Aalto University
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CHANGING BEHAVIOR TOWARDS SUSTAINABLE CONSUMPTION HABITS WITH ECO-FEEDBACK TECHNOLOGIES THROUGH USER EXPERIENCE

A case study on SUSLA carbon footprint calculator

Master's Thesis
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Abstract

As individuals' current consumption habits have unsustainable environmental impacts, there is a need for shift towards more sustainable lifestyles. One potential solution could be eco-feedback technologies (EFTs), which are designed to help its user recognize the environmental impact of their habits. The tool collects and analyses the user's data and provides feedback to the user based on their habits. The goal of the feedback is to educate the user on their actions and shift their behavior towards more sustainable habits. However, EFTs struggle to reach this goal as changes in behavior are difficult to achieve. To better understand the reasons behind the problem, this thesis analyses a certain EFT tool from the perspective of user experience (UX) and evaluates what type of an effect it could have on the user's behavior. The tool, SUSLA carbon footprint calculator (CFC), was analyzed based on its data collection, data analysis and feedback functionalities, which also the tool's UX mainly comprises of.

The research was implemented as a case study and the data collection method used to discover the different aspects of using SUSLA was done through interviews on test users located across Finland. The interview results were analyzed with the help of an analytical framework. Based on the results, further design implications were provided for SUSLA.

The study results show that the UX of SUSLA could be developed further to motivate its users to change their behavior and make the calculator more enjoyable to use in the long term. In order to get more consistent users, the calculator should produce more thorough and versatile content to its user, e.g. educational videos on different sustainability themes. It should also provide them accurate and timely feedback on their habits, such as notifications regarding their daily consumption. Moreover, the data should be based on their actual consumption habits, meaning that the calculator should be integrated to different data sources, e.g. HSL, that provides relevant consumption data on the user, for example their transportation data.

However, as it seems that the CFC should become very advanced and accurate in order to better affect its user's behavior, it is relevant to question its role in affecting consumer behavior altogether. Even though the calculator would become very intelligent, there are no guarantees that its user will change their consumption habits. However, it is noteworthy that the research conducted takes into account only one CFC. All in all, more research is needed especially when it comes to analyzing UXs in different types of EFTs.

Keywords sustainability, carbon footprint calculator, UX, consumer behavior, green IS, material footprint calculator

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Tiivistelmä

Koska yksilöiden nykyisellä kulutuskäyttäytymisellä on kestämättömiä ympäristöllisiä vaikutuksia, on muutokselle kohti kestävämpiä elämäntapoja tarvetta. Yksi ratkaisu voisi olla ympäristökuormitusta mittaavat laskurit ja mittarit, jotka on suunniteltu helpottamaan käyttäjäänsä tunnistamaan käyttäytymisensä vaikutukset ympäristöön. Laite tai sovellus kerää ja analysoi käyttäjänsä dataa ja tuottaa palautetta tämän käyttäytymisestä. Palautteen tavoitteena on valistaa käyttäjää tämän tavoista ja muuttaa käyttäytymistä kestävämpään suuntaan. Teknologialla on kuitenkin vaikeuksia onnistua tavoitteessaan, sillä käyttäytymisen muutoksia on hankala saavuttaa. Ongelman syiden avaamiseksi tämä tutkielma perehtyy yksittäiseen laskuriin käyttäjäkokemuksen näkökulmasta ja analysoi minkälainen vaikutus tällä voisi olla käyttäytymiseen. Tutkittava laskuri on SUSLA hiilijalanjälkilaskuri ja sitä arvioitiin sen tiedonkeruun, tiedon analysoinnin sekä palautetoimintojen perusteella, jotka ovat myös merkittävä osa laskurin käyttäjäkokemusta.

Tutkielma toteutettiin tapaustutkimuksena ja SUSLA:n käytön eri näkökulmien tiedonkeruumenetelmänä käytettiin haastatteluita, mitkä toteutettiin Suomessa. Haastatteluiden materiaali analysoitiin analyyttisen kehyksen avulla ja tulosten perusteella SUSLA:lle kehiteltiin parannusehdotuksia design suositusten muodossa.

Tutkielman tulokset osoittavat, että SUSLA:n käyttäjäkokemusta tulisi vielä kehittää, jotta käyttäjiä voitaisiin paremmin motivoida tekemään muutoksia kohti kestävämpiä elämäntapoja ja laskurin käyttäminen olisi mielekkäämpää pidemmällä aikavälillä. Saadakseen pysyvämpiä käyttäjiä SUSLA:n tulisi tuottaa monipuolisempaa ja perusteellisempaa sisältöä, kuten esimerkiksi opettavaisia videoita liittyen kestävän kehityksen eri osa-alueisiin. Lisäksi sen tulisi tuottaa tarkkaa ja ajankohtaista palautetta käyttäjänsä käyttäytymisestä, kuten ilmoituksia heidän päivittäisistä kulutustottumuksista. Tiedonkeruun tulisi myös perustua käyttäjän oikeisiin kulutustietoihin tarkoittaen, että laskuri tulisi integroida erilaisiin tietolähteisiin. Esimerkiksi HSL:n avulla voitaisiin saada laajemmin tietoa käyttäjän liikkumisesta.

Hiilijalanjälkilaskurin tulisi kuitenkin olla erittäin pitkälle kehittynyt ja tarkka, jotta se voisi paremmin vaikuttaa käyttäjänsä tapojen muutokseen, minkä takia onkin oleellista kyseenalaistaa sen rooli kuluttajakäyttäytymisen muutoksessa. Vaikka laskurista tulisikin erittäin älykäs, käyttäytymisen muutokselle ei ole mitään takuita. On kuitenkin huomioitava, että tutkielma keskittyy vain yhteen hiilijalanjälkilaskuriin. Kaiken kaikkiaan tutkimusta tarvitaan enemmän, etenkin erilaisten ympäristökuormitusta mittaavien laitteiden ja sovellusten käyttäjäkokemusten parissa.

