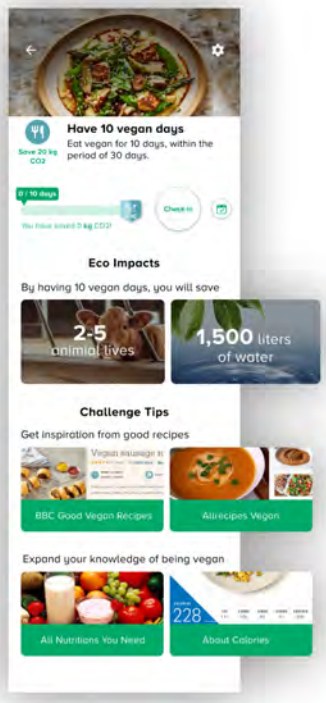


Figure 7.7: Challenge details screen: Unexplored

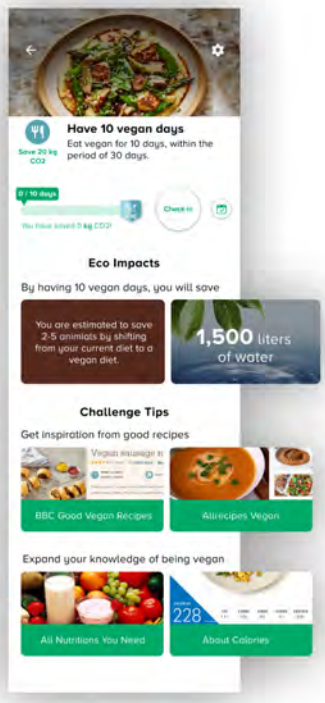


Figure 7.8: Challenge details screen: Exploring a card

7.1.4 Adding challenges

Whenever users want to add new challenges to approach, they will be able to browse new challenges which can be seen in Figure 7.9. After the users add a challenge, they will be able to choose between scheduling the challenge or not, as seen in Figure 7.10. If the users opt to not schedule the challenge, then the challenge will be added to the list in the main screen and the users will be able to do the challenge when desired. If the users instead choose to schedule the challenge, they will be able to select the days that they want to do the challenge on. Figure 7.11 shows the scheduling of a challenge called *No electricity day*, which is a challenge where no electricity should be used for one day. Then the users can schedule this specific day in the view that should represent a calendar. The users are then expecting themselves to do the challenge on that day. Lastly, before completing the process of adding the challenge, users have the option to allow the application to remind

them about when a challenge is due. How the users can see the schedule of an active challenge will be presented in the next section.

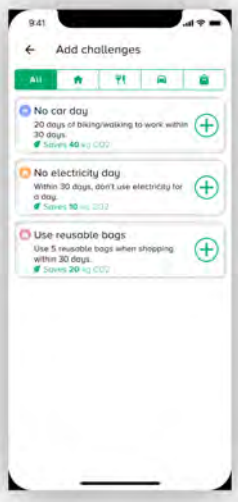


Figure 7.9: Add challenges screen

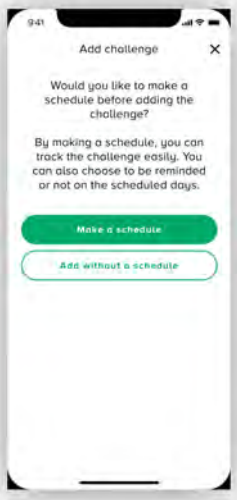


Figure 7.10: Scheduling option

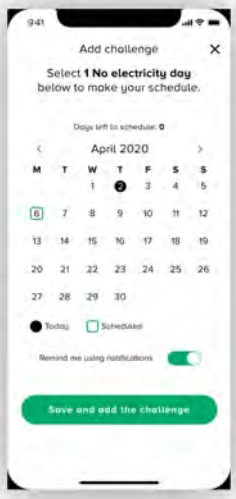


Figure 7.11: Scheduling a challenge

7.1.5 Scheduling challenges

Scheduling of challenges is one of the core functionalities in the prototype created, and users from the evaluations of the prototype meant that the scheduling was a main reason for succeeding with creating habits. Challenges are formatted so that they can both be scheduled, and unscheduled. If a challenge is unscheduled, users can check-in a challenge whenever they want. Scheduling challenges on the other hand, requires users to firstly plan on the days where the challenge should take place. Then the users have to follow the schedule accordingly, and the scheduling system will support the users to understand when different challenges should be done. There is also a reminder option that the users can set, where notifications will be sent to the users on scheduled days to remind them to do the challenges. If challenges for some reason are missed to do, the users are allowed to redeem themselves and do the challenge on another day in order to fill in on the missed day. Furthermore, in terms of presenting the schedules to the users, two versions of calendars shown in Figures 7.13 and 7.12 are used in the prototype. The first one shows how the schedule of one individual challenge looks like, whereas the second figure shows how all challenges' schedules are shown in one calendar.

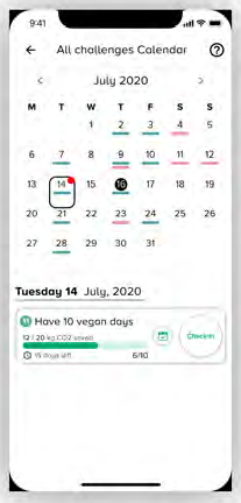


Figure 7.12: Calendar with all challenges

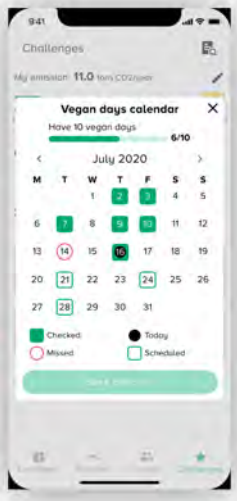


Figure 7.13: Calendar showing an individual challenge

7.1.6 Learning more about what has been accomplished

The two screens presented in Figures 7.14 and 7.15, show the previous progress of what users have accomplished so far. The first one shows monthly progress that is being made by users, as well as what challenges that have been done for the respective month. The second one shows all the previous challenges that have been done by users. The purpose of having such summary screens, especially the monthly progress, is to provide users with motivational information. The progress that users will see from month to month should let users know what they have accomplished and make them continue to put effort into living a sustainable lifestyle. Seeing positive trends could potentially encourage users to continue with the behavior due to feeling more confident. Seeing negative trends on the other hand, could also potentially make users continue to behave sustainably since the users would then be able to reflect on their past behavior and make adjustments accordingly in order to improve.

Furthermore, the prototype has an achievement system in order to motivate users to continue to do challenges, by awarding them with badges. Whenever a challenge has been fully completed, users will be awarded with an achievement and congratulated for their strong efforts, as seen in Figures 7.16 and 7.17. In terms of seeing the achievements that have been collected, all badges are being stored in an achievements screen, shown in Figure 7.18. This screen should act as a place to provide motivation to users, as in showing how well they have been doing.

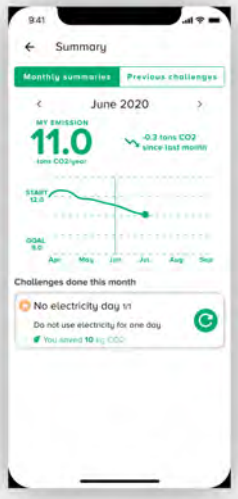


Figure 7.14: Summary of monthly progress

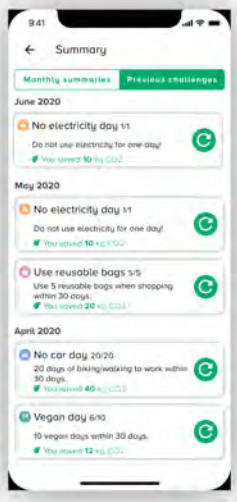


Figure 7.15: Previous challenges done

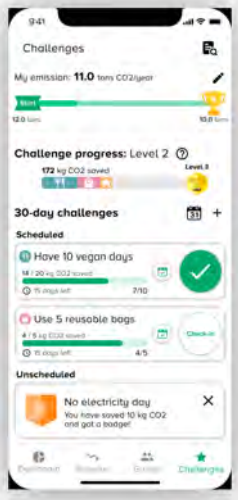


Figure 7.16: Challenge completed

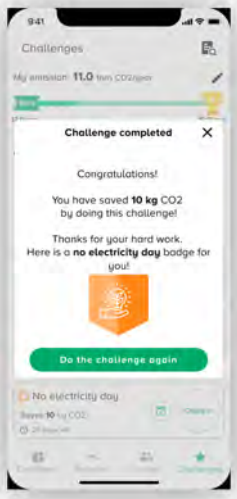


Figure 7.17: Challenge completed popup

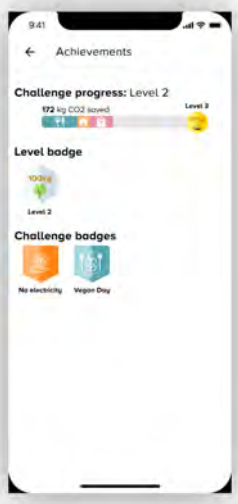


Figure 7.18: Achievements screen

7.2 Factors for designing challenges

This section will present the main answer to the research question of this thesis, which is factors for designing user challenges in carbon calculators that support behavior change in users towards a sustainable lifestyle. The answer is the result of applying *Research through design*, where going through the entire process of creating the prototype presented in the previous section, resulted in being able to extract the set of design factors. The factors are essentially based on reviewing theory within the field of study, exploring design solutions, and lastly, evaluating the design solutions with people involved in carbon calculators.

The following sections will present the design factors in a flow that represents Geller's behavior change model theory (see Section 3.2.1) which addresses how a behavior change is achieved. According to Geller's model, the users would need to go through multiple stages to achieve the behavior change, which are in the order of; *unconscious incompetence*, *conscious incompetence*, *conscious competence*, and *unconscious competence*. The first stage, *unconscious incompetence*, can be regarded as the stage where users have no intention at all in changing their behavior, that is, not wanting to do a challenge. The last stage *unconscious competence*, is the goal stage in which a user naturally does the behavior as a habit. To reach this stage, two categories of design factors have been defined; *Factors for making users committed to start doing a challenge* and *Factors for making users turn a challenge's behavior into a habit*. The first category involves factors for taking users from being *unconscious incompetent* to *conscious incompetent*, and then to *conscious competent*. Then from there, the second category will take users to the goal stage, *unconscious competence*, and thus potentially change their behavior according to the behavior of the challenge.

7.2.1 Factors for making users committed to start doing a challenge

Making users committed to start doing challenges is essentially the key to making them eventually achieve a sustainable lifestyle. If a user cannot be convinced to do a challenge, then the aim of using challenges as the tool to support behavior change towards a sustainable lifestyle will fail. The following will go through the important factors of making users wanting to do a challenge and committed to the challenge, in terms of being engaged and having the ability to do it.

7.2.1.1 Making challenges simplistic to understand and do

Simplicity was regarded as a highly important factor in making users even want to use a system that aims for supporting behavior change, according to the user evaluations. The users meant that if a system is too complex to understand and use, the interest in using the system will be lost. A similar aspect in terms of simplicity is regarding one of Fogg's seven persuasive technology tools, *Reduction: Persuading through simplifying* (see Section 3.4.2.1). Fogg mentions that Amazon's *"one-click"* feature to buy things motivates users to buy things due to the simplicity

to do so. Therefore simplicity plays an important role in making users want to use a certain system. Furthermore, not only does the actual concept and design of the system have to be simplistic, but easy challenges should also be allowed to do. Users from the evaluations of the prototype meant that providing challenges that are too difficult to do could make the users quit in the middle of the process, or even worse, make the users not even want to start the challenge. As a conclusion to simplicity, provide the users with an understandable concept that is simplistic in every aspect.

7.2.1.2 Tailoring challenges for users' preferences

What impressions that the users get when seeing a challenge is an important factor, in order to both attract the users and make them do it. The challenges must be tailored to a user's situation, which Fogg also describes as *Tailoring: Persuasion through customization* (see Section 3.4.2.3). Fogg means that if information appears to be personal then users will care more about the information and really take it in. Therefore if a challenge appears to be personal and tailored to the users' preferences, then the users will care more about the challenge and really want to do it. If a challenge is not useful, meaningful, or even applicable, the users will not commit to it. A concrete example that a user from the evaluations of the prototype gave was that if the user does not own or use a car, but is recommended by the system to do a challenge regarding driving less, then this user would feel frustrated since the system recommended a useless challenge that was not applicable. Furthermore, it is of high importance that the challenges do not make users feel bad, which would repel them from doing challenges. Users from the evaluations meant that a way to prevent this is to make the challenges fun and enjoying to do. A user also specifically expressed that challenges should not challenge users in an unpleasant way, but rather give the users a feeling as if they were doing something natural that they enjoyed.

7.2.1.3 Providing information to teach and encourage users to do a challenge

The information that a challenge provides plays a crucial role in making the users want to do the challenge and become committed. According to Geller's behavior change model (see Section 3.2.1), instructing and encouraging users to do a certain behavior will take the users from being *unconscious incompetent* to *conscious incompetent*, and then become *conscious competent*, which takes the users two steps closer to achieving behavior change. This in other words means that the users will understand the requirements of doing a certain behavior as well as getting the motivation to do it, which in this case is the behavior of a challenge. Two important factors for achieving this according to Fogg's behavior change model (see Section 3.4.1) are; *ability* and *motivation*. In terms of *ability*, a challenge needs to provide the information on how to actually approach and accomplish the challenge. Fogg means that with the ability to do a behavior, users will be more likely to do the behavior. How the prototype created in this thesis approaches this is to present users with tips and instructions on how to do the challenge. Yun et al. also sees this as *Advice*, where the aim is to offer people suggestions about what they can do to reduce their environmental impacts (see Section 3.3.1.2). In terms of *motivation*, a challenge should

provide encouraging information so that users will become motivated to commit to the challenge. As the challenges are within the area of sustainability, the information needs to encourage users to become sustainable. Therefore, the prototype created makes use of presenting environmental impacts to the users, which showed how many animals or how much natural resources that would be saved by doing the challenge. Salo et al. (see Section 2.3.1.3) also mentions the crucial information of this factor as *Knowledge*, where the aim is to make users aware of their environmental impact by showing users how a certain challenge can affect climate issues.

Furthermore, it is important to present the information in an interesting way since it would increase the chances of making users become more interested and willing to take in the information. According to the user evaluations of the prototype, going with a better visualisation approach was shown to be more promising in terms of making users take in the information. Showing a lot of text was for example a bad idea since it would require too much effort for the users to take in, as well as being boring. Making the information more exciting to take in on the other hand was more encouraged. The users meant that the challenge details screen in the prototype (see Section 7.1) allowed for self exploration, as in first seeing some key facts, which then can be explored more by committing to do so. This would in the end make the users more committed to taking in the information since it is themselves who wanted to explore the information.

7.2.2 Factors for making users turn a challenge's behavior into a habit

In order to turn a challenge's behavior into a habit, the goal stage *unconscious competence* must be reached according to Geller's model. This is where users need to do the target behavior repeatedly in order to make it become a natural habit. Although, this also takes into account that a user is *conscious competent*, which could be achieved with the previous mentioned factors; *Factors for making users committed to start doing a challenge*. Only once a user is capable to commit to a challenge's behavior, can the challenge's behavior become a habit. The following will go through factors that have shown to have potential in making users want to do a challenge's behavior repeatedly, and in the end turn the behavior into a habit.

7.2.2.1 Scheduling as a tool to support repetition and form a habit

In order to actually do a certain behavior, Fogg means that the users need to be triggered to do it (see Section 3.4.1). Scheduling challenges is a way to make users plan their progress of doing the challenges over time, which in turn will support the users by triggering them when challenges should be done. This is an important factor in terms of making the users actually commit to what they promise to do in their scheduled plan, as well as supporting them in doing the challenges on time. By letting users plan their own time slots for the challenges, they would probably plan it as conveniently and comfortably as possible. This is important according to one of Fogg's seven persuasive technologies, *Suggestion: Intervening at the right time*

(see Section 3.4.2.4), because there will be a higher chance that the users will do the challenges when themselves feel like it, thus their own scheduling. Users from the evaluations of the prototype have expressed that the scheduling of challenges could be an important factor to assist them in doing the challenges repeatedly since they would be both reminded and pushed to do the challenges. They also meant that by repeating a challenge, there is a high chance that they will adapt to that behavior and eventually form a habit.

Furthermore, there were some users from the evaluations who meant that scheduling as a tool was not for them, thus this factor does not apply to a user target group who dislikes schedules. The arguments made were that adding another schedule on top of their personal or work schedule would be too much to handle. Another argument made was that continuous handling of scheduling was too time consuming. As a conclusion, it is important to understand the target user group when trying to apply this factor, because if people do not like schedules, they would not use the product at all. However, the downside of not using schedules could be that the support of making users commit to repeating a challenge's behavior is lost, due to not providing the same extent of support. Users could potentially forget to do a challenge, or not do a challenge regularly enough to form a habit.

7.2.2.2 Letting users monitor their progress of doing challenges

A factor that has shown to spark motivation to keep on doing challenges was to provide motivational feedback when doing challenges, according to users in the evaluations of the prototype. Whenever users have done a challenge, they should be able to track the progress in a simplistic way with minimum effort, but still be able to receive enough motivational feedback to keep on doing the challenges. The users meant that in this way, they would get motivation from seeing their progress of doing challenges. Salo et al. (see Section 2.3.1.3) also mentions this as *Knowledge*, which is a key feature in a carbon calculator. The knowledge in terms of providing a progress bar that conveys saved GHG emission can be seen as a source of knowledge and thus make users aware of their environmental impact.

Another factor is to provide the users with a place for looking back at what has been accomplished. In the user evaluations, the users highly liked the fact that they would be able to look back at what they have done previously. By seeing their progress of how they continuously are progressing towards a more sustainable lifestyle, they would get more motivated to keep on behaving sustainable. The users also meant that even though they see bad progress being made, the information would still act as a motivation to change and put more effort in acting sustainably.

7.2.2.3 Awarding users to make them motivated to continue to do challenges

A factor that showed to have potential in making users continue to do challenges was to award the users with achievements. The achievements would act as a reward for the users and make them feel like they have accomplished something good, and then

they would want to do more challenges to earn more rewards. This is also something that Froehlich et al. describes as a way to aid users in repeatedly performing a behavior, and that the awarding occurs after a behavior has been performed (see Section 3.3.3.2). Furthermore, Fogg also sees this as an important factor for making users redo a certain behavior by rewarding them, and defines this as *Conditioning: Reinforcing target behaviors* (see Section 3.4.2.7). A concrete example given was that dogs will listen to the owner's commands again next time, if snacks are being awarded to the dogs. However, the type of achievement awarded plays a huge role in whether this factor will succeed. If an achievement is perceived as useless in users' eyes, then the users would not strive for trying to achieve more, thus achievement as a motivational factor will fail. Therefore it is of high importance to award something useful to users in order to apply this factor correctly. This failure could be seen in the prototype of this thesis, where badges awarded to users was shown to not create any motivation, according to users from the evaluations. The users instead meant that they would want rewards that were more valuable and had beneficial usages.

7.2.2.4 Providing triggers to motivate users to do more challenges

As challenges are being completed, users eventually will have to take on new ones. But the motivation to commit and add a new challenge might not always be there. Therefore, how to make users willingly to take on new challenges is an important factor to consider. Fogg also describe this as *triggers* (see Section 3.4.1), where the challenge system in this case needs to trigger users to approach new challenges in an easy and encouraging way for the users. A user from the evaluations of the prototype specifically addressed that users should not have to put effort in finding new challenges and instead, the system should make the users want to add new challenges. How this can be done could be to advertise challenges to users, so that they effortlessly can add suitable challenges without having to find them on their own. A similar scenario that the user from the evaluations gave was that an e-commerce not only lets a user search for products to buy, but it also advertises suitable products for the user to buy and actually succeeds to do so. In that way, even if users do not have the intention to buy something, the e-commerce still can persuade the users to buy something by successfully advertising suitable products. Hence, triggering a user to do more challenges should involve motivation and facilitation to do so.

8

Discussion

This Chapter will present the discussions about what has been made in this thesis. This involves the final results, the process of achieving the result, and lastly, discussions about potential future work that can be done for this thesis.

8.1 The final result

The final results which was presented in the previous chapter involved a set of factors for designing challenges in carbon calculators that should support users towards a sustainable lifestyle. These factors were extracted by applying *Research through design*, where the created prototype used for research also can be seen in the result chapter. The prototype as a result can act as a visual design reference, which can both complement the design factors, as well as provide inspiration for individuals who want to design similar concepts.

8.1.1 The prototype: The Challenges section

The prototype that was created and used to extract the design factors, was seen to be a success according to the researchers of this thesis. By creating the prototype, it was possible to use it as a medium to evaluate design solutions that would lead to the design factors in the end. A significant use case of the prototype was to evaluate whether the scheduling system had potential in supporting behavior change. By providing such a scheduling system prototype to users, they would be able to get a better understanding of it and can evaluate it based on looks and feel. This argument essentially applies to every design solution made in this thesis. Without a prototype as a medium, it would not be possible to answer the research question in the end, since users of the evaluations would not have a concrete medium to evaluate on.

However, to what extent and quality that the prototype provided in terms of extracting the design factors could be argued. Since the prototype was influenced by Svalna's carbon calculator approach, the end result is arguably affected by Svalna. As seen in the prototype, the entire concept of the challenges revolves around counting the GHG emissions of users, but whether the use of GHG emission is the best approach was not researched. Therefore, directly following Svalna's approach to use this unit can be seen as a limitation because using other units or approaches were left out in the research. Another noticeable influence is the use of a the goal progress bar, based on users' GHG emission calculated by Svalna. This goal progress

bar is not directly connected to doing challenges since doing challenges has its own progress bar. The goal progress bar was basically included since Svalna makes use of the GHG emission number, and including this number together with the approach on challenges was considered to increase motivation. The idea was to continuously let users see their goal while they do challenges. Even though it provides a motivation factor, it not only is quite disconnected from the challenge progress, but it also takes up space. Including too many elements in the end can complicate the design and make it harder for users to understand.

In the end, getting influenced by Svalna's approaches was considered as reusing promising solutions and improving them, instead of having to reinvent the wheel. However, this also hindered the options to research the entire area of designing challenges in carbon calculators. If the research was started from scratch and more neutral, the approach of designing challenges in carbon calculators would not involve Svalna's approaches to the same extent. On the other hand, Svalna was not the only reviewed carbon calculator and in fact, five others were involved too. But it can for certain be said that Svalna had the biggest influence on the design created in the end. Nevertheless, using Svalna's carbon calculator and resources, as a starting point can be argued to certainly be worth it. By being able to use an existing carbon calculator for research, it would mean that the research would not have to start from scratch, which is to create a carbon calculator from start. Additionally, Svalna could provide a contacting network to their users, which meant that the evaluations made in this thesis were based on actual carbon calculator users. Finding such users without the help of Svalna would have been a lot more difficult and time consuming.

Going into the actual prototype created, it can be argued that it is too limited in terms of the actual challenges presented to users of the evaluations. The prototype only presented a *vegan* challenge in details. By only evaluating the prototype with one challenge in details could mean that users who disliked the *vegan* challenge would view the prototype differently from users who liked the challenge. It would arguably be better to provide a more abstract type of challenge, without specific information that could affect users. The point to be made is essentially that users should evaluate based on how a challenge is designed, rather than what specific information that a challenge is about. Although, it was made clear to all users involved in the evaluations that the challenge presented was just an arbitrary chosen challenge, and that the challenge information in details should not be taken personally. Additionally, the prototype did present other challenges as well, but not with detailed information. But in the end, users knew that there existed different challenges, therefore the findings should not have been affected based on the limitation of only presenting *one* specific challenge.

8.1.2 The design factors

Moving forward to the answer to the research question, which is the design factors, the thesis group judged that these have been successfully extracted by applying *Research through design*. However, even though these factors were extracted, it has to

be addressed that the factors did not get evaluated further after extracting them based on research and prototyping. This involves the fact that the factors are something that designers of carbon calculators can make use of, thus it is a good idea that these factors could be evaluated with these designers to validate whether the factors are suitable and useful. Making sure that the factors are useful for designers is certainly an important step, but since this thesis did not have time for further work, it could not be done. Additionally, the thesis group regarded that involving users to make the factors accurate, was more important than involving designers to make the factors usable in terms of design purposes. Another point in terms of further evaluation on the factors, is that the factors need to be tested more with users, such as letting users evaluate designs with the factors applied. The reason is because the current factors could be false negatives, that is, the factors might actually not work. Maybe the factors currently only seem to be promising due to the researchers of this thesis making very good and convincing prototypes, or steered the users in the evaluations towards favoring what these factors state. Therefore, it is very important that these factors need to be tested further in order to validate that they actually are valid.

In terms of the factors extracted, they are formulated in an abstract way, without being targeted to a specific carbon calculator such as Svalna's. This makes the factors applicable on any carbon calculator that tries to use challenges with purposes of making users more sustainable. The factors do not mention a specific directions on what units or information to provide, such as GHG emission as a unit. They only go as far as providing concrete examples based on the prototype created. Talking about the factor of providing information in a challenge do not state that a certain type of information needs to be presented, but rather exemplifies this by stating what the prototype in this thesis used. In the end, the factors are defined so that individuals who attempts to use these factors will get the overall understanding on how to design challenges, but the specifics such as facts to provide or how to design a certain element, will be left for themselves to explore.

Although, as mentioned earlier regarding the prototype, the design factors in the end arguably have an influence from Svalna's carbon calculator and thus are limited to Svalna's approach to a small extent. However, this is by no means a negative aspect since the result is still an answer to the research question. It also has to be noted that the result is just one potential solution out of potentially many existing or unexplored ones. Therefore, this thesis' result is by no means the one and only approach in using challenges to support behavior change in users of carbon calculators towards a sustainable lifestyle. So whether the result is influenced by other carbon calculators can be seen as irrelevant since there can be many different approaches. The aim in the end is to provide *important factors* for designing challenges, rather than *all factors*.

Regarding to what extent that the design factors satisfies the research question can also be argued further. The extracted design factors can certainly be more, if not infinite since such a research question can be approached in many different ways

and the result will thus be different for every approach. But in terms of extracting the design factors from the actual prototype made, the set of factors are deemed to be satisfied for producing an approach on challenges as seen in the prototype. Extracting more factors would obviously be possible if there was more time, but by the end of extracting the factors in this thesis, the time was also out.

The research question also specifically mentions *supporting behavior change*, and whether the factors can design such behavior changing challenges can be argued. Creating behavior change was for certain impossible in the scope of this thesis. To confirm whether behavior change is achieved would require a longer time to observe and confirm whether a user's behavior has changed when doing the challenges. Evaluating behavior changing challenges would also require something functional that users can use over time, such as a functional carbon calculator mobile application. However, this was also not within the scope of the thesis since the scope only focused on a conceptual design rather than developing a mobile application. Therefore it is safe to say that the thesis' scope can not make sure that behavior change occurs. But with all research and evaluations made on the design solutions in this thesis, it can be acknowledged that the design factors *potentially* can be used to create challenges that support behavior change. Therefore it is safe to say that the answer to the research question *potentially* can support behavior change, where research made in this thesis can backup this claim. Finally, it can be safe to say that in terms of this thesis scope, the research question has been answered to a satisfied extent according to the researchers.

8.1.3 The aim of making people more sustainable

The purpose of the carbon calculators and the challenge factors designed in this thesis have the aim to make people behave more sustainable. In terms of the factors extracted, they do not dive deep into what a sustainable action should involve, and instead lets the designer (the one who will use these factors to design) research and decide the actual content. The idea is that such details of a sustainable behavior is not something that the factors should decide, because sustainability can differ from person to person. As mentioned before, United Nations (United Nations, 2020) have defined 17 sustainable development goals, ranging from climate change to peace and justice and many more. If a factor instead would have been strict to only focus on sustainable food consumption, it would limit the application area for this factor. Therefore, it is up to the designer to involve any sustainable action, as long as the goal in the end is to protect the planet. Furthermore, an important aspect though in terms of what a sustainable action should involve, is that it should in no way make users feel bad when doing the challenges. There is either no intention in making users feel bad if they do not do the challenges, since that is not the point of trying to make the users more sustainable. The sustainable actions need to be natural to users and they should basically enjoy what they do. If a user has another point of view of a sustainable action and decides to not follow a challenge, then that should be allowed and the system of challenges should not make the user feel bad for not doing it. Everybody have their own understanding and own choices which should

be respected, and what the challenges do in this thesis, is to give recommendations without using force.

8.2 The process

The result of this thesis was accomplished by applying *Research through design* to extract design factors. The design was then created using the *Design process* and application of the methods presented in the methodology chapter. Regarding the *Design process* and the methods used, the thesis group deemed that all methods used were of great importance in terms of producing the end result. However, if the process were to be redone, there certainly would have been different approaches made for each step in the *Design process*. The major change in the approach would be to focus less on Svalna's carbon calculator, and more on how to design challenges in carbon calculators generally. However, this would not mean to leave out Svalna, because the resources that Svalna provided to this thesis research was immensely important. This involved providing their carbon calculator as a medium for research, their users for evaluating design solutions, and lastly, their expertise in the field of designing carbon calculators. Nevertheless, the approach in this thesis should have focused more on how to design challenges in carbon calculators, rather than how to design for Svalna's specific case. This would be especially important from the very beginning, otherwise the result in the end would be too affected by Svalna's carbon calculator, which in fact did happen to a small extent. But as a final result mentioned earlier, the design factors would not only be applicable on Svalna's carbon calculator, but on any carbon calculator that wants to use challenges. However, if the correct approach would have been made from the start, it could be argued that the end result could have turned out to cover a larger perspective of solutions. But as mentioned earlier, a solution is still a solution, and there can be many solutions to this research question.

In terms of user involvements in both the first user requirement gathering and the later stage of evaluating the design solutions, it would have been desirable to involve more users. However, the time constraints did not allow for this. With more users, there would probably be more findings to analyze which in the end potentially would result in more factors generated. More accurate factors could also be a possibility, since a small sample size could introduce biases. Furthermore, the user involvements were mainly Svalna's users, thus the focus again is on Svalna's approach on challenges. Hence, the feedback received from these users might only focus on Svalna, and leave out other valuable findings outside of Svalna's area. Therefore, it would have been ideal to find users who were not only users of Svalna, but also users of other carbon calculators. In this way, it would be possible to extract feedback from users in other carbon calculators too, and in the end gain a bigger perspective of how to create solutions. But since that did not happen, the user feedback was narrowed down to be focused on Svalna's approach, hence it was not possible to explore other potential solutions in the field of carbon calculators.

Another point to be addressed in terms of user involvement, is that users were not involved in the low-fidelity prototyping evaluation. Instead, Chalmers students and experts from Svalna were involved since that was a quicker way to conduct evaluations. If there was more time, users of Svalna or any carbon calculator would definitely be involved, but since that was not the case, the researchers deemed that this was the best approach. Letting users evaluate a high-fidelity prototype that was more realistic was instead the priority, since the researchers did not think that involving users in the low-fidelity prototyping would yield as good result as in the high-fidelity prototyping. So choosing between these two stages regarding where users would be involved ended up in the high-fidelity stage. It is quite important to end up with a prototype that have gone through user evaluations. In the low-fidelity prototype, it already had strong connections to the early user research. Regarding whether these choices and prioritizations affected the end result, the researchers deemed that nothing got worsened. The high-fidelity prototyping evaluations showed that the result had promise, thus it was in a right direction. Involving users in the low-fidelity prototyping could on the other hand end up in getting more ideas and more refined ones, but that the prototype in the end was a failure was not a fact. Therefore, by not involving users in the low-fidelity prototyping did not worsen the end result, but in an ideal scenario, involving users in all stages would be desired.

8.3 Future work

As already mentioned earlier, if more time was given, the scope of this thesis could have been enlarged and thus, answer the research question even better. This specifically targets the question on whether the design factors can be used to design challenges that actually can support behavior change. Therefore, if future work would be applied to this thesis' research, it would firstly be to realize the design factors on a functional product. By applying the design factors and making a functional carbon calculator make use of the challenges, supporting behavior change could be tested. How to approach this could either be to develop a carbon calculator from scratch, or collaborate with a carbon calculator, such as Svalna. If this would be done in collaboration with Svalna, it would be possible to test whether the challenges would support behavior change in their users on a long-term basis. Only with such evaluations and result would it be possible to confirm whether the design factors can support behavior change in users towards a sustainable lifestyle.

Another point in terms of testing the design factors is to address the whether these design solutions are false negatives. As mentioned earlier, this could be due to the prototype being designed very good so that the users got convinced that the design solutions had potential. It could also be due to the users in the research and evaluations being steered by the researchers towards favoring the design solutions. Therefore, the factors need to be applied to a design and be tested by users further, in order to validate whether the factors actually work. The more testing that is made, the higher chance will it be that they work.

Furthermore, it can be argued that continuing to do more iterations on this thesis'

design factors and prototype would yield more and better design factors. But the thesis group means that doing more iterations would not validate whether behavior change can be achieved. Instead, developing a functional carbon calculator using challenges with the design factors applied to test behavior change as mentioned earlier, should be the first step of future work. Only after that should more and better design factors on designing challenges be made. Nevertheless, discussing about the specifics of the current design factors extracted, it would have been interesting to explore further about alternatives of *Scheduling as a tool to support repetition and form a habit*. As presented in this specific factor, scheduling can play an important role in making users form habits of doing the behaviors of the challenges, however, scheduling can also be something that is not preferred by some users. Therefore it would be interesting to see what other techniques there are that can provide the same extent of support. If a technique can be found that satisfies all users, then it would arguably be better than using scheduling, thus a big improvement can be made in this factor. In future work, the starting point of this research could then be; *researching for better alternatives to using scheduling as a tool to support repetition and form habits*.

Another factor that could be explored further is regarding; *Awarding users to make them motivated to continue to do challenges*. Even though this factor talks about the benefits of awarding users, it does not concretely state what kind of reward that should be awarded. It also mentions the failed attempt to use virtual badges in the prototype, which was shown to be useless to users. Therefore, the aspect of *what kind of reward that should be awarded to users in order to create motivation*, is an important direction to approach in future work. Otherwise, if the type of reward does not satisfy the users, then this factor will fail its purpose.

Moving away a bit from improving and validating the design factors in terms of whether they work, another aspect that needs to be addressed is that the end-users of the factors need to be involved. The end-users can be anyone who tries to make use of these factors, such as designers. Therefore, it is important to evaluate with potential designers to see whether the factors are suitable and applicable in terms of applying them in carbon calculators to create the challenges.

8.4 Limitations due to the COVID-19 pandemic

During a major part of the thesis work, a pandemic named COVID-19 was going on and was considered to be very contagious from person to person. Therefore, the government of Sweden did not recommend too close contact with others, and recommended social distancing. As a result of that, the activities in this thesis that required the researchers to be physically close to others, could not be accomplished. However, the thesis' activities that were planned to involve physical presence with others, could be accomplished remotely without any issues. Therefore, the end result was not deemed to be worsened.

9
Conclusion

This thesis aimed to answer the research question:

> *What are important factors to consider when designing user challenges in carbon calculators, to support behavior change in the users towards a sustainable lifestyle?*

To accomplish the task asked by the question, *Research through design* was applied, where a design was created in order to research what the question asked for. The creation of the design was in turn using an *iterative design process* with suitable methods for achieving such a design. Therefore, the end result and answer to the research question are based on theoretical research, user research, design solution exploration, and design solution evaluations by users.

The result in the end to answer the research question was a set of factors for designing challenges in carbon calculators that support behavior change in users towards a sustainable lifestyle. The challenges in this case involve sustainable behaviors for users to do, where one example could be to make users eat more vegan food as a way to become more sustainable. Then the aim is to make the users adapt to the challenge's behavior of eating vegan and thus change their behavior to a more sustainable one. The design created for finding the design factors can also be seen as part of the result, where this design can act as a visual design reference on how it would look like if the design factors were used. Nevertheless, the design factors extracted revolves around how a carbon calculator can make users start do challenges and continue to do them until the behaviors of the challenges have become habits. This can also be seen as achieving behavior change towards a sustainable lifestyle, which is when sustainable actions are being performed naturally. An overview of the factors for designing challenges are listed as two categories seen below, where both of them depend on each other in order to potentially change behavior according to a challenge's behavior:

- Factors for making users committed to start doing a challenge
  - Making challenges simplistic to understand and do
  - Tailoring challenges for users' preferences
  - Providing information to teach and encourage users to do a challenge

- Factors for making users turn a challenge's behavior into a habit
  - Scheduling as a tool to support repetition and form a habit

- Letting users monitor their progress of doing challenges
- Awarding users to make them motivated to continue to do challenges
- Providing triggers to motivate users to do more challenges

Even though a successful result was generated in the end, the result is by no means the one and only solution or approach to designing such challenges in carbon calculators. The design factors can either not be seen as a bulletproof approach in carbon calculators to change behavior in users towards a sustainable lifestyle. This would instead require further work in terms of applying the factors on a carbon calculator that can be used by users, and evaluate whether long-term behavior change can be achieved.

In the end, the thesis group is satisfied with the work and result accomplished. Not only in terms of succeeding in answering the research question, but also because the work that has been accomplished potentially could be used for changing behavior in people towards a more sustainable lifestyle. If that would be possible, then this planet that we live on would become healthier and the work that has been done in this thesis would be well worth it.

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A
Appendix Theory

A.1 Nielsen's heuristics

- **Visibility of system status**
  The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

- **Match between system and the real world**
  The system should speak the users' language, with words, phrases, and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

- **User control and freedom**
  Users often choose system functions by mistake and will need a clearly marked emergency exit to leave the unwanted state without having to go through an extended dialog. Support undo and redo.

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

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

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

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

- **Aesthetic and minimalist design**
  Dialogs should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialog competes with the relevant units of information and diminishes their relative visibility.

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

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

B

Appendix Process

B.1 User research: Consent form

Participant Consent Form for Svalna's User Study

With my signature below, I consent voluntarily to be a participant in this research study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.

I understand that in any report on the results of this research, my identity will remain **anonymous**. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about.

I understand that the information I provide will be treated confidentially and will only be used for the Master's Thesis Project of Chalmers and Svalna's user research.

Please tick the boxes if you agree:

☐ I agree to participate in this research study under the conditions described above.

☐ I agree with my interview being **audio-recorded anonymously**, for the purpose of an accurate analysis. The recording will be deleted once it has been analyzed.