Avainsanat kestävä kehitys, hiilijalanjälkilaskuri, käyttäjäkokemus, kuluttajakäyttäytyminen, green tech, materiaalijalanjälkilaskuri

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List of Abbreviations

CFC = carbon footprint calculator

EFT = eco-feedback technology

IS = information systems

ISO = The International Organization for Standardization

IT = information technology

UI = user interface

UX = user experience

1 Introduction

Due to increasing global warming, our planet is exhausting itself as quickly as ever and there is serious need for solutions that would be able to engage an increasing amount of people to participate in adapting more sustainable lifestyles (IPCC, 2018). Although awareness among the subject has increased during the past years, still not enough concrete actions towards a better tomorrow have been undertaken. Moreover, individuals are largely unaware of the damage some of their daily activities and routines create for the environment (Froehlich, 2011). Hence, it is important to provide accurate information on consumers' personal consumption habits and give advice on how to replace their current habits with more sustainable ones.

One potential solution for increasing awareness among consumers could be increased use of different kinds of eco-feedback technologies (EFTs) (Froehlich, 2011), such as carbon footprint calculators (CFCs). In general, the aim of any CFC is to help its user to calculate, understand and reduce their footprint as low as possible. However, consumers should first of all find the technology and calculate their carbon footprint in addition to understanding the results and the type of actions they can or should undertake in order to decrease their carbon footprint. Regarding behavior change, both the feedback the CFC provides to its user and the user experience (UX) the user gets from using the tool have a great impact on whether the user will end up changing their behavior or not (Froehlich, 2011; Mäkelä & Fulton Suri, 2001).

Therefore, in order to get people to use different types of EFTs that could help them understand their consumption habits and make more sustainable choices, the overall UX of an EFT needs to be successful and meet its user's expectations and needs (Hiltunen et al., 2002; Kraft, 2012; Mäkelä & Fulton Suri, 2001). Out of different types of feedback technologies, this thesis will mainly focus on EFTs as this category includes feedback tools used specifically to provide feedback related to different fields of environmental conservation (Froehlich, 2011), which is the main focus of the study. Moreover, UX of a specific EFT tool, the SUSLA CFC, will be discovered and findings related to functionalities that could further improve the UX will be presented. In addition, potential pain points and the overall usefulness of CFCs and EFTs will be discussed.

1.1 Research problem

According to Van de Ven & Oxford (2007), defining the research problem is one of the most important phases of designing a good research. One reason for this is that is enables accurate problem solving. If the problem is unclear, coming up with a solution that seeks to solve the problem will become very difficult. Hence, getting to the very core of the issue is vital. When discovering potential research problems, it is important to recognize from whose perspective the problem is being looked at (Van De Ven & Oxford, 2007). The perspective has a huge impact on the whole research, as the point of view can become completely different when looking from another stakeholders perspective.

In this research, the problem will be analyzed from the developing organizations' perspective. One of the major problems regarding the use of a CFC, or any similar type of tool, is that it will be used by a very miscellaneous group of people. It can be expected that different groups of people will have more or less different preferences and expectations for the calculator. In addition, the solutions and suggestions the calculator provides to the user may require e.g. a certain financial position. Hence, no matter how good the calculator is in producing suggestions and precise in calculating carbon footprints, if its use doesn't satisfy the users or their behavior doesn't change, in the end, the calculator doesn't have much value. Therefore, the major problems surrounding the calculator seem to revolve around finding ways to satisfy the majority's needs and preferences, especially as for SUSLA the goal is to get a very large amount of users for the calculator (*About SLA*, 2021). Hence, the aim is to discover the key issues and success points the users are experiencing in order to shed more light into the possible problems and setbacks the users face.

1.2 Research question and objective

Once the research problems have been identified, the researcher can move on to formulating appropriate research questions. Coming up with appropriate research questions should be one of the first things a researcher does after discovering the research problems, as the idea of research questions is to give direction to the researcher in order to tackle the research problem (Van De Ven & Oxford, 2007). They set the base for the whole project as the questions and problem are the starting point of the research. The questions also give direction to the rest of the research, such as the used theory, as the role of the research questions is to drive the research into the desired direction. The research questions are also the ending point of the research, as typically the aim of a research is to provide answers to

the questions and a solution or suggestions to the problem. Hence, research questions play an important role in the process of writing a thesis.

RQ: How can UX be used to increase user commitment and shift behavior towards a more sustainable lifestyle and decisions?

The main objective of the research is to discover the most significant aspects of UX regarding behavior change in the context of EFTs and specifically CFCs. For the SLA project, the core objective is to provide user insights regarding SUSLA and its use, in addition to ideas on how to further improve its UX. Insights and solutions will be based on both existing research related to the topic in addition to test user interviews, which aim to reveal more concrete and precise preferences and suggestions from the actual users. On a larger scale, the goal of the thesis is to contribute more research on the field of CFCs and EFTs from the point of view of UX in addition to calculator specific recommendations that may be further utilized in similar researcher in the future.

1.3 Thesis structure

This thesis comprises of different parts discovering, discussing and analyzing the different areas of the research. The introduction presents the reader the background and motivation for the chosen thesis topic. In addition, it discovers current, topic-specific problems and sets the focus for the research and introduces the research questions. In the literature review, the aim is to discover existing research on the topic and bring together different perspectives and findings. The main themes discussed are EFTs, especially CFCs, and different aspects related to UX, which are tied together in a meaningful way. Finally, the analytical framework is introduced to the reader.

The methodology part describes the chosen research methodology and the case study, in addition to further introducing the SUSLA calculator and the project it is related to. Next, the reasons for choosing semi-structured interviews as the research method will be discussed. Lastly comes the practical implementation of the research methodology followed by an explanation of the tools used for analyzing the interview material. This is followed by the fourth part of the thesis, which concentrates on discussing the findings of the research. The structure and different aspects of the CFC used for the case study are evaluated based on the analytical framework in order to shed light on the different experiences the interviewees had during and after the use. In the discussion, the main

findings of the research are presented in addition to further discussing them. In addition, concrete improvement ideas for SUSLA will be presented in the form of design implications. The aim of the implications is to give further suggestions on how to make the calculator more user-friendly and better answer to its user's needs and expectations in order provide a successful UX and affect their behavior. Lastly, the limitations of the research are being discussed in addition to drawing final conclusions. Based on the limitations of the research, suggestions for further research are given in order to provide ideas for future research on the topic.