_____	_____	_____
Name of participant [printed]	Signature	Date

Researchers: Martin So & Mengwei Zhou
Area of use: Master's thesis at Chalmers University of Technology & Svalna

B.2 User research: Semi-structured interview

Warm-up:

- **How long have you used the application?**
  - **How often do you use the application?**
- **What do you usually do with the application?**
- **Why do you use the application?**
- **Currently, what makes you continue using the application, any specific features?**

Key questions:

- **What would make you act more sustainable in your daily life generally?**
- **How much do you think that this application in general makes you engaged in sustainability?** *From a scale from 1 to 5, where 1 is "it is not engaging at all" and 5 is "it engages me very much".*
  - **If you find the application engaging/not engaging you to be environmentally friendly, would you like to explain why?**
- **How do you think the application supports you to act more sustainable in terms of the current three sections?** *Show the application. Ask for elaboration.*
  - **Which section do you think encourages you the most to be sustainable, and why?**
- **Regarding the Goal Section, could you tell us more about your experience?**
  - **How would you rate this section in terms of making you engaged in sustainability?** *1 to 5, where 1 is "not engaging at all" and 5 is "very engaging".*
    - **Why does the Goal Section (not) make you engaged in sustainability?**
  - **Have you attempted any of the challenges that Svalna has suggested to you?** *E.g. "fly less", "try vegetarian", etc.*
    - **How and Why did you do them/ Why did you not do them?**
- **One of our aims is to improve the challenges and actions in the Goal Section:**
  - **What are your opinions on improving the challenges?**
    - **How do you think they could be more encouraging and useful to do?**
    - **Do you have any thoughts on a type challenge that you would like to be included?**
  - **What are your opinions on improving the actions so that they help you act more sustainable?**
    - **Do you have any thoughts on type of actions that you would like to be included?**

Wrap up questions:

- **Do you have any extra input? Ideas, thoughts, concerns?**

B.3 User research: Questionnaire

Demographics

Gender:
- Female:
- Male:
- Other:
- Don't want to answer:

Age:
- Under 18:
- 18 - 29:
- 30 - 39:
- 40 - 49:
- 50 - 59:
- 60 and above:

Occupation:
- Working:
- Studying:
- Retired:
- Other:
- Don't want to answer:

Your usage of Svalna

How often do you use Svalna? (Multiple answers)
- Few times a week:
- Few times a month:
- Few times every quarter of a year:
- I don't use the application anymore:

What is the most usual reason for using the application?
- I am curious about how my emission changed from last time:
- I am part of a group in the application and I want to see how it goes:
- I want to check my emission and see if I can buy more things without exceeding my limit:
- No reason, I don't have anything better to do:

Would you say that Svalna has helped you to reduce your emission?
(1 = No, not at all, 5 = Yes, very much)
- 1:
- 2:
- 3:
- 4:
- 5:

What do you think about the following sections in the application?
(1 = I don't like it at all, 5 = I like it very much)
- **Emission:**
  - 1:
  - 2:
  - 3:
  - 4:
  - 5:
- **Group:**

    - 1:
    - 2:
    - 3:
    - 4:
    - 5:
- **Goal:**
    - 1:
    - 2:
    - 3:
    - 4:
    - 5:

What can Svalna do better?

How well does the following statement apply to you?
(1 = Not true at all, 5 = Very true)

- **You have to be clearer about how the calculations work in order for me to trust them:**
    - 1:
    - 2:
    - 3:
    - 4:
    - 5:
- **Can you show points instead of CO2 so that it is easier to understand:**
    - 1:
    - 2:
    - 3:
    - 4:
    - 5:
- **I would like to receive updates from Svalna, e.g. about how things are going with my active challenges or when a group I am part of passes a goal:**
    - 1:
    - 2:
    - 3:
    - 4:
    - 5:
- **It would be great if you could introduce a shared economy system so the calculations are right for me:**
    - 1:
    - 2:
    - 3:
    - 4:
    - 5:

How well does the following statement apply to you?
(1 = Not true at all, 5 = Very true)

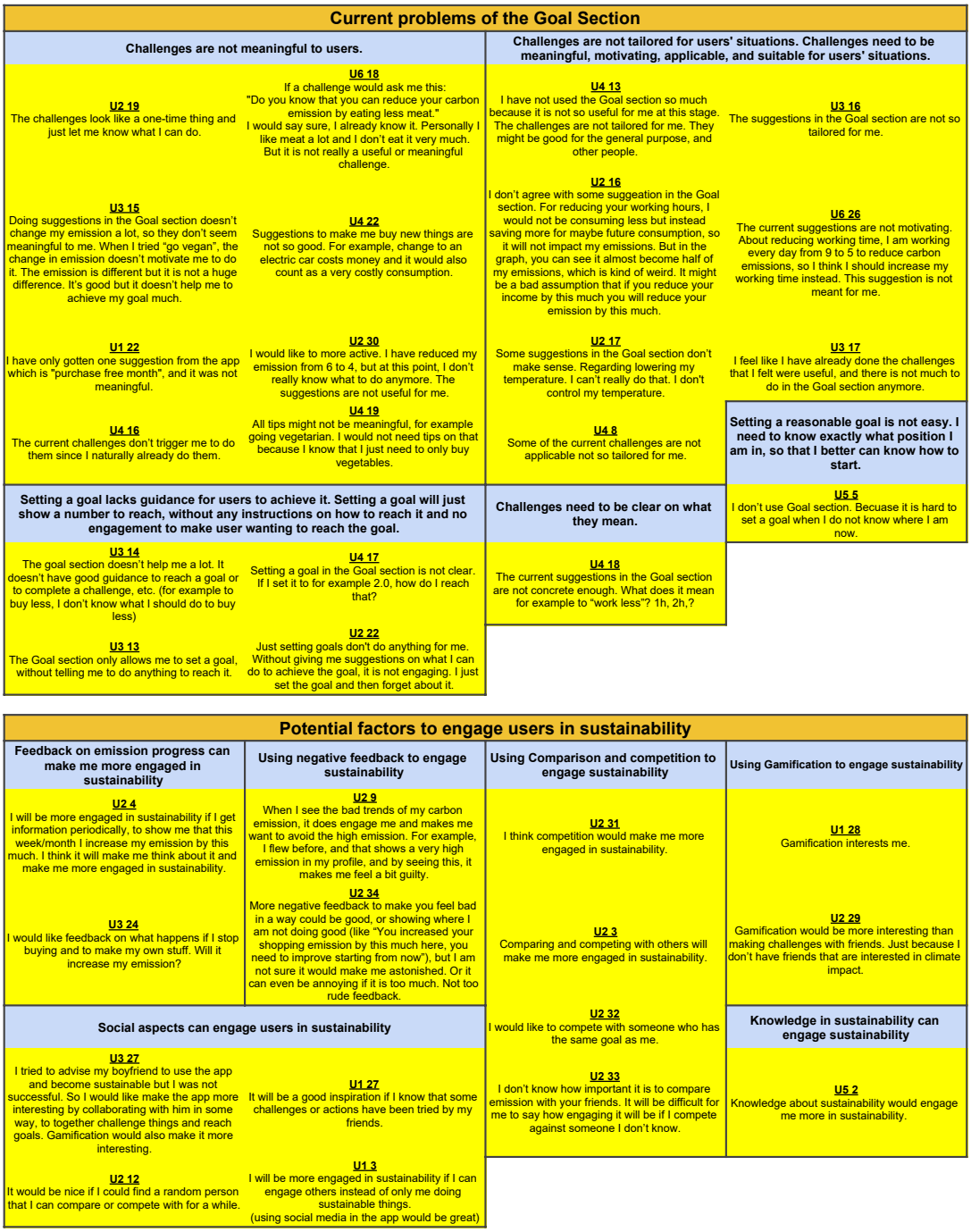
- **I want to monitor my emissions over time so that I can lower them myself:**
    - 1:
    - 2:
    - 3:
    - 4:
    - 5:

- **I want to get concrete suggestions on how I can reduce my emissions:**
  - 1:
  - 2:
  - 3:
  - 4:
  - 5:
- **I need help to be motivated to lower my emissions:**
  - 1:
  - 2:
  - 3:
  - 4:
  - 5:
- **I want to be able to set a hard emission target, that motivates me:**
  - 1:
  - 2:
  - 3:
  - 4:
  - 5:
- **I want to see how I am compared to similar households:**
  - 1:
  - 2:
  - 3:
  - 4:
  - 5:
- **I would love to follow a celebrity who reduces his/her emissions:**
  - 1:
  - 2:
  - 3:
  - 4:
  - 5:
- **I want to get challenges that I can perform with friends:**
  - 1:
  - 2:
  - 3:
  - 4:
  - 5:

If you want to comment on how you answered above or have other ideas, thoughts or suggestions for improvements that we have not asked for, please feel free to describe them below:

-

B.4 User research: Affinity diagram



Potential Improvements of the Goal Section			
Get inspired and motivated to act sustainably by others who are sustainable. **E.g. other people stop flying, then I will feel like I want to stop too.**	**More meaningful challenges**	**Challenges should provide concrete tips on what they mean and how to improve**	
U6 21 It would be good if it was possible to see in the app that your friends have not eaten meat for a week, because I would be motivated by that and not eat meat too.	**U3 25** I would like really difficult challenges which is meaningful for me to do. For the challenges now, I feel like I have already done them.	**U1 26** I really would like to have more concrete tips. If I choose a challenge, the app could guide me to do this and that to achieve this challenge.	**U5 9** I would like more details on what I can improve. Right now I can only see what areas that have high emission.
U6 19 About challenging you to become vegan, I think it could include friends to connect you with other people. The hard thing about not flying, is to see your friends fly, it will make me want to fly too. If you have a friend who said I have not had meat for two weeks or regular cow milk for one week, maybe it will make me feel glad to do the same thing. It could be random people but it will be a stronger effect with friends. Group pressure is great.	**U3 23** I want to try out dumpster diving as a challenge.	**U2 18** The Goal section's suggestions do not give knowledge and understanding about a subject or situation. They should be more concrete, it would be more interesting if I knew what exactly the meaning of them were and then I could focus on what is useful for me.	**U6 27** The suggestion of saving money may sound suitable for me. I would be motivated if I can see how it has been calculated or like how should I save money.
U2 11 I don't know anyone who cares about sustainability to the degree that I do, so it would not be so relevant for me to compare emission with my friends or relatives. If I did it, I think I already know what the comparison would look like.	**U3 22** For potencial challenges, I would like to try to make my own stuff , such as food, bread, skincare, bodycare and other DIY.	**U1 25** The suggestions in the Goal section can be more concrete, because most people don't know what certain sustainable actions mean and the effect of different activities. If I keep recycling, does that mean that I can travel to new york? Is that equal?	**U4 10** Give concrete suggestion or guidance on how to be economical.
Show positive impacts of achieving goals and challenges. If users achieve a goal or challenge, show what benefits they get.	**Tailored challenges based on your activity. The challenges should be based on who you are and what situation you are in.** **A challenge could involve tracking users' activities and respond based on that, e.g. you are buying too much of this, you should stop now...**	**Achieving goals and challenges should show more guidance.** **Give recommendations on what a reasonable goal is, e.g. IPCC global goal for 2025.** **Give guidance on how to reach a goal, and what is needed to be done.** **Introduce a progress of achieving a goal, so that users know how they are progressing towards their goal.** **Reaching a goal can be supported by completing pro-environmental challenges.**	
U6 25 It would be interesting if the app can tell me that my emission will be that lower if your meat consumption can be reduced from xx to xx. Show some more concrete benefits.	**U2 26** Challenges and actions based on your activity would be interesting, but it might be limited to the current constraints of the bank transaction data (it doesn't show you what kind of food it was, etc.). So it needs to rely on the user's input. But manual input is not so good. For example if the app asks me if I ate vegan, I don't think I want to go there and answer this question. Automation is better.	**U1 23** In the Goal section, I would like to know what a reasonable goal should be. The current design only indicates the average carbon emission for Swedish people. But what is the goal for Sweden? Maybe it is good to have a target reference, such as the IPCC global goal for 2025, to help me better understand where I should aim.	**U2 25** I think challenges and actions being linked is very important for the challenge. Doing a challenge should involve supportive and guiding actions/suggestions to users, which should help them achieve the challenge. I think very few people can just know what to do in detail without supervision.
U1 20 In the Goal section, I would like to have tips that shows potential effects. For example; If you did this, you will decrease this amount of emission.	**U3 21** The challenges should be more personal (based on personal activities, who you are and how you act.), everyone has different goals and situations.	**U4 21** It would be better to have a more concrete goal. If I want to reach 2.0/year, maybe give me suggestions or hints to reduce my gas consumption or at least suggestions that are meaningful for me.	**U3 26** I would feel more motivated if I know how long it will take if I do this or that challenge/goal. Step by step is good, with guidance and support.
U4 23 Some benefits can be listed to motivate people to act on some sustainable behaviors. For example, it will save you money to buy old clothes instead of new.	**U2 24** Challenges and goals should either be active and dynamic. Have different scenarios for different emission categories, or based on who your activities. The actions or the challenges or whatever should be dynamic in terms of which kind of purchase I make.	**U3 18** If the goal is too big, maybe it takes a year or two years, it will be difficult to know how I progress or if I can complete it. You feel more motivated if you know how long it will take to acheive something. (progressive personal challenges)	**U4 24** Doing challenges and actions to reach some goal needs to have some kind of progress. This will let me see how I am doing. Am I on the right track? What do I need to do now? What challenges can I do? When will I reach my goal? etc.
U4 20 For potential suggestions, I want more details on what I should do and what the benefits are.	**U2 23** If the app knows when I purchase too many things, suggestions in a way that will make me stop are good, and explaining why I should stop, etc. Also, if I want to take a challenge to stop going to coffee shops, then maybe I could get reminders to don't go to them and if I do, maybe it should keep warning me, etc. Then it would be more interesting.	**U2 28** It would be good to show that to reach a goal, you could cut out this and that purchase or to lower your electricity consumption.	**U3 19** The goal should not be too general, otherwise it will be difficult to know how I progress or if I can complete it. For example, I wanna reach 1.5, do I wanna reach it within a year or two? How long it will take for me? (maybe have a graph to say how long will it take for me to come to 1.5 ton carbon emission with this goal/ challenges; or to tell me to do this and that, you will reach 1.5 with in several months. They will both motivate me to do it.)
U2 27 It would be helpful if you can see the impact if you do a challenge/goal, which actually inspires you by showing the difference. More concrete information on the benefits.	**U2 35** If you are on a challenge, like stop going to Starbuck, and it says that you have several transactions to Starbucks. I think it should be some feedback on that. Maybe not very direct response, but more like, this month you did this and you need to do that to lower your emission.	**U3 20** It would be nice to have more info or guidance once I set a goal, such as I have to do this or that to reach the goal.	**Let users set more tailored goals. Different goals for different emission categories.**
			U1 24 In the Goal section, other than a total amount of emission, I would like to set separate goals for different categories, like food, shopping, etc.

The Emission section

The Emission section is good for showing categorized emission over time

U2 20
The emission section is useful since it shows the emissions over time.

U4 6
The emission categorization is useful for me to see the trends in each of them.

U4 4
I mainly use the Emission section, which makes me continue using the app.

U1 14
The Emission section makes me act more sustainably, because it shows my emissions.

Show more details in the emission

U1 30
Would like to have more details if I click on an emission category (to know what the things are that generate carbon emission as detailed as possible). Eveything I buy should be as detailed as possible.

Show more tailored emission

U6 28
It will be more interesting to see the emissions in relation with the information I care more about such as how much my meat consumption is or how much my shopping consumption is.

The Users

Some users have already been highly motivated and engaged in sustainability

U6 1
My level of knowledge is quite high and my engagement in sustainability was very high before using Svalna.

U6 10
I am trying to use my electricity more and more when renewable production is strong.

U6 30
I am already quite aware of what I should do sustainably and don't need too many tips.

U6 5
I work with sustainability and I am very interested in climate change professionally.

U6 16
I am already very engaged with sustainability.

U2 1
I study sustainability and always have sustainability in mind.

U1 19
I really like setting a goal. But I will always minimize my emissions, no matter if I have it or not.

Users take various actions on becoming environmental-friendly

U5 1
I try to be environmental-friendly. I have been vegetarian for many years.

U4 1
I am an environment-friendly person in general. I use solar energy, taking the bike to work, train to farther places, grow my own vegetables.

Users have their own interested areas to improve their emission

U6 12
I am also interested in sustainable dietary choices and lowering travel emission.

U6 8
I have been very engaged recently with my electricity usage although I gained the knowledge from the app that it is a very small portion of my carbon footprint.

Users would like to become more sustainable than their current daily life

U1 1
Personally, sustainability is really a large part of my life. I think about sustainability all the time and even study sustainability.

U3 8
I use the app to know in what areas that I can lower my emission more.

Users are aware of their obstacles to become more sustainable

U2 2
Sometime I will do exceptions if needed. Such as buying things that are felt needed (phone, etc.)

U6 17
I know quite well about where my climate problems are. I do not fly privately for many years. But I do eat meat and buy clothes and I know it's my flaw.

Responsibility to protect the environment and animals motivates users to take pro-environmental actions

U5 7
My motivation to be sustainable is to protect the environment and animals.

U6 20
I am happy to engage with the app as often as Instagram because I think it would be probably great for myself and for the world (although generally, I would like to use my phone less)

U3 4
My motivation is to take care of the animals and nature. They don't have a voice. It started with animals and then I started to decrease my meat consumption and to ate a lot of vegan and vegetarian food. Gradually, I started to stop this and stop that and knew I could do this and I could do that. I can try even more vegan food, more secondhand.

U3 1
I am a very environment-friendly person since I was little. I love animals and nature, even more than humans.

Negative emotions motivate users' will to change

U3 28
I always think of what I can do to improve my lifestyle become even more sustainable. I want to change things and do things.

U3 30
I feel super sad when I see we are destroying our planet.

U3 3
I get frustrated by seeing other people not being environment-friendly, for example, when I moved to Stockholm, I got a very bad feeling because they were not sustainable. (I saw these consumption of food and products and I didn't feel comfortable with that; Is this how I am supposed to live when I live in this city now? I want to live exactly how I lived as a kid when I lived in Africa).

Knowledge helps users to be more aware of the importance of sustainability

U3 2
Getting knowleage about how to act sustainably on the internet and some inspirational podcasts, have made me more engaged in sustainability.

U6 13
Education and working around sustainability makes me very engaged in acting sustainable.

A sense of sociality motivates users to become more engaged

U1 2
I will be more engaged in sustainability if I am being around with people who have the same environmental concerns as me and discussing sustainability with them.

The measurability of pro-environmental behavior motivates users (design factor).

U6 9
The measurability of my eletricity usage makes me very engaged, which I get from another app. It gives me information about electricity use per hour and per day. I can get the results of energy-efficient effort very quickly, which motivates me a lot.

The users have the goal to track their emission and keep it low to stay sustainable

U1 9
I use the app mainly because I want to calculate my emission and keep it low.

U4 3
I use the app because I want to use it to check my emission and stay sustainable.

U4 7
I use the app to track my emissions to see how I am doing and to know where I need to improve.

U3 7
I use the app because I want to keep track of emissions to keep it low.

U6 4
I use the app because I am curious about my footprint and would like to know what I can do to reduce my footprint.

U1 6
I use the app to set my goal as 1.8 ton CO2/year and follow it.

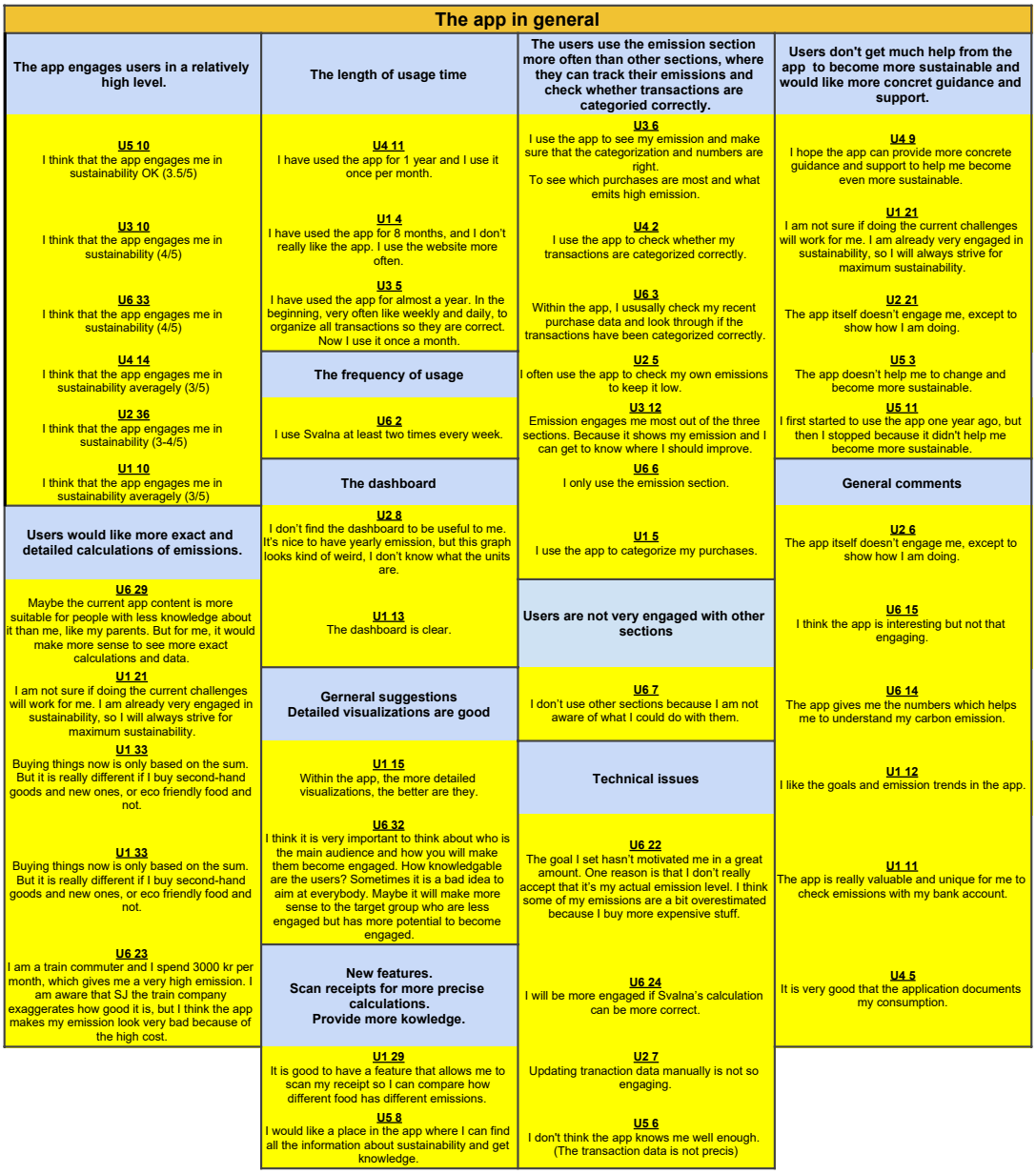
U3 11
I need this app to check if I consume too many things in some categories. And if I do, it will engage me to consume less.

U3 9
I use the app because in the Emission section I can see and track my emissions.

The users have the goal to learn about their emission

U1 7
I use the app to learn my emissions and the cause of them.

U6 31
I use the app mainly to get help to understand my personal emissions better.


The app in general
The app engages users in a relatively high level.
U5 10
I think that the app engages me in sustainability OK (3.5/5)
U3 10
I think that the app engages me in sustainability (4/5)
U6 33
I think that the app engages me in sustainability (4/5)
U4 14
I think that the app engages me in sustainability averagely (3/5)
U2 36
I think that the app engages me in sustainability (3-4/5)
U1 10
I think that the app engages me in sustainability averagely (3/5)
Users would like more exact and detailed calculations of emissions.
U6 29
Maybe the current app content is more suitable for people with less knowledge about it than me, like my parents. But for me, it would make more sense to see more exact calculations and data.
U1 21
I am not sure if doing the current challenges will work for me. I am already very engaged in sustainability, so I will always strive for maximum sustainability.
U1 33
Buying things now is only based on the sum. But it is really different if I buy second-hand goods and new ones, or eco friendly food and not.
U1 33
Buying things now is only based on the sum. But it is really different if I buy second-hand goods and new ones, or eco friendly food and not.
U6 23
I am a train commuter and I spend 3000 kr per month, which gives me a very high emission. I am aware that SJ the train company exaggerates how good it is, but I think the app makes my emission look very bad because of the high cost.
The length of usage time
U4 11
I have used the app for 1 year and I use it once per month.
U1 4
I have used the app for 8 months, and I don't really like the app. I use the website more often.
U3 5
I have used the app for almost a year. In the beginning, very often like weekly and daily, to organize all transactions so they are correct. Now I use it once a month.
The frequency of usage
U6 2
I use Svalna at least two times every week.
The dashboard
U2 8
I don't find the dashboard to be useful to me. It's nice to have yearly emission, but this graph looks kind of weird, I don't know what the units are.
U1 13
The dashboard is clear.
Gerneral suggestions
Detailed visualizations are good
U1 15
Within the app, the more detailed visualizations, the better are they.
U6 32
I think it is very important to think about who is the main audience and how you will make them become engaged. How knowledgable are the users? Sometimes it is a bad idea to aim at everybody. Maybe it will make more sense to the target group who are less engaged but has more potential to become engaged.
New features.
Scan receipts for more precise calculations.
Provide more kowledge.
U1 29
It is good to have a feature that allows me to scan my receipt so I can compare how different food has different emissions.
U5 8
I would like a place in the app where I can find all the information about sustainability and get knowledge.
The users use the emission section more often than other sections, where they can track their emissions and check whether transactions are categoried correctly.
U3 6
I use the app to see my emission and make sure that the categorization and numbers are right.
To see which purchases are most and what emits high emission.
U4 2
I use the app to check whether my transactions are categorized correctly.
U6 3
Within the app, I ususally check my recent purchase data and look through if the transactions have been categorized correctly.
U2 5
I often use the app to check my own emissions to keep it low.
U3 12
Emission engages me most out of the three sections. Because it shows my emission and I can get to know where I should improve.
U6 6
I only use the emission section.
U1 5
I use the app to categorize my purchases.
Users are not very engaged with other sections
U6 7
I don't use other sections because I am not aware of what I could do with them.
Technical issues
U6 22
The goal I set hasn't motivated me in a great amount. One reason is that I don't really accept that it's my actual emission level. I think some of my emissions are a bit overestimated because I buy more expensive stuff.
U6 24
I will be more engaged if Svalna's calculation can be more correct.
U2 7
Updating tranaction data manually is not so engaging.
U5 6
I don't think the app knows me well enough. (The transaction data is not precis)
Users don't get much help from the app to become more sustainable and would like more concret guidance and support.
U4 9
I hope the app can provide more concrete guidance and support to help me become even more sustainable.
U1 21
I am not sure if doing the current challenges will work for me. I am already very engaged in sustainability, so I will always strive for maximum sustainability.
U2 21
The app itself doesn't engage me, except to show how I am doing.
U5 3
The app doesn't help me to change and become more sustainable.
U5 11
I first started to use the app one year ago, but then I stopped because it didn't help me become more sustainable.
General comments
U2 6
The app itself doesn't engage me, except to show how I am doing.
U6 15
I think the app is interesting but not that engaging.
U6 14
The app gives me the numbers which helps me to understand my carbon emission.
U1 12
I like the goals and emission trends in the app.
U1 11
The app is really valuable and unique for me to check emissions with my bank account.
U4 5
It is very good that the application documents my consumption.

The Group section			
I want more things to do in the Group section: Comparing with others Share tips Competition		**The Groups are good for seeing how others are doing. Social media could expand this feature even more.**	**I don't use the Group section**
U1 32 An improvement in the Group section: An example; Me and my group of friends meet twice a year to see how our emissions look like together and how we improved, by using some website that calculate carbon emission. Would be good to have it in the app.	**U1 31** About my emission and the average of a group in the Group section, I would love to compare mine with a specific person. I would like to write or see some comments there and they should convey some tips to explain how his/her transportation for example can be that low. More interactions and actions in the group section in general would be good.	**U4 12** I look at the Group section sometimes to checks how my city is doing.	**U2 10** I am not in any of the groups so I don't use the Group section.
U2 14 It's interesting to compare myself with the group averages. But once I have done that, I only got the knowledge that I spend more on housing than the average but the other categories are much lower. Not much more to do.	**U1 17** The Group section does not have so many interactions available currently.	**U1 16** In the Group section, I have my little group and my friends here. Maybe people don't like to involve social media but I would love to connect my Facebook, otherwise, the social aspect will not be so updated, or personal.	**U5 4** I haven't used Group section because I made the decision to not use social media.
U2 15 Would like more actions to do within the group, either things to do or competing.		**U2 13** It's interesting to compare myself with the group averages.	

B.5 User research: List of concrete findings from the six interviews

- *Current state of users in terms of sustainability:*
  - Some users have already been highly motivated and engaged in sustainability.
  - Users are aware of their obstacles that prevent them from becoming more sustainable.
  - Users take various actions on becoming environmental-friendly.

- *Users' goal when using the carbon calculator:*
  - Users would like to become more sustainable than their current daily life.
  - The users have the goal to learn about their emission.
  - The users have the goal to track their emission and keep it low to stay sustainable.

- *Problems with the carbon calculator currently:*
  - Setting a goal lacks guidance for users to achieve it. Setting a goal will just show a number to reach, without any instructions on how to reach it and no engagement to make users wanting to reach the goal.
  - Setting a reasonable goal is not easy. Users need to know exactly what positions they are in so that they better can know how to start.
  - Challenges are not tailored to users' situations. Challenges need to be meaningful, motivating, applicable, and suitable for users' situations.
  - Challenges need to be clear about what they mean.

- *Solutions to make users more engaged in sustainability:*
  - Knowledge helps users to be more aware of the importance of sustainability.
  - Knowledge in sustainability can engage sustainability.
  - Social aspects can engage users in sustainability.
  - Feedback on emission progress can make users more engaged in sustainability.
  - Giving negative feedback to users can be a useful motivator in order to make users act sustainably.
  - Creating negative emotions can motivate users' will to change.
  - Responsibility to protect the environment and animals can motivate users to take pro-environmental actions.
  - Using gamification to engage sustainability is a suitable option.
  - Using comparison and competition between users can engage sustainability.

- *Solutions in the Goal section:*
  - Let users set more tailored goals. Different goals for different emission categories.
  - Achieving goals and challenges should show more guidance.

- Give recommendations on what a reasonable goal is, e.g. IPCC global goal for 2025.
- Give guidance on how to reach a goal, and what is needed to be done.
- Introduce the progress of achieving a goal, so that users know how they are progressing towards their goal.
- Reaching a goal can be supported by completing pro-environmental challenges.
- Get inspired and motivated to act sustainably by others who are sustainable. E.g. *"other people stop flying, then I will feel like I want to stop too"*.
- Show the positive impacts of achieving goals and challenges. If users achieve a goal or challenge, show what benefits they get.
- The challenges should be tailored in terms of content, so that they are based on who the users are and what situations they are in.
- A challenge could involve tracking users' activities and respond based on that, e.g. *"you are buying too much of this, you should stop now..."*
- Challenges should be meaningful and provide concrete facts on what it means to do them, and tips on how to improve.

B.6 User research: Persona 1: Charlie

Charlie is a person who has grown up with a good understanding of how people should behave in order to be sustainable and keep the earth healthy. She knows very well what kind of actions that are sustainable and what are not, thus allowing her to act fully sustainable if she wants to. But the downside with Charlie when it comes to acting sustainable is that she has no engagement in doing so. Even though she knows that it is really good to be sustainable, she will still not do so because she always has had a quite consuming lifestyle. If she deems that a purchase is necessary for her life, such as getting a new smartphone because it is getting a bit old, then she will buy a new one. Another exception that she makes is to be a meat eater. She knows very well that being vegan is a better option for the environment, but she still eats meat very often because she likes it too much. However, Charlie really would want to change her lifestyle into a sustainable one, thus needing all the help that is possible.

Charlie believes that a carbon calculator can help her in getting a sustainable lifestyle by getting engagement to act sustainably, but that was not true. The carbon calculator only helps her in calculating her emissions and shows that she is consuming a lot, which she already indirectly knows because she is aware of not behaving sustainably. Although showing emissions of one's behavior is helpful for aiding in tracking progress, the carbon calculator still lacks in engaging Charlie to act sustainably. A high emission visualized to Charlie to convey that she is consuming too much is simply not enough to engage her to lower it. What instead could engage Charlie would be if the carbon calculator could encourage her in some way when she acts sustainably. This would give Charlie motivation to keep on acting sustainable and a sense of feeling that what she is doing is right.

Charlie thinks that the carbon calculator has the potential to encourage her to act sustainable due to involving pro-environmental challenges, however, they are very abstract and meaningless, and do not motivate her in any way as of now. If completing goals and challenges instead could show that Charlie achieves something more concrete and interesting, then she would be more motivated to complete them. Furthermore, what makes Charlie more interested and engaged in different activities are mainly two areas; joy, such as playing games, and social aspects, such as competing and comparing with others.

B.7 User research: Persona 2: Kim

Kim is a person who loves nature and animals and has a very good understanding of the devastating effects on earth that will occur if people do not start to act sustainably. Therefore she is very engaged in the idea of acting sustainably and has the ultimate goal to have a sustainable lifestyle, however, she lacks the ability to actually act sustainable due to not knowing what meaningful sustainable actions are. In her daily life, she tries to do what she thinks is best for the environment since she loves and cares about the earth. But at the same time, she is concerned about whether she actually is acting sustainable due to lacking knowledge in the area of sustainability. She knows that recycling is a sustainable act, but at the same time, she thinks that recycling a lot will allow her to travel to New York as a compensation. Another dilemma she has due to lack of knowledge is whether she should buy a new electric car. The electric car will use green energy, but at the same time, buying new things causes unnecessary emissions. In the end, lack of knowledge is an obstacle for Kim in having a sustainable lifestyle.

Kim would really want to have someone instruct her to properly act sustainable and in the end, achieve a sustainable behavior. Therefore, she uses a carbon calculator which helps her to calculate her emissions and show how sustainable she is. This fits Kim very well since the carbon calculator can keep track of her activities and let her know if her behavior is on a sustainable level, such as seeing how much she consumes in her daily life. However, she does not really find the carbon calculator to help her to actually become sustainable due to not giving her enough of concrete instructions on how to achieve it. Kim wants to be guided in reducing her emissions with concrete information on what it means to reduce certain consumption and how exactly it helps the environment.

Kim thinks that the carbon calculator does have the potential to provide concrete information and guide her on what it means to do certain sustainable behaviors. But the way it is designed currently is too abstract and does not provide any useful knowledge at all to Kim. Kim means that if the carbon calculator could provide more concrete facts, guiding instructions on how to act, and be meaningful and relevant for her and her behavior, then it could ultimately make her behave more sustainably in the end.

B.8 User research: Storyboard 1

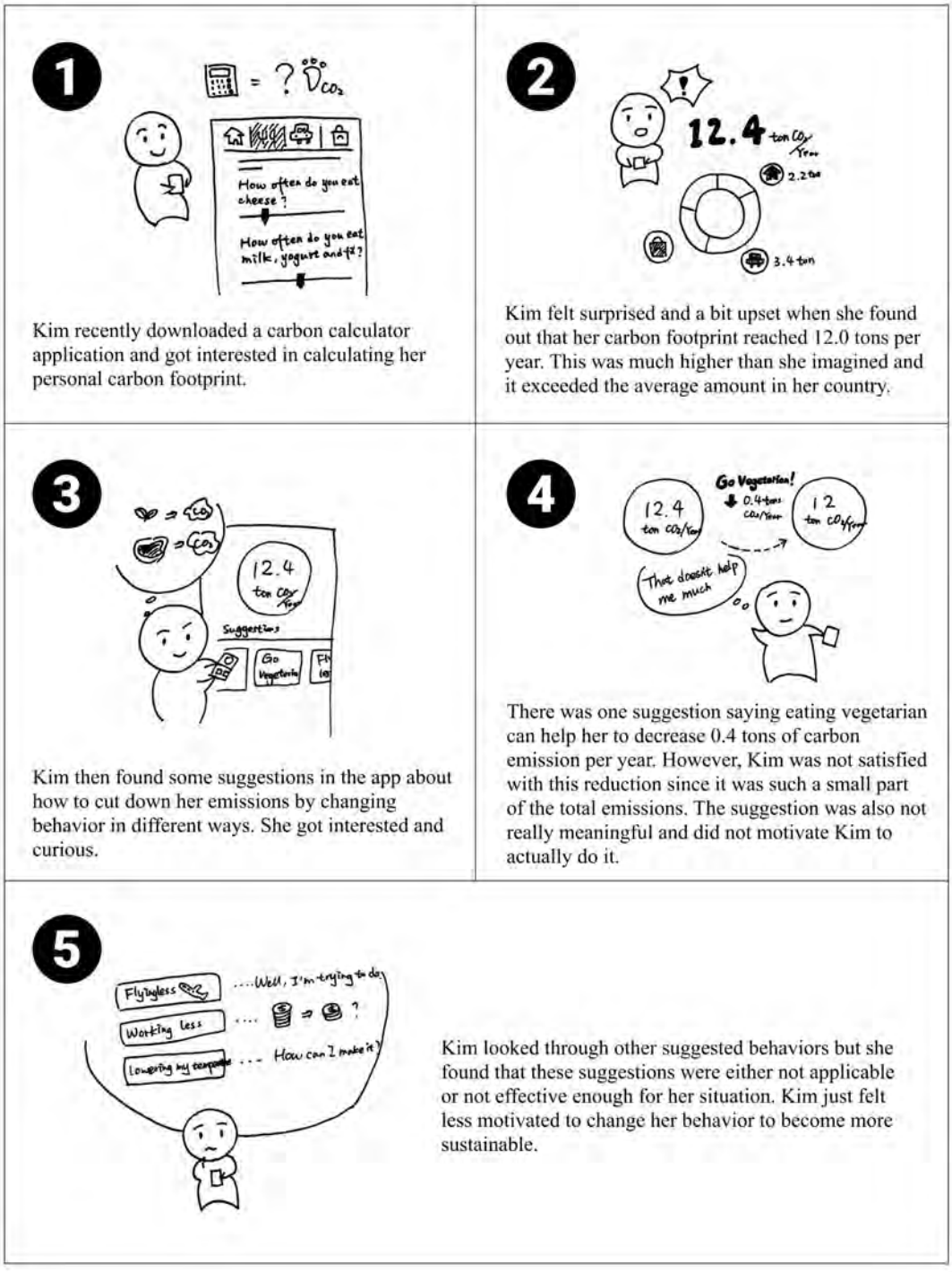


Figure B.1: Storyboard 1: Kim does not feel like the pro-environmental challenges within the carbon calculator fits her needs, motivates her, nor are meaningful.