2 Literature review

In a literature review, the researcher aims to find the most relevant and timely research related to their topic (Webster & Watson, 2002). Therefore, a literature review is an efficient way to discover gaps in existing research and by so direct the researcher to find more about these gaps. In addition, by conducting a thorough literature review, the researcher reaches a comprehensive base for conducting their own study. What's more, a literature review is supposed to look at existing research from a critical perspective (Rowe, 2014). The researcher should aim at identifying biases and simplifications, and from here potential gaps and need for further research. By so, the researcher can avoid pitfalls on conducting already existing research with no added value to the field (Silverman, 2011). All in all, a literature review comprises of what has already been discovered, what is still lacking from the specific field and what further research could concentrate on (Rowe, 2014).

Therefore, in this section, relevant and existing research related to EFTs, such as CFCs, and the different aspects of UX will be discovered in order to provide a thorough background for the research. Key points regarding what the UX comprises of and how to design a successful UX will also be discussed. The main topics will be tied together in a meaningful way so as to create a comprehensive whole and shed light on how and why the topics are related. In addition, the analytical framework for data analysis will be presented in addition to explaining its purpose of use.

2.1 Green IS for behavior change

Global warming and other sustainability issues are slowly but inevitably taking their toll in our everyday life and decisions, as the climate and natural environment as a whole are changing (IPCC, 2018). According to IPCC (2018), serious shifts towards more sustainable procedures need to be implemented in order to tackle the issues of climate change. The Paris Agreement from 2015 is one concrete example on how governments have responded to this need, as according to the agreement, the goal is to limit global warming to 1,5 degrees Celsius (compared to pre-industrial levels) by binding its parties to implementing actions that will reduce their greenhouse gas emission (United Nations, 2015). According to research, information systems (IS), which also includes information technology (IT), plays a major role in making current global sustainability goals reachable (Watson et al., 2008). This view is specifically related to Green IS, which aims to tackle

sustainability problems on a larger scale with the use of IS. However, IS is also seen as one of the causes for increased environmental issues, as e.g. data storage uses huge amounts of energy (Dedrick, 2010). Hence, IS can be perceived as both the cause and the cure for some of the existing environmental problems (Watson et al., 2008).

During the past fifteen years, Green IS has been receiving an increasing amount of interest and it has been studied from different perspectives (Harnischmacher et al., 2020). The wide focus area of the research also includes nudging and behavior change (Harnischmacher et al., 2020) and according to studies, Green IS has huge potential in nudging whole societies into more environmentally sustainable direction, as it provides different means for decreasing the impacts of climate change (Hasan et al., 2014). On an organizational level Green IS can be utilized to become more profitable by e.g. minimizing the amount of different types of waste organizations produce (Watson et al., 2008). Moreover, by engaging in Green IS, organizations also do good outside their business, as green IS contributes better outcomes for multiple stakeholders, such as the society (Raisinghani & Idemudia, 2015; Watson et al., 2008)

What comes to individuals, Green IS is considered as one solution for shifting consumer behavior towards more sustainable habits (Shevchuk & Oinas-Kukkonen, 2016), as advances in technology relevant for behavior tracking and behavior change, such as human-computer interaction, are moving fast forward and continuously enable more advanced and personalized solutions (Froehlich, 2011). For example EFTs, tracking and calculating are great examples of how Green IS can be used to provide information and hence guide individuals' behavior (Watson et al., 2008). Typically these tools aim to affect its user's behavior by collecting and analyzing their data in addition to educating its user on their current habits and how they affect the environment (Froehlich, 2011). Tools used for personal tracking and behavior change include all sort of electricity and water monitors, which provide its user data on their electricity and water consumption. These can be either physical tools and gauges or applications, to mention a few. Different types of EFTs can help collect and assess its user's consumption data and by so increase awareness (Büchs et al., 2018) and potentially result in habits that are less burdening for the environment. However, literature regarding Green IS in the context of behavior change is still currently rather concise and existing research has not been able to completely shed light on the methods of successfully changing individual behavior (Shevchuk & Oinas-Kukkonen, 2016).

2.2 Role of feedback in behavior change

Human behavior comprises of multiple different aspects and there are many differing theories that try to explain our behavior and what it consists of (Chatterton, 2016). In general, one's actions that are taken and left untaken are based on cultural norms, social relationships, individual motivations and emotions, to start with. Human minds are complex and our behavior can often be guided by unconscious elements that we are not aware of. However, changes in behavior typically stem either from self-reflection or external feedback on one's behavior (Carver & Scheier, 1982). Then again, due to the complexity of human nature, the simple presence of feedback does not guarantee behavioral changes. The success of the feedback is determined by e.g. what type of feedback method is used and its timing (Lechermeier & Fassnacht, 2018). Especially when it comes to encouraging behavioral changes towards a more environmentally friendlier direction, in general, a sustainable lifestyle is perceived costlier and more time consuming, hence making consumers more reluctant to changing their habits (Lin, 2017). Moreover, a more sustainable lifestyle typically includes abandoning some habits, such as cutting down the amount of buying new clothes or shifting dietary habits towards a more plant based one, which can feel obnoxious. Therefore, in order to achieve behavioral changes in the context of sustainability, the methods used for providing feedback, its timing and delivery need to be successful (Froehlich, 2011; Lechermeier & Fassnacht, 2018).

2.2.1 Eco-feedback technology

In their study, Froehlich (2011) discovers the potential of one type of green IS: EFT. Like other feedback technologies, it is designed to measure and track its user's behavior. In the case of EFTs, however, measuring is done in the context of sustainability. The assumption behind EFTs is that most people are not aware of the environmental burden their activities cause. Hence, EFTs aim to fill this information gap through some kind of a technological device. In other words, EFTs aim to provide its users data on their consumption habits they might not otherwise be aware of and display it in a way that is easy for the user to understand. EFTs can concentrate either on one sector, such as water or energy consumption, or more thoroughly on multiple different aspects of consumption, which is typical for e.g. carbon footprint calculators. It can provide data and feedback for either individuals or groups based on their actions and habits. The way the data and feedback are

presented can vary heavily depending on the technology at use and the consumption sector that is being measured or tracked.