B.9 User research: Storyboard 2

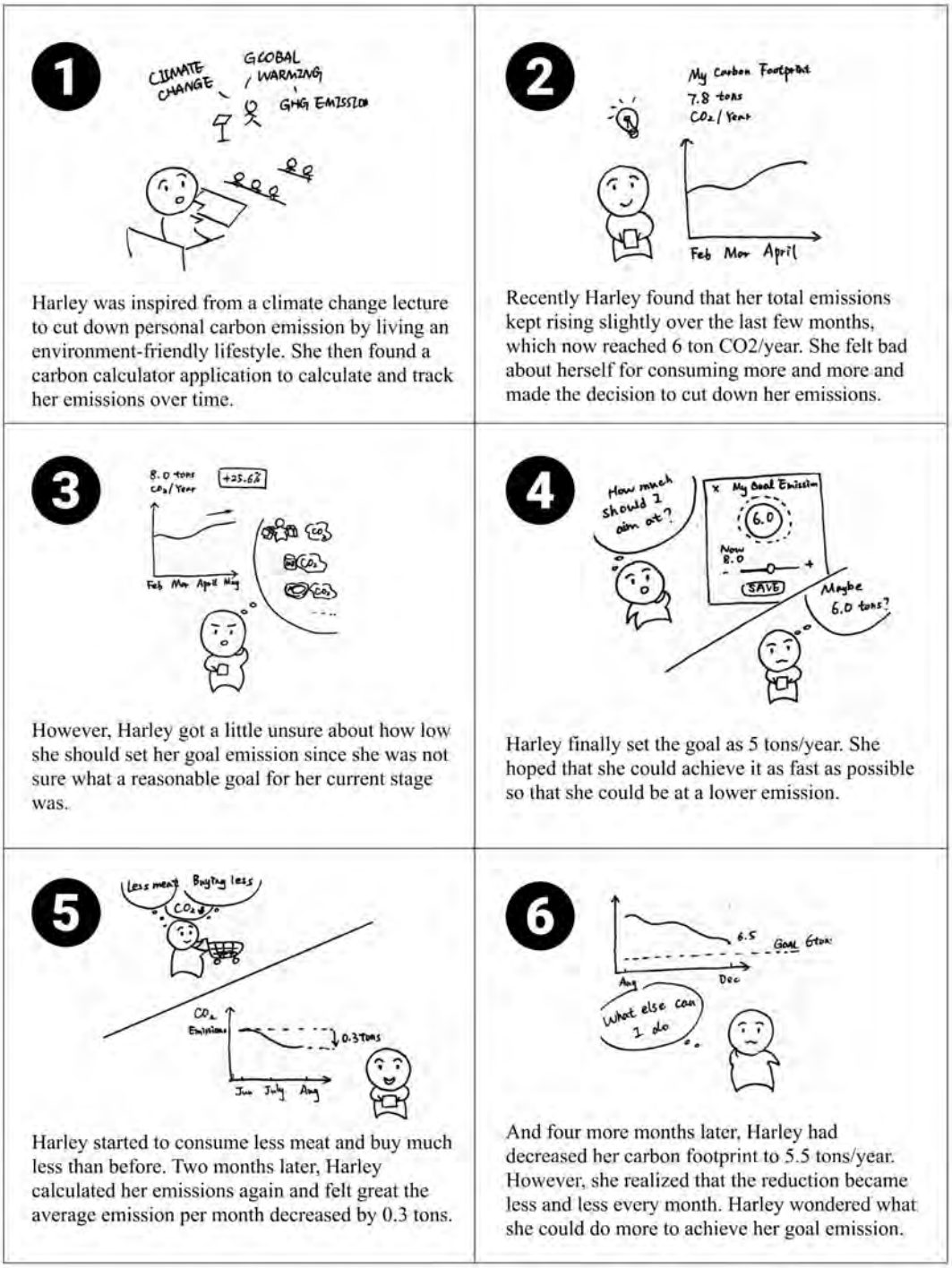


Figure B.2: Storyboard 2: Harley wants more support on how to reduce her emission once she sets a goal.

B.10 User research: Storyboard 3

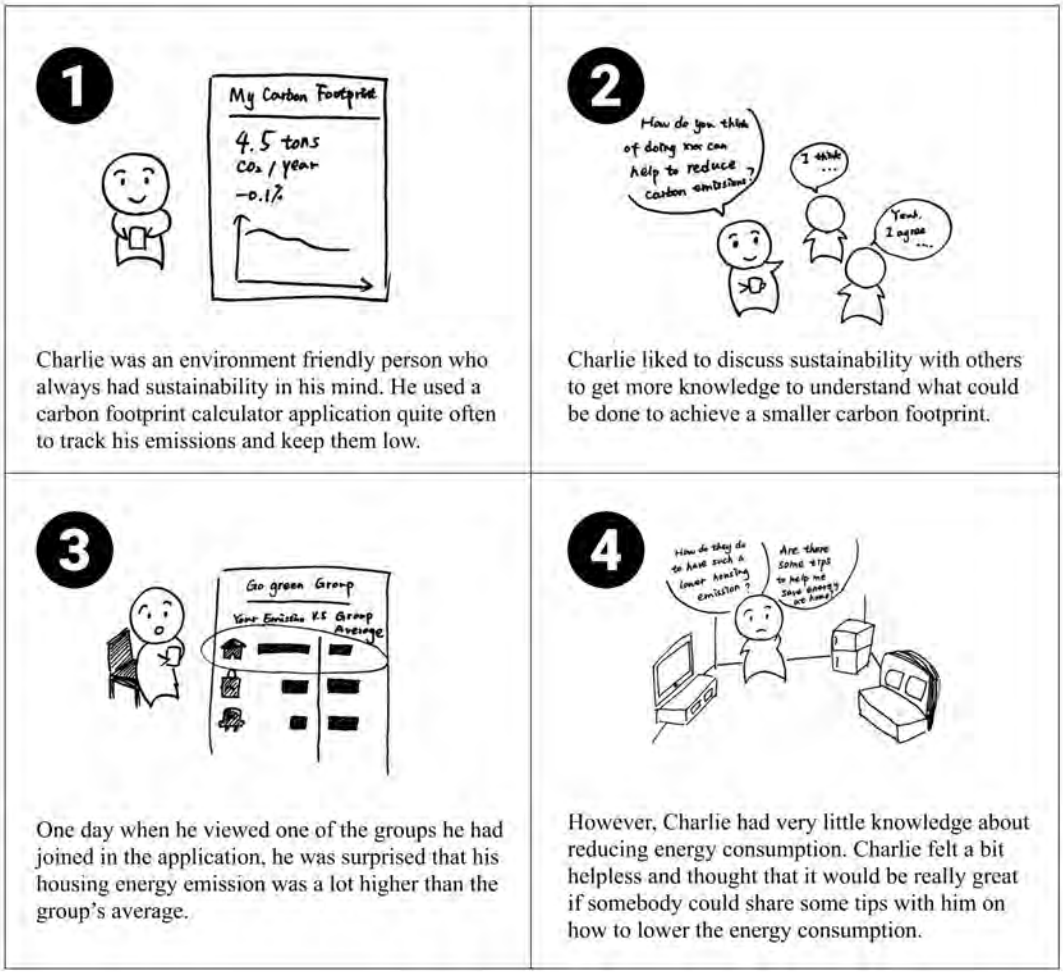


Figure B.3: Storyboard 3: Charlie is not very knowledgeable in sustainability, but believes that if other people could help him, he would be able to improve.

B.11 User research: Storyboard 4

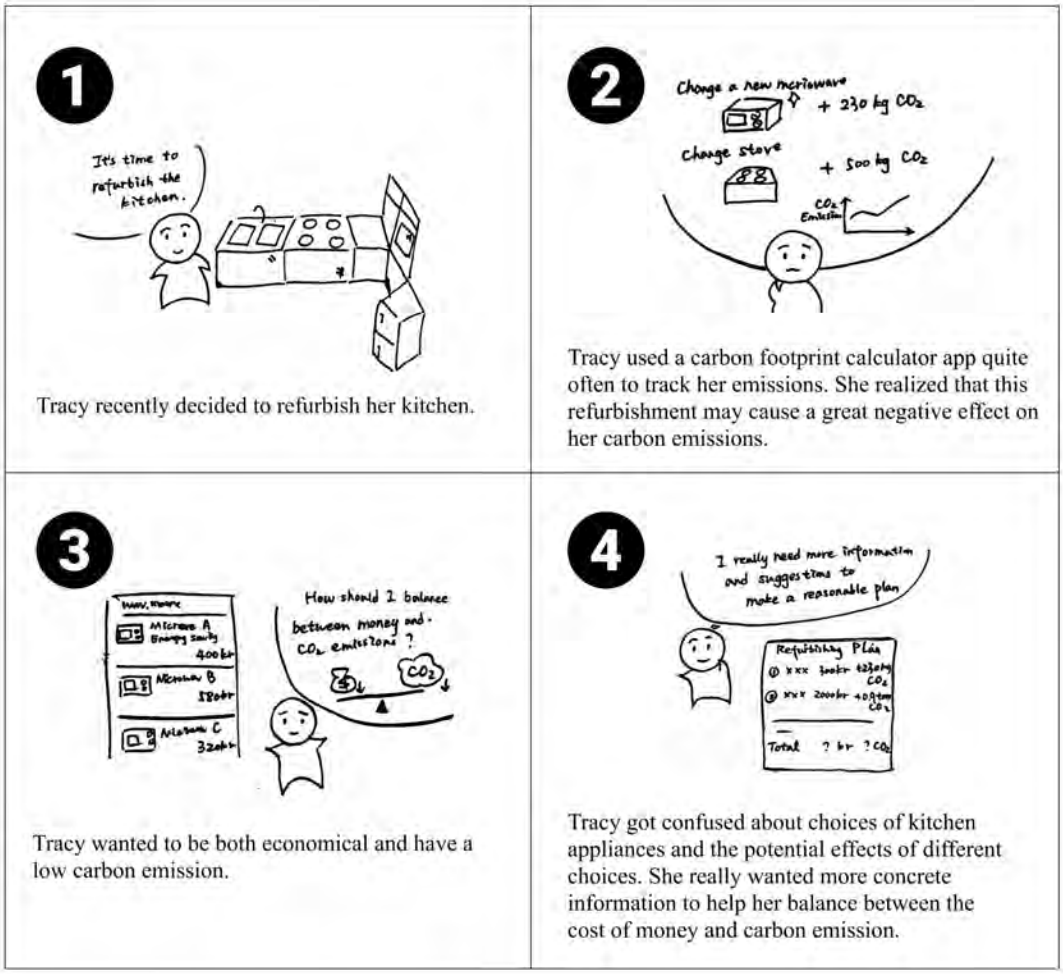


Figure B.4: Storyboard 4: Tracy is not sure of how refurbishing her kitchen will affect her economy and carbon emission. She could really make use of something that explained to her what the best option would be.

B.12 Ideation: KJ technique

Concrete user findings
Current state of users: - Some users have already been highly motivated and engaged in sustainability - Users are aware of their obstacles to become more sustainable - Users take various actions on becoming environmental-friendly
Problems of users in the app: - Setting a goal lacks guidance for users to achieve it. Setting a goal will just show a number to reach, without any instructions on how to reach it and no engagement to make users wanting to reach the goal. - Setting a reasonable goal is not easy. I need to know exactly what position I am in so that I better can know how to start. - Challenges are not tailored to users' situations. Challenges need to be meaningful, motivating, applicable, and suitable for users' situations. - Challenges are not meaningful to users. - Challenges need to be clear about what they mean.
User Goal: - Users would like to become more sustainable than their current daily life - The users have the goal to learn about their emission - The users have the goal to track their emission and keep it low to stay sustainable
Solution to make users more engaged in sustainability: - Knowledge helps users to be more aware of the importance of sustainability - Knowledge in sustainability can engage sustainability - A sense of sociality motivates users to become more engaged - Social aspects can engage users in sustainability - Feedback on emission progress can make me more engaged in sustainability - Using negative feedback to engage sustainability - Negative emotions motivate users' will to change - Responsibility to protect the environment and animals motivates users to take pro-environmental actions - Using Gamification to engage sustainability - Using Comparison and competition to engage sustainability
Goal section solutions: - Let users set more tailored goals. Different goals for different emission categories. - Achieving goals and challenges should show more guidance: - Give recommendations on what a reasonable goal is, e.g. IPCC global goal for 2025. - Give guidance on how to reach a goal, and what is needed to be done. - Introduce the progress of achieving a goal, so that users know how they are progressing towards their goal. - Reaching a goal can be supported by completing pro-environmental challenges. - Get inspired and motivated to act sustainably by others who are sustainable. E.g. other people stop flying, then I will feel like I want to stop too. - Show the positive impacts of achieving goals and challenges. If users achieve a goal or challenge, show what benefits they get. - Tailored challenges based on your activity: - The challenges should be based on who you are and what situation you are in. - A challenge could involve tracking users' activities and respond based on that, e.g. you are buying too much of this, you should stop now... - More meaningful challenges - Challenges should provide concrete tips on what they mean and how to improve.

Instructional intervention			
Education		**Advice**	
Provide concrete sustainable facts that will teach users how to act and what they mean in terms of saving the earth.	Education should build up users' understanding of why they should act sustainable.	Give meaningful and useful advice on how to be sustainable.	Advice should tell users what is right to do at the moment.
Customisable education: Provide an **option** for different education levels, e.g. I want to learn slowly/intensively. This means that the amount of effort on users will vary.	Provide ways that users can learn about sustainability related knowledge, such as how the calculation works, how different types of ideas may affect the environment, some tips to help users to save energy at home or reduce food waste.	Advice can appear in different ways to remind users about how to act, when suitable. E.g. notification, pop-up, small box in goal section.	Customized advice from the system depending on user's preference: 1. Interested area / 4 categories to improve or area suggested by the system. 2. General description allows for more freedom or more concrete instructions. 3. The system can provide dynamic advice based on users feedback (maybe by asking questions to users, such as are you happy with your current advice, want it more easy or challenging?)
Provide education based on what users want to learn. Focus on transportation, eating, shopping etc?	Be able to sign up for "school". Users will be teached "tips and tricks" every day, e. g. when they open the app, or in some box in the goal section. This will give new insights to the users everyday that they didn't know. For example; did you know that if you did this, you will save this and that...	Give advice based on activity of users. E. g. you are shopping too much, you should shop less by doing this and that.	Advice/tips can be given/shared between users. (**Social aspects**)
Quiz can be used to know how much knowledge users have and some tailored topics can be recommended to users.	Quiz. Mini-game where users can play quiz and earn points. The questions will be about sustainability.		All suggestion/challenges can be found in one place if a user want to quick check. User filters such as different category: transport, home, food .. Show how these actions can affect their footprint in a period of time (one time, one month, one year)

Motivational intervention			
Goal-setting		**Comparison**	**Engagement**
Instead of knowing only a number of carbon emissions, user can see a potential effect to environment if the goal is achieved to let users get more direct and real feeling of their behavior; or add game elements to make it more fun ; add a character to evoke people's emotions.	Setting a goal in Svalna should motivate and engage users to achieve it. As an end result, their consumption should reduce, by acting more sustainable.	Comparison with other people (friends/random) can engage a sustainable behavior. When you see other people act sustainable, you will feel that you need to be sustainable too in order to not be left out of the society.	If acting sustainable can be fun, then it will be more engaging to do it.
The app can assist users to set a reasonable goal according to some theory/data/organisation and users' current stage. e.g. IPCC global goal for 2025	Supervised execution of challenges. Guide the users through accomplishing a challenge. Teach users how to do, tell them why it is good, keep telling them what they achieve for every step.	Compare different goals or challenges on what is the most useful for your individual aim. E.g. see what challenge is best for improving consuming less food. Each challenge can for example have stats, where the stats show how much an area will be reduced. Each challenge has its own strength.	Gamification: The tree game Build the biggest forest, compete with friends. Earn points to build the forest by acting sustainable. Buy different trees with points that you earn from reducing emission, completing challenges, keep being sustainable. Big and beautiful trees require more points. The more beautiful and big forest you have, the more you can show off to your friends. E.g. you completed the challenge of: biking to your work everyday for a week. you get 100 points. With the 100 points, you can buy a cheap tree and put in your forest. Complete more challenges/goals or keep emission low, in order to earn more points. Be able to see other peoples forests and see how they achieved them.
On top of a graph and number, show an avatar such as an animal or tree. When emission is higher, the avatar will start to die, and when it is lower, the avatar will get healthier and happier.	Joint goal can be set for multiple users when they would like to collaborate (can be friends, family or random users). And users can know each other's performance, which can create competition at the same time.	Leaderboard: Compare with others to see how is most sustainable. Being in the top and better than others is quite motivating.	Challenge friends to do challenges. See who can be more sustainable. E.g. weekly competition. The winner gets points. The big competition maybe is one year. Final winner maybe gets some achievement on their profile.
Flexible goals: Allow users to set more specific goals in certain areas, rather than having one goal for everything. You maybe can have one big goal for everything, and sub-goals for different areas.	Users can choose to achieve goals in different modes (users can change the modes whenever they wish) - Leisure (provide some actions for users to try to reduce their carbon emission, and provide knowledge, actions should be easy and probably a one time task, such as follow this recipe to have a vegan meal today! targets beginners) - Competition (invite another user to compete with you or match a user randomly) - Adventure (provide some challenges for users to choose and take on. The length of time can range from weeks to months depending on their preference. Targets expert users)	Be able to compare with a 100% sustainable target. Then you can see in what areas you need to improve. E.g. you are falling behind in shopping, so now you know that you need to shop less.	Improve the social aspect by having profiles that can show how sustainable you are. What challenges you completed and how much emission you have. Show others how green you are. Building a profile can engage you more, since you have something to aim for now, which is to build the best profile.

Supportive intervention		
Feedback	**Commitment**	**Rewards & Penalties**
Motivational feedback for keeping up the engagement in sustainable actions.	Challenge as a commitment can improve the probability that users will commit to being sustainable.	Rewards & Penalties can keep the sustainable behavior.
Weekly, monthly or yearly feedback can be provided as a report to work as a motivator or reflection factor. (can be combined with the **goal setting**)	Users can view all pledges and take the ones they are intersted in. The effects will be provided at the same time for users to see the potencials.	When users complete an action, a reward or penalty can be a certain amount of carbon emission to reduce or increase the total amount.
Advice + Goals		**Advice + Feedback + Reward**
Users get more concrete advice after setting a clear goal, where users can set the targeted area, the amount of reduction and the time to complete it (can be taken as a **challenge** to say whether a user can reach the goal in a period of time; smart and setting to reduce mental load - **reduction**)	Once users set a goal, the app can provide a progressive way for users to achieve it, such as providing selectable **actions** or show sub-goal for each month to aim for. For example, if the users plan to use half a year to achieve a goal, different actions can be selected by users to act upon for each month.	Instant advice can work as a notification if the app knows that the user is in specific location. And users can get direct feedback if they choose to take the action. For example, if the user is in a restaurant, the app can send a message advising a vegetarian dish for the user. If users agree to take the action, they can get some kind of reward.

Fogg: Useful Motivators			
Hope and Fear	**Social acceptance and Social rejection**		**Pleasure and Pain**
Fear: Showing negative feedback or outcome to users might make them rethink their actions, and instead act sustainable. E.g. you flew very much, and caused emission of 100 people together.	Other than decreasing personal carbon emission, users can also choose to engage others in reducing carbon emissions . For example, users can share tips or give suggestions for others. A type of reward can be some virtual points to show how sustainable a person's lifestyle is.	Get motivated by friends. Show that friends have not been flying for a year, and if you are the only one who flies, you will feel less motivated to fly, so that you are not a social rejection.	If a user is very sensitive to animals or nature getting hurt, then showing what negative effects that they will get if not acting sustainable, can be motivating.
Attempting a useful goal or challenge will give users hope to want to finish it.	Users can make part of their emission data public and open for suggestions and discussions.	User can offer suggestions for each other if they need some tips to improve.	
	The app can provide some popular topics containing interesting environmental knowledge and suggestions for users and at the same time allow users to give their own opinions or discuss with each other.	The user will receive a virtual medal / badge in her profile once a challenge has been completed. It can be a great inspiration for others (friends) when they see that some challenges or actions have been tried by someone else.	
	Add elements to build a more attractive profile system related to sustainability to make people engage in building their own profile.	Users can invite other users to achieve a challenge together.	

Fogg: Increase in ability		
Time	**Money**	**Physical effort**
Challenges are set to be completed within limited time. - Before taking the actions, users can decide how long they would like to complete a challenge (some variables can be levels of difficulty depending on the amount of carbon emissions, different activities like traveling, refurbishment...)	Saving money can be a factor to motivate users. - Some tips or challenges can show how it could help users to be economic (how it has been calculated) as potential effects of some actions	Consider Goals and Challenges to be suitable and easy for users' physical abilities.
Using the app in general to become sustainable should not require too much time. Make it simplistic and less time-consuming to use the app.	The cost of doing goals and challenges should consider who the person is. But in general, it should not cost to act sustainable.	
Brain cycles	**Social deviance**	**Non-routine**
Actions should be easy to understand and remember. Video/image instructions can be provided to aid users to understand the expected actions.	Do not suggest users to break the social norms and rules of society. Such as doing things that will make others look negatively at you. Users will not feel comfortable to do them if that happens.	Aspects for users to improve should be based on the understanding of what users are used to doing now. **More options** can be provided for users to take the actions they prefer.
Keep Goals and Challenges simple, by using more visualizations than words. Looking quickly at something should be enough to understand what is going on.		

Fogg: Triggers		
Sparks as triggers	**Facilitator as triggers**	**Signal as triggers**
Some instant/periodical **feedback** once an action is done to work as a motivation or reflection. For example, if the app detects one transaction (or transactions during a week) with relatively high emission, users will get notified by the app, where some negative effects can be provided to motivate users.	Context-based instruction for users based on their location. For example, if a user is at a supermarket, the app can send instant messages to give tips to suggest a more low carbon shopping.	
	The way to remind users can be decided by users based on their preferences. For example, users can decide to receive messages from the app if the emission goes over 300 kg CO_2. or Users will receive a message that they will soon exceed 1000 kg CO_2, and get reminded to cut down the emissions within one month.	

Fogg's seven tools:			
Reduction: Persuading through simplifying	**Tunneling: Guided persuasion**	**Tailoring: Persuasion through customization**	**Suggestion: Intervening at the right time**
Doing Goals and Challenges should not require too much attention by the users. Simplify the process of Goals and Challenges, for example automation of completing tasks, few clicks.	Progressive Goal system: The aim is to reach a final goal, but on the road, there are checkpoints (small goals). Accomplish a little bit at a time. And for every small goal, users will be guided to it. In other words, have multiple easy guides rather than one big goal with a complicated guide.	Challenges should be based on users' situations.	location/context-based message contains knowledge and tips.
Goals and Challenges should be simplistic. Too much text is annoying. Simple but effective visualizations can be good.	Supervised execution of challenges. Guide the uses through accomplishing a challenge.	There should be multiple Goals and Challenges that users can choose between.	Suggest tips whenever users are starting to consume more. Praise users for acting sustainable when they do so, which will motivate them to keep on acting sustainable.
		A quick setup to help users get more tailored information. A setup can contain questions like: - choose aspects you may be interested in to improve - choose topics you may be interested in to know more about - What do you want to learn from the app: green diet/low carbon travelling/energy use - I wish to become more sustainable in the mode of (leisure/competition/adventure) - What would you like to be notified about?	
Self-monitoring: Taking the tedium out of tracking	**Surveillance: Persuasion through observation**	**Conditioning: Reinforcing target behaviors**	
User can ask the app to send a message if one transaction is detected to create carbon emission over a certain amount.	Make the users feel like they are observed by the application. If users do not act sustainable, the users should be aware that the app knows this and the app will report bad behavior as well as providing other negative effects on the user. (No privacy. Do not force observation, instead ask users if they agree)	Provide virtual reward for users if they complete a goal or actions. Rewards can be an amount of reduction on the carbon emission or some virtual points. (more points means more sustainable); some **game elements** can be added.	
Continuous detailed tracking of a certain area that the users want to analyze better.			

B.13 Ideation: Affinity diagram

User centered design				
1	2	3	4	
More personalized profile in terms of sustainability	**Understanding the users and tailor things for them**	**Motivational factors**	**Design concerns of challenges and goals**	
Add elements related to sustainability on current profile to attract and engage people in building their own profile.	Quiz can be used to know how much knowledge users have and some tailored topics can be recommended to users based on their preference.	If acting sustainable can be fun, then it will be more engaging to do it.	Doing Goals and Challenges should not require too much attention by the users. Simplify the process of Goals and Challenges, for example automation of completing tasks, few clicks.	The cost of doing goals should consider who the person is. But in general, it should not cost to act sustainable.
Improve the social aspect by having profiles that can show how sustainable you are. The profile can be used to display infomation such as the emissions and the actions or challenges done by the users (some forms can be badges or medals). Show others how green you are. Building a profile can engage you more, since you have something to aim for now, which is to build the best profile.	A quick setup to help users get more tailored information. A setup can contain questions like: 1. Choose aspects you may be interested in to improve. 2. Choose topics you may be interested in to know more about 3. What do you want to learn from the app? (green diet / low carbon travelling / energy use) 4. I wish to become more sustainable in the mode of (leisure/ competition/ adventure) 5. What would you like to be notified about?	Challenge as a commitment can improve the probability that users will commit to being sustainable.	Goals and Challenges should be simplistic. Too much text is annoying. Simple but effective visualizations can be good.	Keep Goals and Challenges simple, by using more visualizations than words. Looking quickly at something should be enough to understand what is going on.
Users can choose to make part of their emission data in their profile public and open for suggestions and discussions.		Attempting a useful goal or challenge will give users hope to want to finish it.	Using the app in general to become sustainable should not require too much time. Make it simplistic and less time-consuming to use the app.	Consider Challenges to be suitable and easy for users' physical abilities.
		Make the users feel like they are observed by the application. If users do not act sustainable, the users should be aware that the app knows this and the app will report bad behavior as well as providing other negative effects on the user. (No privacy. Do not force observation, instead ask users if they agree)	Do not suggest users to break the social norms and rules of society. Such as doing things that will make others look negatively at you. Users will not feel comfortable to do them if that happens.	The cost of doing challenges should consider who the person is. But in general, it should not cost to act sustainable.
			Consider Challenges to be suitable and easy for users' physical abilities.	

Tips/education, feedback, and how they are communicated to users				
5	6	7	8	9
Useful concrete tips for users	**Location based tips**	**Notify users**	**Feedback on users' actions**	**Tailored education**
Provide concrete sustainable facts that will teach users how to act and what they mean in terms of saving the earth.	Instant advice can work as a notification if the app knows that the user is in specific location. And users can get direct feedback if they choose to take the action. For example, if the user is in a restaurant, the app can send a message advising a vegetarian dish for the user. If users agree to take the action, they can get some kind of reward.	Advice can appear in different ways to remind users about how to act, when suitable. E.g. notification, pop-up, small box in goal section.	Suggest tips whenever users are starting to consume more. Praise users for acting sustainable when they do so, which will motivate them to keep on acting sustainable.	Provide education based on what users want to learn. Focus on transportation, eating, shopping etc?
Be able to sign up for "school". Users will be teached "tips and tricks" every day, e. g. when they open the app, or in some box in the goal section. This will give new insights to the users everyday that they didn't know. For example; did you know that if you did this, you will save this and that...	location/context-based message contains knowledge and tips.	Give advice based on activity of users. E. g. you are shopping too much, you should shop less by doing this and that.	Fear: Showing negative feedback or outcome to users might make them rethink their actions, and instead act sustainable. E.g. you flew very much, and caused emission of 100 people together.	Customisable education: Provide an **option** for different education levels, e.g. I want to learn slowly/intensively. This means that the amount of effort on users will vary.
Give meaningful and useful advice on how to be sustainable.	Context-based instruction for users based on their location. For example, if a user is at a supermarket, the app can send instant messages to give tips to suggest a more low carbon shopping.	The way to remind users can be decided by users based on their preferences. For example, users can decide to receive messages from the app if the emission goes over 300 kg CO2. or Users will receive a message that they will soon exceed 1000 kg CO2, and get reminded to cut down the emissions within one month.	If a user is very sensitive to animals or nature getting hurt, then showing what negative effects that they will get if not acting sustainable, can be motivating.	Education should build up users' understanding of why they should act sustainable.
Advice should tell users what is right to do at the moment. E.g. you have been shopping too much last month, this month you can shop maximum X kr, otherwise you will cause too much emission.		User can ask the app to send a message if one transaction is detected to create carbon emission over a certain amount.	Motivational feedback for keeping up the engagement in sustainable actions.	Provide ways that users can learn about sustainability related knowledge, such as how the calculation works, how different types of ideas may affect the environment, some tips to help users to save energy at home or reduce food waste.
Customized advice from the system depending on user's preference: 1. Interested area / 4 categories to improve or area suggested by the system. 2. General description allows for more freedom or more concrete instructions. 3. The system can provide dynamic advice based on users feedback (maybe by asking questions to users, such as are you happy with your current advice, want it more easy or challenging?)			Some instant/periodical **feedback** once an action is done to work as a motivation or reflection. For example, if the app detects one transaction (or transactions during a week) with relatively high emission, users will get notified by the app, where some negative effects can be provided to motivate users.	
Actions should be easy to understand and remember. Video/image instructions can be provided to aid users to understand the expected actions.			Continuous detailed tracking of a certain area that the users want to analyze better.	
Saving money can be a factor to motivate users. - Some tips can show how it could help users to be economic (how it has been calculated) as potential effects of some actions				

Goals				
10		11	12	13
Goal ideas		Progressive Goal	Customizable goals	Assistive goals
Rewards & Penalties can keep the sustainable behavior.	Setting a goal in Svalna should motivate and engage users to achieve it. As an end result, their consumption should reduce, by acting more sustainable.	Progressive Goal system: The aim is to reach a final goal, but on the road, there are checkpoints (small goals). Accomplish a little bit at a time. And for every small goal, users will be guided to it. In other words, have multiple easy guides rather than one big goal with a complicated guide.	Users get more concrete advice after setting a clear goal, where users can set the targeted area, the amount of reduction and the time to complete it (can be taken as a challenge to say whether a user can reach the goal in a period of time; smart and setting to reduce mental load - reduction)	The app can assist users to set a reasonable goal according to some theory/data/organisation and users' current stage. e.g. IPCC global goal for 2025
Weekly, monthly or yearly feedback can be provided as a report to work as a motivator or reflection factor. (can be combined with the goal setting)	On top of a graph and number, show an avatar such as an animal or tree. When emission is higher, the avatar will start to die, and when it is lower, the avatar will get healthier and happier.	Once users set a goal, the app can provide a progressive way for users to achieve it, such as providing selectable actions or show sub-goal for each month to aim for. For example, if the users plan to use half a year to achieve a goal, different actions can be selected by users to act upon for each month.	There should be multiple Goals that users can choose between.	
Goals setting can be related to financial factor to motivate users.	Instead of knowing only a number of carbon emissions, user can see a potential effect to environment if the goal is achieved to let users get more direct and real feeling of their behavior; or add game elements to make it more fun ; add a character to evoke people's emotions.		Flexible goals: Allow users to set more specific goals in certain areas, rather than having one goal for everything. You maybe can have one big goal for everything, and sub-goals for different areas.	
When users complete a goal, a reward or penalty can be a certain amount of carbon emission to reduce or increase the total amount.	Compare different goals on what is the most useful for your individual aim. E.g. see what challenge is best for improving consuming less food. Each challenge can for example have stats, where the stats show how much an area will be reduced. Each challenge has its own strength.		Users can choose to achieve goals in different modes indicating their expected level of engagement (users can change the modes whenever they wish) - Leisure (provide some actions for users to try to reduce their carbon emission, and provide knowledge, actions should be easy and probably a one time task, such as follow this recipe to have a vegan meal today! targets beginners) - Competition (invite another user to compete with you or match a user randomly) - Adventure (provide some challenges for users to choose and take on. The length of time can range from weeks to months depending on their preference. Targets expert users)	

Challenges				
14	15	16	17	18
Challenge ideas	Progressive challenge	Supervised Challenges	Tailored Challenges	Customizable challenges
Compare different challenges on what is the most useful for your individual aim. E. g. see what challenge is best for improving consuming less food. Each challenge can for example have stats, where the stats show how much an area will be reduced. Each challenge has its own strength.	Progressive challenge system: The aim is to reach an end of a challenge, but on the road, there are checkpoints (small challenges). Accomplish a little bit at a time. And for every small challenge, users will be guided to it. In other words, have multiple easy guides rather than one big challenge with a complicated guide.	Supervised execution of challenges. Guide the uses through accomplishing a challenge.	Challenges should be based on users' situations.	There should be multiple challenges that users can choose between.
All suggestion/challenges can be found in one place if a user want to quick check. User filters such as different category: transport, home, food .. Show how these actions can affect their footprint in a period of time (one time, one month, one year)		Supervised execution of challenges. Guide the users through accomplishing a challenge. Teach users how to do, tell them why it is good, keep telling them what they achieve for every step.	Aspects for users to improve should be based on the understanding of what users are used to doing now. **More options** can be provided for users to take the actions they prefer.	**Challenges** can be set to be completed within limited time. - Before taking the actions, users can decide how long they would like to complete a challenge (some variables can be levels of difficulty depending on the amount of carbon emissions, different activities like traveling, refurbishment...)
Saving money can be a factor to motivate users. - Some challenges can show how it could help users to be economic (how it has been calculated) as potential effects of some actions				Keep Goals and Challenges simple, by using more visualizations than words. Looking quickly at something should be enough to understand what is going on.
When users complete a challenge, a reward or penalty can be a certain amount of carbon emission to reduce or increase the total amount.				
Users can view all pledges and take the ones they are intersted in. The effects will be provided at the same time for users to see the potentials.				

Use gamification to create more fun for users	Social aspects			
19	20	21	22	23
	Users can help each other to become more sustainable	Collaboration among users	Comparison with others	Competition
Gamification: The tree game: Build the biggest forest, compete with friends. Earn points to build the forest by acting sustainable. Buy different trees with points that you earn from reducing emission, completing challenges, keep being sustainable. Big and beautiful trees require more points. The more beautiful and big forest you have, the more you can show off to your friends. E.g. you completed the challenge of: biking to your work everyday for a week. you get 100 points. With the 100 points, you can buy a cheap tree and put in your forest. Complete more challenges/goals or keep emission low, in order to earn more points. Be able to see other peoples forests and see how they achieved them.	Advice/tips can be given/shared between users. (Social aspects)	Joint goal can be set for multiple users when they would like to collaborate (can be friends, family or random users). And users can know each other's performance, which can create competition at the same time.	Comparison with other people (friends/random) can engage a sustainable behavior. When you see other people act sustainable, you will feel that you need to be sustainable too in order to not be left out of the society.	Challenge friends to do challenges. See who can be more sustainable. E.g. weekly competition. The winner gets points. The big competition maybe is one year. Final winner maybe gets some achievement on their profile.
Provide virtual reward for users if they complete a goal or actions. Rewards can be an amount of reduction on the carbon emission or some virtual points. (more points means more sustainable); some **game elements** can be added.	User can offer suggestions for each other if they need some tips to improve.	Users can invite other users to achieve a challenge together.	Get motivated by friends. Show that friends have not been flying for a year, and if you are the only one who flies, you will feel less motivated to fly, so that you are not a social rejection.	
Quiz. Mini-game where users can play quiz and earn points. The questions will be about sustainability.	The user will receive a virtual medal / badge in her profile once a challenge has been completed. It can be a great inspiration for others (friends) when they see that some challenges or actions have been tried by someone else.		Leaderboard: Compare with others to see who is most sustainable. Being in the top and better than others is quite motivating.	
	Other than decreasing personal carbon emission, users can also choose to engage others in reducing carbon emissions . For example, users can share tips or give suggestions for others. A type of reward can be some virtual points to show how sustainable a person's lifestyle is.		Be able to compare with a 100% sustainable target. Then you can see in what areas you need to improve. E.g. you are falling behind in shopping, so now you know that you need to shop less.	
	The app can provide some popular topics containing interesting environmental knowledge and suggestions for users and at the same time allow users to give their own opinions or discuss with each other.			

B.14 Ideation: Sketches based on the ideation Affinity diagram

Figure B.5: Sketches from Researcher 1

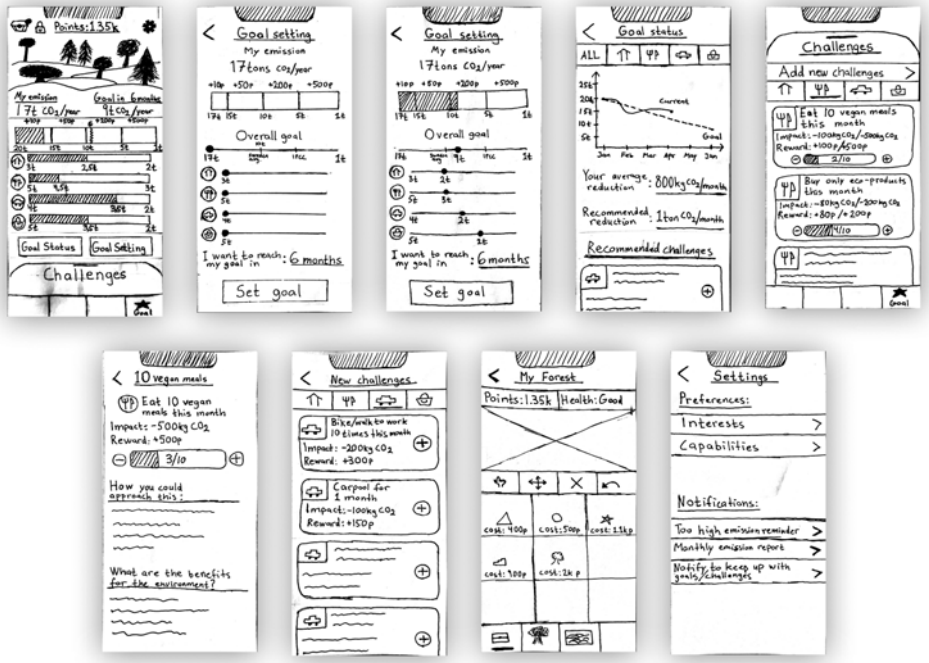
Figure B.6: Sketches from Researcher 2

B.15 Ideation: Table of merged sketch ideas

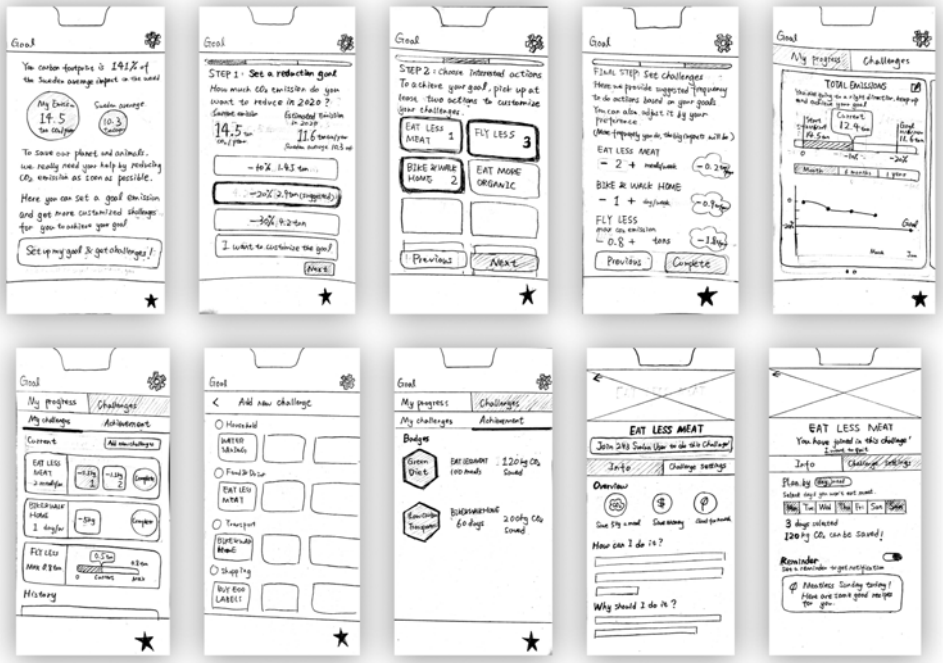
Idea	How	Details
Avatar representing your emission	My forest	- The forest becomes healthier the less emission you emit - You can improve your forest (buy trees, etc.) with points. Acts as profile building. Then you can show off to others.
Track emission	Progress bar	- The bar shows where you started, and what minimum emission can be. It also shows where your goal target is. - The bar shows different intervals of how much points you can earn. The lower emission, the more points you earn (weekly, monthly). - The bar shows a green part which represents how much you have reduced so far. The rest will represent how much emission you can reduce, divided into the 4 areas of emissions.
Track goals	Go into individual goals	- For each emission goal, you can see graph showing how you are doing (good/bad), and recommends if you need to improve. - It also shows recommendations on challenges you can do.
Set reasonable goal	See detailed status of current emission	- See where you are at in all emission areas.
	Set an overall goal	- Setting overall goal will adjust sub-goals automatically too. - You can see how much your emission goal will be at. - You can see potential points being earned at this target goal.
	Set sub-goals	- Set a goal for each emission if wanted. - It is possible to not set a goal for a sub-emission.
	Guidance to set goals	- See IPCC guideline on what a target goal can be. - See other guidelines (sweden average, etc.) - Let users see what potential benefits are for different target emissions. E.g. let users see what it means to set a goal to 1ton/y food emission.