The use of an EFT starts with the technology collecting data on its users actions and habits (Froehlich, 2011). The time span for this can vary from a one-time survey all the way to continuous tracking. The next step is to then deliver the user personalized data, i.e. feedback on their environmental impact in a form that they can easily understand. In the context of EFTs, understanding specifically relates to the understanding of the environmental impact of their habits. The core functionalities of EFTs are to first of all provide feedback and secondly pay attention to how it is provided. The existence of the feedback enables the user to gain more information, but if the feedback is presented in an unclear way, the user will not benefit from it. Hence, the way the feedback is displayed affects the EFT's overall usefulness.

Based on the feedback the user should become more aware of their consumption habits and its environmental consequences and by so be able to shift their consumption towards a more sustainable direction (Froehlich, 2011). On a more concrete level, the feedback allows the user to identify unsustainable habits that they might not otherwise be able to identify and by so reduce or get rid of these habits. As an example, in an online survey conducted for over 650 respondents regarding their thoughts on the most water consuming actions in their households, the majority of the respondents had very flawed ideas on what actually contributes most to their water usage. Without the feedback, the respondents would have most likely not been able to reduce the impact of their habits. Therefore, increasing the user's awareness is a key aspect in enabling them to become more conscious.

Moreover, knowing what type of feedback works best for the user to become more aware is crucial for an EFT to function as planned (Froehlich, 2011). In general, the collected data should be presented in the most simple and relatable way as possible, e.g. the amount of CO_2 emissions presented as trees needed to grow in order to compensate caused emissions from a specific action (Ableitner et al., 2018). By using metrics that the user is already more familiar with makes it easier for them to both understand and keep track of their actions and their consequences (Bartram, 2015). In their study regarding feedback intervention in energy consumption, Ableitner et al. (2018) analyze perceptions and actions related to different feedback methods based on hot water consumption during showers. They found that the study participants mainly preferred to view their water consumption in liters opposed to other feedback measures used in the study, such as the

energy efficiency class (kWh). Moreover, those who viewed their consumption in liters in addition to paying close attention to their consumption managed to cut down their energy consumption the most. Furthermore, according to Piccolo, Scharl and Baranauskas (2012) in order for users to utilize the feedback of a technology, they first need to realize *what* the technology is and how it works. Based on an EFT's purpose, multiple different types of technology can be used to both collect the data and present the feedback, such as applications, different types of physical calculators and screens etc. (Froehlich, 2011). Therefore, it is important to conduct thorough research and examination when deciding and designing the UI for an EFT in order to find the most suitable alternatives. Related to the feedback type and the way it will be presented, the importance of individuals and their actions in making a change should also be well communicated to the user (Piccolo et al., 2012).

Although there are differing results when it comes to research on the actual effects an EFT has on its user, at the very least the use of EFTs typically result in increased awareness of its user's consumption habits (Ableitner et al., 2018; Abrahamse et al., 2005; Büchs et al., 2018). However, according to Froehlich (2011) finding universal incentives and reasons for changing behavior is highly complex and there is a lack of study when it comes to bridging the gap between reasons for changed behavior and feedback technology in general.

2.2.2 Carbon footprint calculator

A CFC is a type of an EFT that focuses on the carbon emissions that are caused by an individual's actions (Lin, 2017). It is typically a digital tool that enables its user to give data one their consumption habits, which then is processed into appropriate feedback by the calculator (*Carbon footprint calculators*, 2021). In the simplest versions, the feedback communicates to the user their environmental impact, which is their total carbon footprint that is usually based on a one year time span. A CFC can also be used to calculate the carbon footprint of e.g. organizations or buildings etc., but in this thesis the focus will be in individual's footprint calculations.

The use of a CFC usually starts with the user filling in a questionnaire on their consumption habits (*Carbon footprint calculators*, 2021). The questions aim to cover different consumption sectors that are considered important regarding the carbon footprint and are typically related to energy usage, traveling and dietary habits etc. However, this can vary highly as some CFCs are designed to be less comprehensive, whereas others aim

to cover as many aspects as possible. Once the questionnaire is filled, the CFC calculates the user's annual emissions and provides the user their personal carbon footprint, which is typically expressed as tons of CO_2 or CO_2 equivalent (Selin, 2020). Moreover, some calculators, such as WWF's calculator, also give the user more or less guidance on how to reduce their carbon footprint, e.g. suggesting to fly less (*How Big is Your Environmental Footprint?*, 2021). The carbon footprint itself is defined as the amount of carbon dioxide that one person (or alternatively an organization, government etc.) produces and is often expressed as kg/year (Merriam-Webster, 2021; Selin, 2020). The calculations take into account both direct and indirect emissions that are caused by a product or service (Selin, 2020), meaning that also energy needed to produce e.g. a TV is taken into calculations. Moreover, the footprint also typically includes methane, nitrous oxide and chlorofluorocarbons.

Like any other EFT, the aim of a CFC is to provide its user information on the environmental effects of their consumption habits (Biørn-Hansen et al., 2020). The feedback of a CFC typically pinpoints its user their most exhaustive habits, as the structure of CFCs is usually divided into different domains, such as diet and leisure etc. (*Carbon footprint calculators*, 2021). By providing the user this feedback, a CFC can at its best result in behavioral change if the user understands the feedback and ends up taking action (Froehlich, 2011). For example, a user who consumes meat and dairy products on a daily basis fills in a CFC in order to calculate their carbon footprint. Once finished, they get their results which show that their diet is very exhaustive for the environment. Here, the user gets feedback on their dietary habits and realizes that in order to decrease their dietary carbon footprint they need to change their dietary habits into more sustainable ones. Without using the CFC, the user might not have realized the environmental impact their dietary habits are causing.