Challenges - Challenges are grouped in the 4 areas	Current active challenges	- See current active challenges - Challenge information: See emission impact Rewards Concrete facts about what is good about doing the challenge Progress Instructions Difficulty level (one time, repetitive, etc.) Time limitation
	See new challenges and add them	- Add new challenges - Challenge information: See emission impact Rewards Concrete facts about what is good about doing the challenge Progress Instructions Difficulty level (one time, repetitive, etc.) Time limitation
	Examples of challenges	- To achieve a certain amount / percentage of carbon emissions (Limit your emission within 500 kg next month / cut down 10% emissions by the end of June) - To achieve a reduction in one or several categories - To keep a behavior in a period of time (Eat vegetarian for a month) - Users can set preference on interested topics and levels of engagement (modes) to get customized challenges
First time setup	- User goal preference setup for first time users for knowing more about what users want. - Ask users a set of questions	- Understand user's preference on improving carbon footprint, e.g. what is the user willing to do. - Understand user's current behavior and habit. - Understand capabilities of the user. - Choose aspects you want to improve in. - Choose topics you are interested in to get more knowledge about.
Profile	Personal content preferences	- Change preferences from the setup: Interests Capabilities etc.
	Notification system settings	Set reminders to detect large emissions: - To inform users when a large emission over X kg is detected.
		Summary report of my recent engagement: - To receive a weekly/monthly report on how I am doing with the activities. - Capture negative trends or impacts to motivate users to act upon.
		Collect my rewards: - A place that users can collect reward and give them a sense of achievement.
		Supervised execution of challenges: - Notify users if they are about to fail a challenge and make them know how to act.

B.16 Low-fidelity prototyping: Paper prototype version 1a



B.17 Low-fidelity prototyping: Paper prototype version 1b



B.18 Low-fidelity prototyping: Paper prototype version 2

B.19 Low-fidelity prototyping: Evaluation on paper prototype version 2

	Good	Potential improvements	
Overall	Overall flow is very clear. It provides a good support to do the challenges, and there is a lot of information and lots of actions to do.		
	It is a good motivation for users to checkin the challenge by themselves. It would motivate users to use the app more often. Users feel motivated because they know that they are doing something good. It lets them feel good about themselves.		
Goal		When challenges are completed, there should be direct progress in the goal based on the challenge impact. Otherwise the goal and challenges are not so connected. The goal progress could show potential progress, so that there will be motivation to actually behave more sustainable.	Some updated progress in the goal bar can be added to show that it is not static.
		The goal and challenges should be separate. If the user can not directly affect the goal progress by doing challenges, why should the user do the challenges below. Or doing challenges could tell the user that the impact is an estimated reduction, but it is still not a strong connection and it makes the user confused. At the beginning, the user thought that doing challenges would directly and visually make progress in the goal bar.	The goal bar visualization can be made with more fun, encouraging and environmental context: - such as a running human icon that runs towards the user's goal, which will make the user want to go for the goal more. - some elements like CO2, plants, trees. - can see some rewards, like badges can be collected on the progress bar.
		Confusing about how the goal is connected to the challenges (if it was not told in the onboarding).	
Tracking Challenges/ Check In	Prefers buttons that allow for multiple counts. They have better visualization and the user can know the progress more easily. But it is easier to undo in the single count button. Simple and intuitive to press the button to complete. Prefers the 2/3 button (count button), because it allows for multiple check-ins. It is more simple and takes less space.	Confused about the activities below today and this week. Will it also check for the week if I check below today section? Maybe today section can be named as reminder to differentiate with week section. To see that today you promise to do xxx, do not forget to do that.	1/2 button (count button) needs more visual indication to tell it is tappable. (Progress shown on pie chart can be better)
	Likes the card version most. But the user does not want to scroll too much if there are too many challenges.	For undoing a challenge count, maybe + - can be added.	
Calendar view	It is clear and gives the users the opportunity to check their activity in case they forget to check-in challenges on a specific day.	Short summary can be added as an overview of a month above the calendar. (Week 4 you completed XXX; This month you completed XXX; you missed XXX in week 5)	Scrollable cards might be hard to find among many cards. (Small icon buttons below the cards can be added to help users to find the cards quicker)
	The user can see their history to know whether challenges are completed or not.	A user would like a place to manage all challenges, maybe an entrance beside plus icon button.	A user would like to see a summary of the day when it has been selected instead of showing all the challenge cards.
Challenges		Predefined challenges may give a reason like why doing on Monday is good.	Change "challenge term" to "challenge duration".
		It will be easier for users to choose a challenge when they can see the difficulty level. E.g. eat vegan 3 days/week (easy), 5 days/week (normal), 7 days/week (difficult).	Prefer challenges defined by the app instead of customizing own challenges. Would like predefined challenge because the users are lazy people. Don't want to spend too much time on deciding own challenges. One week or month challenges sounds good. If the user is not satisfied with the predefined challenges, the user may do customizations. For expert users, the content of challenge can be more challenging and engaging to attract them.
Information in a challeng's details		Would like to see more instructions on what the user should eat (maybe a visualization with a plate with suggested food, or a pie chart to show suggestions about the distribution of food categories or nutritions. More info on how to eat healthy vegan or how to save money by eating vegan).	Why to eat vegan fact, can be shown before the user enters the eat vegan card, e.g. to show some small icon to indicate the benefit of eating vegan.
		Compared to environmental impact, the impact of saving money and being healthy can be more concrete with numbers (for example, it can help me save how much money per year by eating vegan or people who eat vegan have lower risk to get some disease).	Would like recommendations, like good recipe websites that can provide good information.
		Would like to see more pictures and videos to be motivated (e.g. poor animals being killed).	A user will be more motivated to not see animal cruelty. It will make the user feel better when eating vegan. Does not want to see cruel stuff, but instead wants to see more positive impacts.
Challenge reminders	Users like reminders. The beginning of the day or week may be a good time to remind users on all the challenges to do today or this week. The reminders can also be useful to remind people to check in, in case they forget to check in before the end date.		
Challenge failure		Regarding allowing exceptions for people to skip the task in a challenge, the users think the challenges should be strict and they should not allow for exceptions. If a user has a difficulty in doing the challenge, it will be a good opportunity for them to reflect and adjust their behavior or to find more suitable challenges. The users also mentioned that the challenge tasks may allow for exceptions if it is a very hard challenge. The app can either give users free passes to skip the task or allow them to do the task on another day. Some scenarios to be considered: (1) The user took the challenge to eat vegan everyday for a month. The user was sick for two days and had to eat some meat. (2) The user took the challenge to walk to school everyday for a month. The user chose to take the bus in a bad weather.	The users did not think that they should get a penalty if a challenge can not be completed, because it may make them feel less enthusiastic and interested in doing the challenges. The app should just show that the challenge has not been completed and users can do it any time they want in the future. (One idea is to encourage users to try the challenge again for next week/month. Or the uncompleted challenge could be kept for users and only the count will be cleared to zero at the beginning of the new week.)
Monthly report	Participants think it is valuable for them to check the progress monthly.	The current design requires an extra click to view monthly progress which might be unnecessary. The goal progress is like a repetition of the one in the main view. One suggestion is to put the content into the main view. The progress of the last month can be shown in the goal section and monthly summary of the challenges can be added to the calendar view. It was also mentioned that it would be good to receive a report every month automatically with a summary of the progress of last month with some details highlighted.	The "report" should work like a static summary and it should not contain cards and more interactions. It would be good to see some rewards achieved in previous months. The environmental impact could be made easier to grasp, e.g. reducing 1.2 ton CO2 means saving 120 trees.
Rewards	One participant think unlocking challenges sounds motivating to her.	Every badge should be unique and you should not be able to collect same badges. But if the reward can be a virtual object, like a carrot or plant, it would be good to get it many times. It can be a gamification to build an own garden. Ideas about reward system: Plan A: People get points by completing challenges. And they can get badges by reaching a certain amount of points. A progress bar can indicate to users which badge can be collected according to the progress. Plan B : People get points by completing single activities and get badges by completing challenges.	More motivational factors: - level up system - To motivate people who already have sustainable behavior, some reward can be given immediately when they finish their profile. For example, she can get one badge if the app know she has a eco-friendly diet. - (social aspects) share achievement in groups or on social media

B.20 High-fidelity prototyping: Heuristic evaluation result

Rating	Usability problems	Resolved
4	When scheduling a challenge, it can be easy to miss-tap on the X button, which closes and cancels the scheduling. When closing the scheduling, there should be a warning window asking if you really want to exit. Otherwise, users can by mistake cancel their time-consuming scheduling process.	Yes
	Challenge progress needs an information pop-up button, which users can tap on to see what this progress means.	Yes
	The calendar view should have an information icon in the top right corner. When tapping on it, a pop-up should show up with legend descriptions. E.g. what does blue color bar mean, what is a red circle, etc.	Yes
	Dragging the slider to plus should increase the goal emission. It should not allow the user to set a goal emission higher than the current. Adjust 12.0 emission to the maximum of the bar.	Yes
	The icon to confirm to redo the challenge should be different from the completed icon. Replace with the redo icon. For the redo button when completing a challenge, the no option icon looks like an error and it can be improved as a simple close icon in the top right corner.	Yes
3	In the individual challenge calendar, instead of using small circles to define the status of a day, use a full-size rectangle filled with color, of that day. This makes it easier to see the status.	Yes
	When completing a challenge, make it clear that users should tap on the badge to collect it. Make the badge obvious to tap on. If the user has not completed a challenge, and it has passed 30 days, the challenge will complete by itself and it will say on the card that the challenge has ended, and shows how much CO2 was saved and how many times the user did the challenge.	Yes
	There are 4 versions of a challenge format: - 30-days and scheduled - 30-days and unscheduled - One-time and scheduled - One-time and unscheduled The “One-time and unscheduled” is the only one with an unlimited period. The rest have a 30-days time frame or some set date. Firstly, the “One-time and scheduled” challenge should be considered to be changed into only being able to schedule it 30 days ahead. Otherwise, maybe you schedule it 6 months later, and totally forget about it? Secondly, the “One-time and unscheduled” challenge has an unlimited period. This means that it could be idling in the list of your current challenges forever, without prompting the user to do it. This type of challenge should be considered to have a 30-days time frame too, but it can be done on any day within the 30 days. As a conclusion, all types of challenges should be within 30 days, and what differs the challenges are whether they are scheduled, or 30-days/one-time.	Yes
	The challenge progress number CO2 saved says for example 160kg. But it will be more clear if it is for example 160kg CO2 saved. Otherwise, it can be confusing about what this number means.	Yes
	When scheduling a challenge, the schedule pop-up tells the user to select e.g. 10 days. But whenever the user selects different days, it still says 10. Instead, there should be a counter so that the user can get a way to see how many days there are left to schedule. Otherwise, the user needs to count manually which can be annoying.	Yes
	Inside a challenge, the CO2 saved label only says “-20”. Now it seems like the user eats 20kg less food, but in reality, it is 20kg CO2 saved. Make this label more clear. It can also be made more visible, since this is an important fact to show the users.	Yes
	What is IPCC? Provide some information pop-up or make it more descriptive.	Yes
	Define the challenges better whether they are “one-time” or “30-days” challenges. One-time challenges should show days left.	Yes
	There should only be one badge at a time for the levels. E.g. you are level 3, then you only have the level 3 badge. Otherwise, you would end up with 50 different badges when you are level 50, which would take a lot of space. And most it is just the highest level you are interested in, you already know that you have passed level 1 to 50.	Yes
	Onboarding could need an emergency exit in the steps. Right now, you have to step backward in order to get to the first screen where the navigation bar is, and then you can change to another screen.	Yes
	Make the challenge title and description better. The title could be more descriptive but still short. The description could also be formulated better.	Yes
	The second step of onboarding is unclear about how the topics will relate to the next step. Make it more clear that the topics are about potential sustainable behavior they would be interested to do.	Yes
	When you want to change goal emission, there is no information about your current goal emission. Add current goal emission or make slider stop at current goal emission.	Yes
	The visualization of a finished challenge can be more unique to be different with checked challenges.	Yes
	In the calendar view, missed challenges can be highlighted more such as a red notification dot.	Yes
2	The goal-setting benefit information could be made more interesting. Only showing water and trees saved can be boring. Provide more information and use more interesting visualizations.	No
	The challenge progress bar and numbers could be made bigger so that it is easier to see.	No
	In the onboarding goal setting, instead of saying 10% or 20%, explain what it means with a real-world example. And only having 10% or 20% options might be too few or the interval is too small.	No
	In the add challenges list, it should be clear on what has been done before. But all challenges should always be visible, so that users can redo challenges if they want to.	No
1	In the goal-setting, “My current emission…” label in the middle is a bit difficult to see when the circles are in the background.	No
	Users should be able to save a scheduled challenge so that it is possible to do/redo it in the future with just one click. For example, a “Favorite” section that contains your saved challenges that you want to keep on doing.	No
	In the first step setting a goal: The visual hierarchy is not so clear. The image using much space doesn’t have a meaning. Put the text “I would like to set my goal to ...” on the top below the progress bar. The planet picture can be removed or replaced with smaller elements related to carbon emission.	No

B.21 High-fidelity prototyping: Usability testing task completion result

Task completion			
Tasks	**Task description**	**Average errors**	**Average difficulty level 1 = very difficult 5 = very easy**
Task 1	Imagine that you use this section of the app for the first time. Here you see an onboarding process to guide you to do a quick setup before using this section. You would like to go through this process by following the sub-tasks below: a. Set your emission goal target to 9.0 tons CO2/year. b. Let the app know that you are interested in eating vegan. c. Look more into details of a challenge that is about eating vegan, and then add it. d. Schedule this challenge so that it will occur today and in the next four days.	0.67	4.17
Task 2	Find out how the challenge progress works.	0.33	4.33
Task 3	Let's say that you have had a vegan day today, now you would like to let the app know that you have done it.	0	5
Task 4	Add a new challenge that is about "not using electricity for one day", and schedule it for next week, on the 9th of April.	2	4.25
Task 5	Find and look at the overview of how your challenges are scheduled, and explain what is going on in the view.	0.33	4.33
Task 6	You decide to do the "no electricity" challenge today, so complete the challenge and see your reward.	0	5
Task 7	Imagine it has been a few months, and you have several ongoing challenges. You have missed to track a challenge in the app from a previous day, but you did actually do that challenge, and just forgot to track it in the app. Please find out which challenge it is, when it was, and track it.	0	4.67
Task 8	Find out where you can see your statistics of what you have done previously.	1	3.5

B.22 High-fidelity prototyping: Concept evaluation interview

About your engagement in a sustainable lifestyle

How engaged are you in having a sustainable lifestyle, in your daily life?

- Give a rating from 1 - 5, where 1 is not engaged at all, and 5 is very engaged.
- Why this rating?
    - Examples of what engages you in your daily life?

How much knowledge would you say you have regarding having a sustainable lifestyle?

- Give a rating from 1 - 5, where 1 is no knowledge at all, and 5 is enough knowledge.
    - Why this rating?
        - Examples of what gives you the knowledge to live a sustainable lifestyle?

Questions about this new way of designing the challenge system

How do you think that this way of designing challenges have the potential to support you to act sustainably? for example...

- Would you say that you would be more supported in having a sustainable lifestyle if you used this design, and why?
- What parts of the design are more important when it comes to supporting you to become sustainable?
        - What and why?
- For getting more support in having a sustainable lifestyle, what else would you like to have in the design?
- How would you say that this new design compares to Svalna's current Goal section design?
    - Does this new design engage you more and give you more knowledge, in terms of living a sustainable life? In what aspects?

Thoughts on the challenge scheduling system?

- Do you think that creating a scheduling system will support you to do the challenges more?
    - Would you become more willing to behave sustainably with the scheduling?
- If you could get a better system that could support you to be sustainable, what would that be?

Thoughts on the rewarding system and how it engages you to be sustainable?

- Does collecting badges and leveling up encourage you to be sustainable?
    - Is the reward fulfilling, and make you want to do more challenges?
    - Would another kind of reward be more motivating to receive?
        - What would that be?
- How could it improve? Involving a social aspect, such as sharing progress and profile?

Evaluation of design alternatives for the challenge details screen

If you could rate these 3 design alternatives, on which of them that support you the most to become more sustainable, how would you rate?

- Why this rating?

B.23 High-fidelity prototyping: Questionnaire for evaluating the design alternatives

Background

How engaged in being environment-friendly would you say that you are in your daily life? (1 to 5, where 1 is not engaged at all, and 5 is very engaged)

How much knowledge do you think that you have in order to act environment-friendly in your daily life? (1 to 5, where 1 is no knowledge at all, and 5 is very much knowledge)

If there were an application that had the goal to engage and teach you to become environment-friendly, which of the following approaches do you think would work the best for you? (Multiple answers question)

- Showing you summarized static information about benefits and tips on becoming environment-friendly.
- Being able to interact and explore topics yourself about being environment-friendly.
- Showing you videos about being environment-friendly.

Evaluating the three design alternatives

(The following two questions will be asked for each of the three design alternatives, while also presenting the design alternatives)
How much more engaged in acting environment-friendly would you become after looking at this design, compared to today?

- I would not become more engaged in acting environment-friendly with this design.
- I would become more engaged in acting environment-friendly with this design.
- I would become less engaged in acting environment-friendly with this design.

How much more knowledge in acting environment-friendly would you get after looking at this design, compared to today?

- I would not get more knowledge in acting environment-friendly with this design.
- I would get more knowledge in acting environment-friendly with this design.
- I would become less knowledgable in acting environment-friendly with this design.