However, affecting the user's behavior can be very difficult no matter how well a CFC is designed. As with EFTs in general, the user's motivation behind using a CFC in the first place might vary very heavily, as some might calculate their carbon footprint purely out of interest with no further fascination into the subject. Moreover, although they might become more aware of their unsustainable habits, this still does not yet guarantee that they will actually *change* their habits (Froehlich, 2011). In addition, where suggestions related to e.g. energy conservation typically have a direct impact on the user's financial savings (Ableitner et al., 2018), the suggestions of a CFC do not always result in cost savings. Vice versa, some of the suggestions might be very costly and therefore even impossible for the

user to implement if they do not have the required financial situation, such as suggesting to change from a diesel car to an electric car. All in all, the success of a CFC depends very highly on the commitment of its user (Gholami et al., 2013), which seems to be very difficult to attain.

Previous research regarding the effects of CFCs on behavioral changes have resulted in more or less differing results. Some research indicates that the use of a CFC has no or only a very small effect on its user's behavior (Büchs et al., 2018), whereas other studies have been able to proof that some test users have been able to more effectively reduce their environmental burden (West et al., 2015). A research studying university students' commitment towards continuous use of a CFC, Lin (2017) discovers that a certain group is more likely to stick with using the calculator continuously. Not surprisingly, this group consisted mainly of users who are quite environmentally conscious and have already to some extent more sustainable lifestyles. This per se isn't a bad thing, but it is important for CFCs to reach also those users whose lifestyles are very environmentally burdening. Hence, one of the main critique CFCs receive is related to the fact that they tend to draw more of those users who are already environmentally conscious instead of those who would actually be more in need of it (Biørn-Hansen et al., 2020). Other critique CFCs typically face are related to their high emphasis on individuals and their actions in the whole of sustainability issues (Spaargaren, 2011). What's more, as the calculation method behind each calculator can be very different, one of the problems with CFCs also include the lack of sufficient and accurate data, which can cause wrongful decision making and distrust (Biørn-Hansen et al., 2020).

2.3 User experience

As mentioned previously, when considering the functionalities of EFTs, the core idea is to get the user to better understand the effects of their behavior on the environment and through feedback, shift their behavior into a more pro-environmental direction (Froehlich, 2011). In order to increase the possibility of succeeding in this task, one significant point of view to take into account regarding the use of an EFT is to provide the user a successful UX. Hence, the literature review will now shift to discover relevant aspects related to creating a successful and enjoyable UX with systems in general and with EFTs. As UX can be very different when it comes to products, services and systems, this thesis will mainly focus on UX in the context of digital tools and not so much of physical products. Moreover, although EFTs can be either physical or digital tools, as the EFT tool studied in

this thesis is a digital CFC, narrowing the research to digital tools serves better the overall aim of the thesis.

The term user experience refers to the overall experience an individual user gets from using a product or service (Hiltunen et al., 2002). Typically, the experience begins already before the user gets to the point of actually using the product or service. Norman and Nielsen (2006) argue that it includes everything in between getting to know a company all the way through to using their product. This means including also e.g. customer service to the experience (Norman & Nielsen, 2006). However, there seems to be multiple different views on what is and what is not included in UX. One of the most popular definitions of UX comes from the International Organization for Standardization (ISO):

> *"User's perceptions and responses that result from the use and/or anticipated use of a system, product or service."*
>
> (International Organization for Standardization, 2019)

The aforementioned definition is a rather simple way to describe UX, but nevertheless succeeds in making it more easily understandable. On a more complex level, this experience includes some kind of emotions in addition to expectations that can be met, exceeded or in the worst case completely dismissed, meaning that they have not been met to any extent (Hiltunen et al., 2002). In addition, UX is heavily linked with many different fields of design and not just visual design, as UX design is not simply about aesthetics but also about how a product or service functions in overall (*User Experience (UX) Design*, 2021). Garrett (2011) even talks about designing an experience, not necessarily a system or service. All in all, the role of UX especially in the digital world is becoming increasingly vital and companies that undervalue its power to customers are starting to lag behind competition (van de Sand et al., 2020).

In their book "Mobile User Experience" Hiltunen et al. (2002) list five different success categories that UX comprises of: usability, utility, availability, aesthetics and offline issues. Especially usability and utility are widely perceived as the two core concepts regarding the overall success of UX as they together form the usefulness of a system (Grudin, 1992; J. Nielsen, 1994a). Once again, there are some differing thoughts regarding the terminology, but following ISO the definition of usability is as follows:

"Extent to which a system, product, or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use."

(International Organization for Standardization, 2019)

Nielsen (2012), on the other hand, divides usability into five quality components and talks about different tasks that the user has to accomplish. Learnability refers to the ease of use of the design and how the user succeeds in doing what they are supposed to do, whereas efficiency determines how quick the user becomes in carrying out the task once they have learned the system. Memorability assesses situations where the user is revisiting the design after some time and whether this will cause temporary inefficiencies in the use. Errors take into account the frequency, amount and scope of potential flaws in the design and finally, satisfaction refers to the overall feeling the user gets regarding the design. The core idea of these quality attributes is to avoid pitfalls in UX design, as according to Nielsen (2012), failing in one or more of these aspects of usability will result in the user leaving e.g. a website or application. What comes to the term utility, it relates heavily with the usability of the design and answers the question 'Does the system do what it is supposed to do'. It is also one of the most important quality attributes for usability. Especially with websites and applications, special attention should be given to their usability as it is one of the first things a user experiences when entering the platform (J. Nielsen, 1999). All in all, both utility and usability are required for a successful UX, as without one or another, the experience will be left short (J. Nielsen, 2012).

What comes to UX and behavior change, the topics together have been studied to some extent. With digital tools, research focuses mainly on applications and websites. Especially when it comes to influencing user behavior, studies typically focus on increasing sales through e.g. customer subscriptions, different sales strategies and visual UI tricks (Kintscher, 2016). Although some aspects might be applicable also to behavior change in the context of EFTs, the end results are rather different in both, as EFTs aim to change the user's behavior in order to increase their motivation and interest towards sustainable lifestyles (Froehlich, 2011), whereas commercial websites and applications aim to increase their profits through consumer purchases (Fard, 2021). Then again, other similar type of tools can be used to better understand how UX and UX design affect the user's behavior. One potential area of research are health applications, which function to some extent similarly as EFTs, as in collecting data, analyzing it and providing feedback to

the user. When analyzing the success of different kinds of health applications that also aim to change their user's behavior and guide them towards healthier lifestyles, the same problems arise as with EFTs, e.g. how to motivate the users to stick to their plans, use the health application and change their behavior in order to achieve a healthier life (Karppinen et al., 2016). Although EFTs and health applications are focused on two rather different areas of life, both still mainly have the same goal of changing their users' behavior and health applications could therefore provide interesting insights also for EFT developers and designers. Nevertheless, there is a clear gap when it comes to EFTs and how their UX affects user behavior. However, in order to shed more light into the topic, this thesis aims to provide more answers to the overall UX the CFC users have had with SUSLA in addition to addressing the core pain points they have experienced with it.