Final question

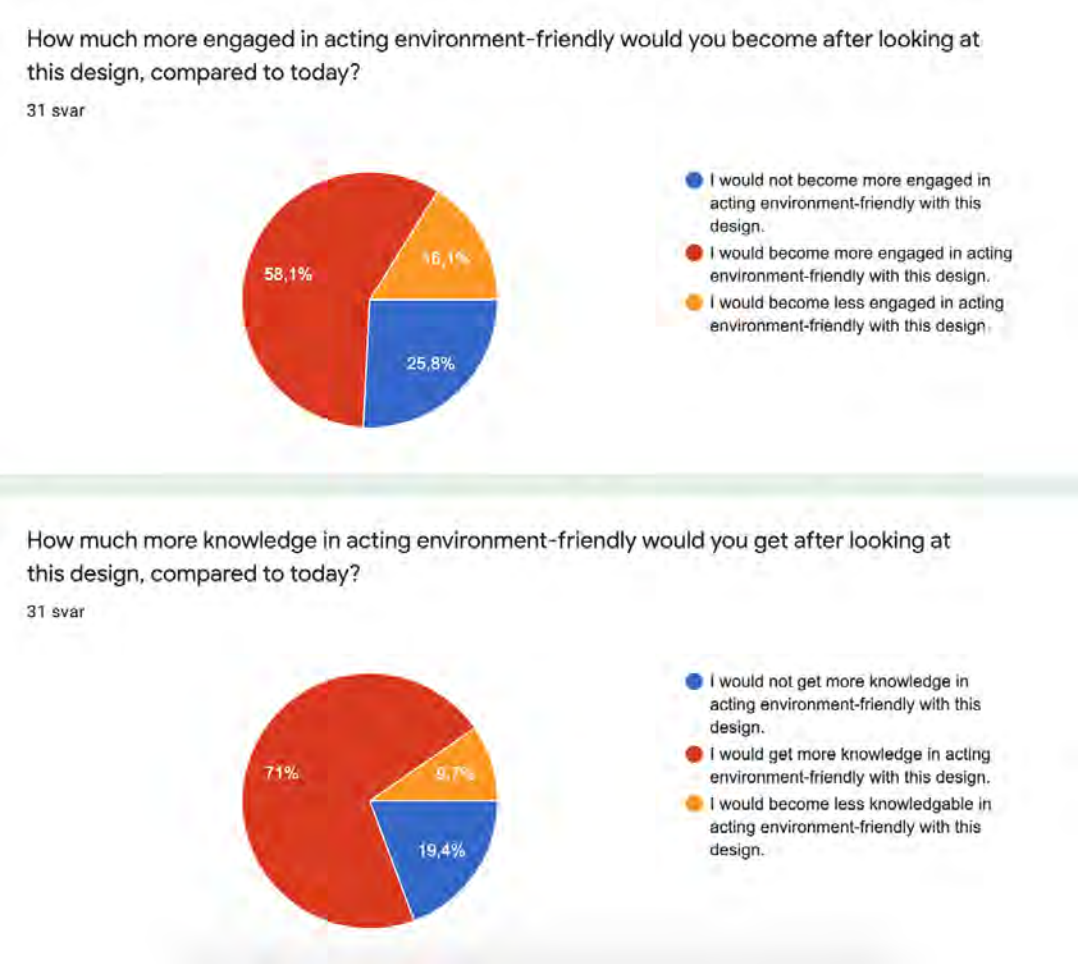
If you were to use an application that had the goal to make you behave more environment-friendly, please rank which of the three designs that would succeed the most.

- Would succeed the most:
- In between:
- Would succeed the least:

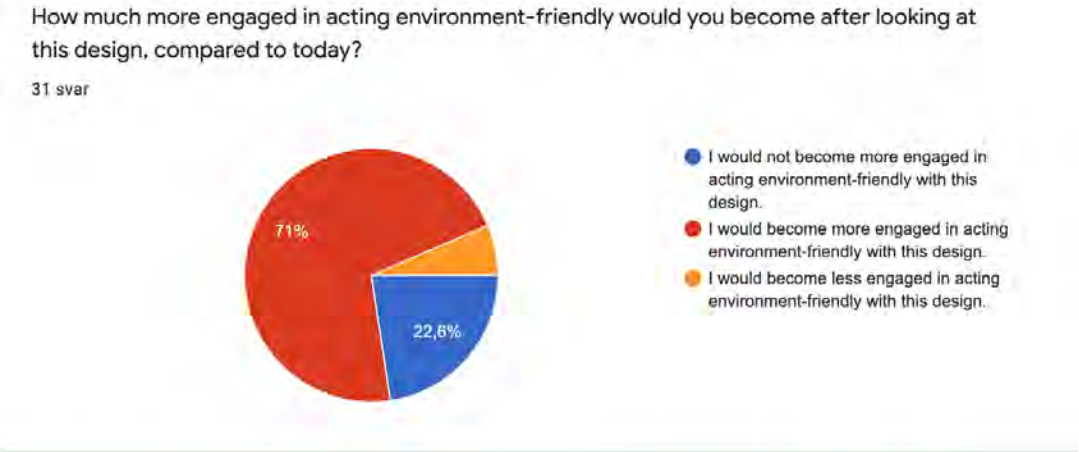
If you have additional feedback, please write below:

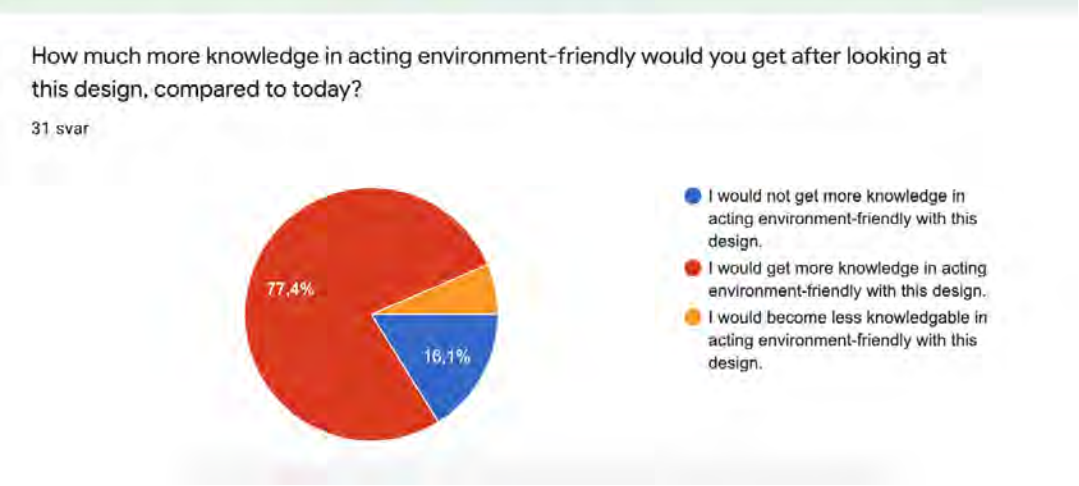
-

B.24 High-fidelity prototyping: Questionnaire result of design alternative one

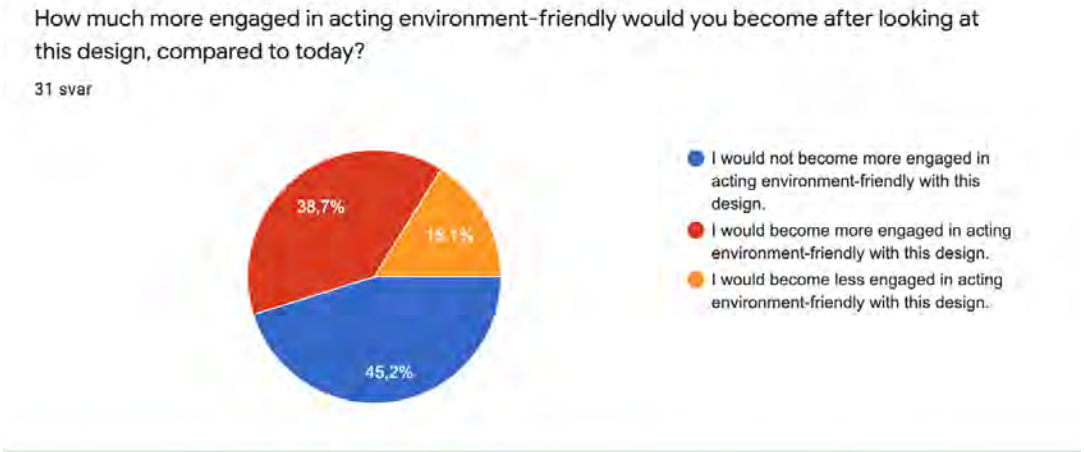


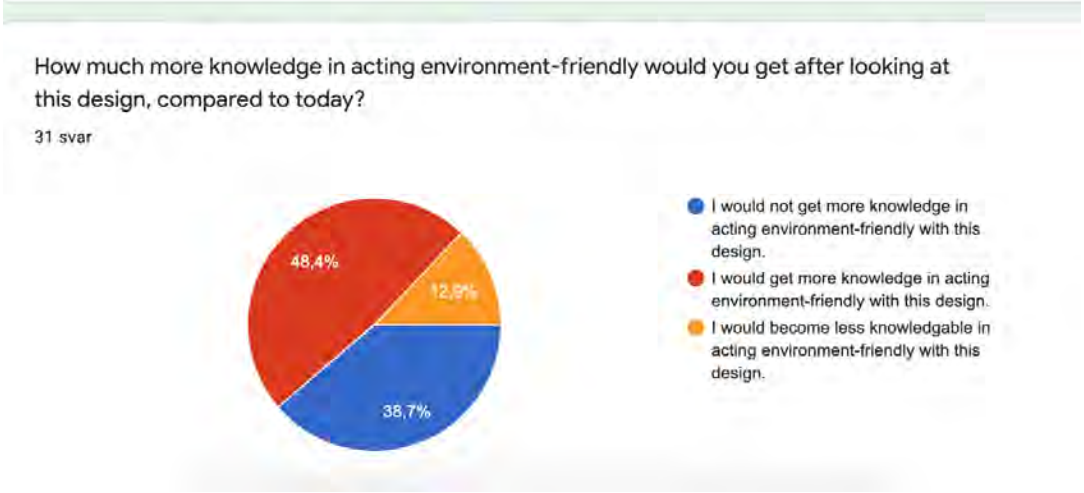
B.25 High-fidelity prototyping: Questionnaire result of design alternative two





B.26 High-fidelity prototyping: Questionnaire result of design alternative three





B.27 High-fidelity prototyping: Usability problems found in the usability testing

Design parts	Usability problems				
	4 Usability catastrophe	3 Major usability problem	2 Minor usability problem	1 A cosmetic problem only	0 Not a usability problem
Concept in general	Confusing regarding how the Goal progress, Challenge progress, and Challenges are connected. Not clear that the Challenge progress is only about a representation of emission that you potentially can save. Thinks that completing challenges would reduce the real current emission.		Two different calendar icons are too much in the main screen, confusing which one is which, what the differences are.		Facts/numbers regarding the environmental impact are not correct.
			Elements should not be too close, otherwise there can be issues with tapping correctly.		
Onboarding	The end of the onboarding when having added and scheduled a challenge is confusing. There is nothing that tells the user that the challenge has been added and scheduled, and that the user now can continue with the onboarding. Should the user go back in order to continue the challenge? The flow is not clear because after adding and scheduling a challenge, the user will be navigated back to the challenge details view, without any information on what happened. Onboarding has a confusing flow. From the onboarding, the user goes to adding a challenge and scheduling, but then is lost in the challenge details view after having added and scheduled the challenge. Unsure if going back will cancel the scheduled challenge. The user wants to finish the onboarding, and not go into complex sub paths such as the process of adding and scheduling a challenge, in the middle of the onboarding progress.		It is unclear what the quit button means on the bottom, in every onboarding screen.		
Goal emission progress		It is not clear about the connection between goal progress and challenge progress. The user thought the trophy will be obtained finally by leveling up.	Confusing whether the goal progress is yearly.	Goal setting circle proportions don't seem to be correct.	
			The colored circles in the goal setting are difficult to see.		
Challenge progress	It was not clear that the challenge progress in reality would not affect the real emission directly.		The challenge progress bar's content was not clear on what it meant. The user thought that the bar represented the current challenges' progresses. But in real, the bar shows the CO2 that already had been saved. E.g., the bar shows sub-progresses of the four emission categories, and then the user thought that there were four ongoing challenges within these four categories.	It is hard to notice the change of the challenge progress bar, since the progress is tiny. The user did not notice the change in the progress bar when checking the vegan day challenge. But the user noticed the second time when the user checked for no electricity day.	
			The challenge progress badge's "100kg" tag is too small. It would be better if it could be in text above or below the bar.	The challenge progress badge is not clear that it is a badge, and not clear that you will receive it after reaching the next level.	
			The challenge progress bar should only have colors, if icons also are used, then it will be too crowded.		
			It is too much text for the user to read, about how the levels and badges work.		
My challenges list		The user wondered where the challenge went when it was completed but disappeared from the interface. The user suggested "my challenges" can be replaced by "ongoing challenges"			
Big calendar view		When a challenge is missed, the red notification should not only be shown in an individual challenge card's calendar button. The notification should also be shown on the big calendar button, so that there is consistency and no misunderstandings will be made. Right now, the user will only tap on the challenge card's notification, because that is the only place with a notification. But going via the big calendar view is also possible, but it is not visualized to the user.	The overview calendar icon is a bit small, which is hard to notice.		
			It's confusing to have two calendars. Maybe the individual calendar can show the filtered out result based on the big calendar view,		
			The individual challenge calendar should have the same design as the big calendar view, so that there is consistency. Otherwise it can be confusing to understand, because the two screens do similar things but the designs are different.		
			Learning the legends is not something that the user wants to do. The legends are only applicable to this app, and the user needs to have in mind other calendars that are used too. Even though there is a legend information, it is still not good to have to remember these colors in the brain, as it will confuse usages of other calendars.		
			The calendar could need more spacing between dates.		
Individual challenge calendar view			In the individual calendar, the notification is a red circle around the date. But in the big calendar view, the notification is a dot on the date. This should be consistent, otherwise it will be confusing regarding why these are different, but mean the same thing.	The user suggested the legend of scheduled and checked challenges can be in different color. Will there be a difference between checking in on a scheduled day, and an unscheduled day?	
			The individual challenge calendar should have the same design as the big calendar view, so that there is consistency. Otherwise it can be confusing to understand, because the two screens do similar things but the designs are different.		
			The calendar could need more spacing between dates.		

Design parts	Usability problems				
	4 Usability catastrophe	3 Major usability problem	2 Minor usability problem	1 A cosmetic problem only	0 Not a usability problem
Adding a challenge	It is unclear whether the added challenge has been added after getting back to the challenge selection screen (same in the onboarding too). (The user basically did not see that the plus button had changed to an "added"-sign) Finishing scheduling a challenge is very confusing. Suddenly, you get navigated back to either the challenge details screen, or the adding challenge list view. There is no confirmation or information that you have actually scheduled and added a challenge. It is unclear if the schedule is already in the challenge after finished scheduling. In the add challenges view, there should be some kind of label that says that you have added a challenge, in case you did that. The current "added"-sign is obviously not clear enough for indicating that the challenge has been added. When a challenge has been added, it was not so easy to understand that it had been added by just looking at the "added" sign, in the "add challenges" screen. The user thinks that when a challenge has been added, the user should be informed that it actually had been added, and then be redirected to the main screen. The added button in white is not clear to users whether the challenge has been added. It can be made into green compared, which is consistent with the progress bar.		The plus icon for navigating to adding challenges is too small.		
	Not clear what the scheduling will do when adding a challenge. It is unclear to users how making a schedule will work for them. The skip and start now button is not clear to the user. Does it mean that the user is free to do the challenge whenever wanted? Or should the user do it daily or weekly? what is the usual routine?				
Challenges	Confusing to understand when a challenge is scheduled by looking at a card. The user remembered that the challenge was scheduled, but it does not say so anywhere. At first, it was not clear on how the system would know that the user had missed to check-in a day. But then the user realized that the challenge was scheduled. Therefore, there is an issue that it is not clear whether a challenge has been scheduled or not.	The name of the challenge in a card should be more descriptive. E.g. "Have 5 vegan days", instead of just "Eat vegan". Otherwise, the user needs to go into details of a challenge just to get reminded again what the challenge was about.	The congratulation pop-up should not have a "congratulations" symbol behind the text. It makes the text difficult to read.	Some of the challenge cards' names contain "!" at the end, and some don't. Be consistent and maybe don't use "!" at all.	Notifications are not preferred.
		The challenge check-in button is a bit confusing. What does a bell mean? Does it make a sound or a notification?	It is not clear on what the calendar icon does in the challenge card.	The firework background is distracting and can be removed.	
		It is not clear that all challenges are in the format of 30-days, and that they have to be finished within 30 days. It might have been clear that the added challenge was 30 days, because it said so in the details, but there is nowhere that says that the entire system only provides 30-days challenges. The 30-days label on cards is confusing. The user did not know that challenges are 30-days only. So it was difficult to understand what 30-days meant. It is not clear on what "30 days left" means in the challenge card.	The user did not notice that a challenge can be added inside the challenge detail screen, and thought that you had to go back to the "add challenges" list screen in order to add it.	The description of the challenge can be shorter.	
			The user wondered what else that can be done if the user forgot to do the challenge on that day. Can the challenge be scheduled for another day, or should it just let the user know that it was missed. (In that occasion, the app should let the user know if it is possible to do the challenge in another day or whether the challenge was failed)	The congratulation pop-up should not force the user to redo the challenge too much, therefore, the redo button can be separated a bit more, such as having more space between the congratulation message and badge, and the button.	
				The top part of the challenge details screen, where information about the challenge is, it is a bit cluttered. Too much text and some elements might not be needed. Is the Food-icon needed for example.	
				Consistency is important. If the challenge card contains a green leaf, then the challenge details screen should also include a green leaf.	
				The challenge check-in button might be too big. Instead, the space should be used for other important information in the card.	
				In the card, having "2/10 CO2 saved" is redundant with "1/5 times". Maybe only have one? The text is also quite small.	
				The add button in the challenge details does not need to include an add-symbol, because it is already clear that the green color means add, and the button also have descriptive text. Keep it simple.	
				Using a bell icon in combination with text is not so good. It would be preferred to only use text. Or also only just a check-in symbol, taking into account that the symbol would be self-explanatory.	

Design parts	Usability problems				
	4 Usability catastrophe	3 Major usability problem	2 Minor usability problem	1 A cosmetic problem only	0 Not a usability problem
Scheduling system			The legend of today makes the users feel that it can not be scheduled due to its dark background.		
			The user thought that it was possible to reschedule a challenge, which is not possible.		
			The legend of the "scheduled days" looks like a checkbox and makes the user want to tap it.		
Summary screens			The summary icon is no self-explanatory. The summary icon is confusing. It is not clear on what that icon would lead you to. Is it an FAQ? Make this icon more self-explanatory that the content inside contains a summary. The summary icon is not clear on what it means. Therefore, it is difficult to know that the content in that screen would be the summary. The icon of the summary view is confusing, which looks like a place to search. It is tricky to find the summary view. The user first thought that the summary was in the big calendar view. The icon of the summary view is a bit hard to find. The user thought the current place of the icon usually worked as settings, and the summary can be put into my profile.	The summary icon looks more like history more than statistics. But for the content of the summary page, the user feels it is more like a place to see history.	
			When looking at past challenges, it was not clear that the "redo" button meant that a challenge could be redone. The redo button seems like it is asking the user to refresh the challenge, so it is not clear on what it means. The user got confused about the redo challenge icon at first and said it looked like a refresh button.		
			The user did not think that the challenges below the graph were only for the selected month.		
			Using a graph in the summary view is very nice. But the numbers, placement of months, and all the details of the graph should be designed to be more understandable.		