What comes to especially UX design, the role of feedback has a slightly different meaning than what is discovered in this thesis. Typically, feedback in UX design relates to whether the system reacts to a user's interaction or not (Higgs, 2020). However, this type of feedback is highly important especially when the user is completing their tasks and goals, which will be discussed more thoroughly later on. Nevertheless, as feedback in this context concentrates more on the design aspect of UX and doesn't necessarily match with the one discussed in this thesis with EFTs, research on system feedback doesn't provide the necessary research needed for this study. Therefore, research on feedback and how the UX affects it and the user's way of perceiving it has very minimal contributions in the existing literature. Hence, research on the topic is needed especially when it comes to EFTs in order to bridge the current knowledge gap.

2.3.1 User interface

What comes to the user interface (UI), it is a rather inseparable part of UX. UI is, to mention a few, the visual, tangible and interactive part of using a product or system (*User Interface Design*, 2021). Therefore, UI brings alive the usability and utility of the design. According to ISO, the term UI is defined as follows:

> *"All components of an interactive system (software or hardware) that provide information and controls for the user to accomplish specific tasks with the interactive system."*
>
> (International Organization for Standardization, 2019)

Due to the importance of achieving a satisfying and well-functioning UI, there are multiple well-known guidelines and principles that give direction for e.g. developers and designers on how to build the most satisfying and successful interfaces. One of the most famous and appreciated guidelines are Nielsen's 10 Usability Heuristics presented in Table 1 (J. Nielsen, 2020, 1994b). As the name suggests, the heuristics aim to maximize usability and minimize all kinds of errors. However, it is noteworthy that the heuristics are indeed guidelines and not ready solutions, e.g. a background color for a website that will be liked by all visitors. Moreover, even though there are differences in users and their preferences, the principles, guidelines and heuristics do help in identifying the best solutions for different platforms, needs, tasks and goals (Garrett, 2011). Although there are differences in especially aesthetic taste, the usability and functionality of a system doesn't need to be compromised by the visual preferences of majorities. Regarding EFTs, the UI has a vital role in providing the feedback for the EFT user (Froehlich, 2011). Moreover, as different interfaces allow for different feedback types, the decisions made regarding the interface design also heavily affects the possibilities and overall success of the feedback in addition to overall willingness to use the tool.

Table 1: Usability Heuristics (Table: Nielsen, 2020, retrieved from https://www.nngroup.com/articles/ten-usability-heuristics/)

Heuristic	Description
1: Visibility of system status	The design should always keep users informed about what is going on, through appropriate feedback within a reasonable amount of time.
2: Match between system and the real world	The design should speak the users' language. Use words, phrases, and concepts familiar to the user, rather than internal jargon. Follow real-world conventions, making information appear in a natural and logical order.
3: User control and freedom	Users often perform actions by mistake. They need a clearly marked "emergency exit" to leave the unwanted action without having to go through an extended process.
4: Consistency and standards	Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform and industry conventions.
5: Error prevention	Good error messages are important, but the best designs carefully prevent problems from occurring in the first place. Either eliminate error-prone conditions, or check for them and present users with a confirmation option before they commit to the action.
6: Recognition rather than recall	Minimize the user's memory load by making elements, actions, and options visible. The user should not have to remember information from one part of the interface to another. Information required to use the design (e.g. field labels or menu items) should be visible or easily retrievable when needed.
7: Flexibility and efficiency of use	Shortcuts — hidden from novice users — may speed up the interaction for the expert user such that the design can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
8: Aesthetic and minimalist design	Interfaces should not contain information which is irrelevant or rarely needed. Every extra unit of information in an interface competes with the relevant units of information and diminishes their relative visibility.
9: Help users recognize, diagnose, and recover from errors	Error messages should be expressed in plain language (no error codes), precisely indicate the problem, and constructively suggest a solution.
10: Help and documentation	It’s best if the system doesn’t need any additional explanation. However, it may be necessary to provide documentation to help users understand how to complete their tasks.

In order to better ensure that the design and usability principles implemented to the system result in the best possible UX, there are several ways to further test the UI. One efficient method is to conduct a heuristic evaluation, which can be done without external test groups (J. Nielsen & Molich, 1990). In all simplicity, heuristic evaluation consists of individually testing the system by paying attention to different usability principles while testing and analyzing how well they are being executed in addition to evaluating which heuristics are relevant and apply for each step. The system is first tested alone and each tester should make their own notes. After each tester is ready, the team can discuss their findings together. However, it is unlikely that one single person will discover all usability issues that the system still holds. Therefore, heuristic evaluation works best when multiple people test the system individually, as this increases the chances of finding usability problems on a larger scale.

Another method is usability testing, which has become one of the most established methods for analyzing e.g. an applications user friendliness (Hiltunen et al., 2002). In contrast to heuristic evaluation which can be done individually, this method requires test users. A typical setting for usability testing consists of one test user and a researcher, also known as the facilitator, who will guide the test user and give them tasks to complete (Moran, 2019). The facilitator will then ask questions, make notes and pay attention to the test user when they are testing the system. The core idea is to find out existing problems in the interface through real users and real tasks they are asked to complete. One of the downsides of usability testing is that it can be very time consuming and therefore also costly, especially as usability testing should be done frequently. Moreover, the facilitator's role can be rather challenging as they can easily affect the end results of the study making the results biased.

All in all, especially with digital platforms, if the user has a bad experience, it is more likely that they will not return to the platform than giving it a second chance (Garrett, 2011). Even a mediocre experience will not save the situation. Therefore, being able to provide a satisfying UX is a vital asset and for an EFT to gain consistent users, it needs to minimize all errors and flaws in the UX it provides. Moreover, to achieve usability and utility, it is vital to identify user expectations and needs (Hiltunen et al., 2002; Kraft, 2012) in addition to user tasks and goals (Garrett, 2011; Hiltunen et al., 2002), which will be discussed next.

2.3.2 User expectations and needs

A user's overall experience is affected by user expectations in two critical ways (Hiltunen et al., 2002). First of all, the user will view a product or service from a certain predetermined perspective based on their previous experiences (Hiltunen et al., 2002; Mäkelä & Fulton Suri, 2001). Secondly, the user sets their criteria for the new product or service based on these previous experiences. In the context of a CFC, the user might have had previous experiences with CFCs or other EFTs and therefore view new similar type of technology from the same perspective and have certain criteria for the calculator. The user's expectations play a vital role in the overall UX, as if user expectations match with the actual experience, the user is more likely to continue using the product or service (Lin, 2017). On the other hand, if expectations aren't met, the user will feel less likely to be encouraged to continue the use. Hence, identifying user expectations is vital in order to increase the chances of providing a successful UX to the user and by so aim to gather long-term users and decrease the chances of losing any (Hiltunen et al., 2002).

In addition to discovering user expectations, identifying end-user needs is at least as important (Kraft, 2012). User needs can be either existing ones or ones that have not yet been discovered. Immediate user needs are typically clear needs which the user can rather easily express. They are also the most simple and self-evident expectations from a product or service, such as expecting to be able to use a telephone to call someone. Perceived user needs are typically not that rational needs and are based in good marketing by companies. They are needs that are in most cases created for the user without them originally having a need for the specific product or service. Moreover, these needs typically do not solve any problems and can be categorized as rather unnecessary needs. Latent needs are also needs that the consumer might not be aware of. However, they differ from perceived user needs in a way that they can be solutions to existing problems that the consumer doesn't even realize could be solved more simply. This applies also to existing inventions where e.g. a new design can be a latent need. Such needs are typically left for producers to recognize, which can be very problematic due to the fact that discovering latent needs is a rather difficult and time consuming task as they indeed need to be discovered. Examples of simple needs that CFC users could have might be e.g. to understand their consumption habits better or in all simplicity to know what their carbon footprint is.

What comes to CFCs, according to Lin (2017), in order to achieve user commitment the user has to perceive the calculator useful and it has to match with the users' ever

growing demands for the tool. Therefore, as the user needs are prone to change more or less, keeping up to date with them is highly relevant for CFC developers. Moreover, related to the calculator's usefulness, it should aim to provide its user such data and functionalities that bring value to the user's daily life. Unfortunately, though, it is very typical for businesses to develop and design systems from their own perspective, assuming that most users are similar to them and have the same needs as they have (Garrett, 2011). Hence, it is vital to acknowledge the target group i.e. the end-users and discover what type of needs do they actually have. As the end-users are the ones who will actually use the product or service, identifying their needs and preferences is a good starting point for many projects in general (Kraft, 2012).

However, sometimes even defining the end-users can turn out to be a difficult and time consuming process (Garrett, 2011). Depending on the product or service, the target group can vary from a very small group of users to a very large and versatile one. Nevertheless, there are different ways to find out the types of needs the target group has. One of the most efficient ways to discover especially latent needs is interviewing users, specifically when it comes to an existing product or service (Kraft, 2012). Another potential way to discover unidentified needs is considering the use from the users perspective and analyzing whether it simplifies their life or not. In other words, in order to have a solution, there first needs to be a problem or a need for something. In addition, user needs can be discovered through segmentation, which is an efficient way of categorizing different users and their needs from each other (Garrett, 2011). This can also help recognize whether there are big similarities or differences between different user segments and their needs. In overall, there are different ways to discover needs depending on whether the target group is already a user of a product or service or whether they still need to be found. Nevertheless, when building the solution, the need should be frequently revisited in order to assure the right direction of the project.

All in all, the ultimate goal of understanding different user needs is to contribute to the overall experience the users get from using a product or service and to avoid creating any negative emotions that could affect the experience (Hiltunen et al., 2002; van de Sand et al., 2020). Needs reveal what the user wants and once they have been discovered, the designers and developers should aim to fulfill this need in the best possible way (van de Sand et al., 2020). This is vital also in order to become the most popular solution for a specific need, as the solution needs to be better than what potential competitors have come up with (Hiltunen et al., 2002). In order to be able to design better EFT tools for

consumers, this thesis will aim to discover and better understand what types of expectations and needs different CFC users might have in addition to giving suggestions on how to answer to these needs and expectations.

2.3.3 User tasks and goals

In addition to needs and expectations, the user also has goals that are typically based on the user's needs (Garrett, 2011; Hiltunen et al., 2002). User goals are the final outcomes that the user expects to achieve or perform as a result of using a system (Hiltunen et al., 2002). In between the needs and goals are the tasks that the user needs to accomplish in order to reach their goal. These tasks can be anything depending on both the needs and goals and the context of use. Moreover, one user can have simultaneously multiple different goals and tasks. What comes to fulfilling these tasks, for digital tools the UI plays an important role and it should be designed according to the user tasks (Garrett, 2011). Therefore, the user tasks are vital to identify as they will heavily guide the overall design of the interface.

Once again, a simple example of a goal that a CFC user who has a need for calculating their carbon footprint could have is to decrease their footprint. More detailed examples of tasks that could then realize this goal could be to provide the user a platform where they can calculate their carbon footprint in addition to giving them suggestions and options on how to reduce their carbon footprint. These tasks are of course very simplified, but nevertheless a good starting point as the tasks can be broken into multiple sub-tasks to further clarify all needed steps in order to reach the user's goal (Hiltunen et al., 2002). However, according to Kraft (2012), the most important tasks are core tasks that the user is trying to accomplish. They are the main tasks that the user wants to perform when using a system and hence typically also take most of the users time. Core tasks can be either existing ones that are already available for the user or such tasks that the user would prefer to be able to perform (Kraft, 2012). Kraft states as follows:

> *"A core task is hence any task that users expect to be able to perform with your product. It is important to emphasize that core tasks are defined by the users."*
> (Kraft, 2012, chapter 5, pp. 2)

Core tasks are indeed tasks that the user wishes to perform, not solutions or functionalities which they are commonly misunderstood as. Not surprisingly, they might be very different depending on the user (Kraft, 2012). Therefore, for each target group, the

core tasks need to be identified separately in order to avoid overgeneralization. Moreover, the tasks tend to be dynamic and can change through time and technological development, and hence should be revisited frequently in order to stay up to date with them. Core tasks typically change even quicker than the user needs. All in all, core tasks should always be prioritized when considering changes or further developments in a system as they are the tasks that the user must be able to accomplish. What comes to identifying these tasks, one possibility to better understand what is between the user's needs and goals is to conduct user story mapping (Patton & Economy, 2014). In all simplicity, the user story mapping goes through the whole range of tasks and activities that the user might face when they are using a system, told as a story. It is typically used in agile development and hence works well when building digital tools.

2.4 Analytical framework

The theory presented and used in this thesis is based on Froehlich's (2011) sensing and feedback loop for human behavior that is used for EFTs in his research. The original framework comprises of the same research questions that together build the framework for the sensing and feedback loop. For this thesis, I have adapted the original framework by categorizing the aforementioned research questions as EFT design phases in addition to elaborating further on the different phases by giving each of them a more detailed description (Table 2).

In the original framework, sensing acts as the starting point as some sort of a sensing system that collects its user's data needs to first be established (Froehlich, 2011). The type of data and its collection method combined with the chosen device that will perform the tasks all set the basis for using a feedback technology. These are identified in the adapted framework under sensing. Once the means for data collection have been identified, the next vital decisions are made regarding feedback visualization and delivery (Froehlich, 2011). Core themes revolve around making the feedback easily understandable for the user in addition to presenting it in a visually satisfying and meaningful way. In addition, taking into account the best possible timing for the feedback is important in order to maximize the benefits of the feedback. In my adapted framework, these are taken into account under feedback. Especially in continuous use where the technology is sensing its users behavior for a longer time period than just once-only i.e. when the user's behavior is being tracked, the feedback starts to build a pattern of behavior (Froehlich, 2011). This, then, can be used to analyze if the user's behavior is changing to one direction or another, or at all. However,

this phase is not covered in this thesis, as it would have required more extensive research, which then would have become too time consuming.

All in all, the original framework was chosen to be adapted due to its well-fitting structure for the overall thesis topic and research question. It covers all of the most vital aspects of an EFT and also fits well with the UX aspect. In addition, the framework helps to discover and understand possible pain points the users might have in addition to being able to better analyze what phase or aspect(s) of the EFT tool cause the problems. Although this thesis doesn't specifically focus on the continuous use of a CFC in such way that the users would be studied and analyzed for a longer time period, the framework still provides an excellent view on the most important aspects building and using a feedback technology.

Table 2: Analytical framework (Adapted from Froehlich, 2011)

EFT Design Phase	Description
1. Sensing	
1.1 **What** type of data is being collected	Choose the type of data that will be collected.
1.2 **How** the data will be collected	Choose a platform or a technological device that best serves the technology's purpose regarding data type, collection method and presentation.
2. Feedback	
2.1 **What** type of feedback will be provided	Decide what type of feedback methodology will be used in the technology.
2.2 **How** the feedback will be provided	Decide an appropriate way to visualize the feedback in order for the user to understands the effect of their current consumption habits.
2.3 **When** will the feedback be provided	Decide the timing of the feedback to the user.

3 Methodology

This section will discover the reasoning behind choosing to implement qualitative research in addition to the methodology used for data collection. Firstly, qualitative research will be discussed, followed by presentation of case study research. Semi-structured interviews, interview structure and data collection process, and the sample size and diversity will be discussed next. Lastly, data-analysis and research ethics will be explained.

3.1 Qualitative research

When deciding whether to use qualitative or quantitative research for data collection purposes, the research questions play a great role (Silverman, 2011). The methodology should be chosen so that it best provides answers to the research questions. For this thesis, qualitative research was chosen for several reasons.

What comes to discovering habits and practices, these can better be observed by qualitative measures (Silverman, 2011). Especially interviews provide an opportunity for the interviewer to ask a set of questions in a face-to-face situation and observe the interviewee while collecting data. In addition, the interviewer can ask follow-up questions if something interesting arises. With quantitative methods this could become very difficult. Moreover, as the research is implemented as a single-case study, one of the most efficient ways to implement such is to conduct in-depth interviews (Yin, 2009).

However, one of the downsides of interviews are biases from both the interviewer and interviewee, which are important to recognize and aim to minimize (Yin, 2009). Especially interviewer biases can occur at different phases of the research process, e.g. during an interview by asking questions in a biased manner or when interpreting the interview results (Hiltunen et. al., 2002). In addition, also the interviewee might end up answering the questions in such way that they expect the interviewer for them to answer (Yin, 2009). Therefore, avoiding biases starts already before the actual interview, when writing the interview questions (Hiltunen et. al., 2002).

3.2 Case study research

A case study is a research method that is focused on some specific phenomena that is typically contemporary and whose nature is such that the researcher has little or no control of (Yin, 2009). In addition, case studies are typically used as a method for ‘how’ or ‘why’ type of research questions. Therefore, the aim is to provide in-depth research on a very

precise topic, such as in the case of a carbon footprint calculator. Depending on the field of study, the topic can vary very widely.

However, there is also some criticism towards the generalizability of case study findings in addition to the difficulty of conducting a good case study (Yin, 2009). Then again, case studies can also be done repeatedly as multiple-case studies, which increases the aspect of generalizability. In addition, the goal is not to provide such data that is generalizable to e.g. a whole population, but rather more on a theoretical level. What comes to the difficulty of implementing a case study, it is a relevant problem, but fortunately there is an increasing amount of guidance available to take advantage of when designing a case study research.

In this thesis, a case study was used to discover the user perceptions of a specific EFT. The selection of the case study tool was chosen before the start of the whole research process. In fact, the introduction of the case study subject, SUSLA CFC, was the starting point for the research and the user needs the tool had gave direction for the main focus of the thesis. Therefore, the calculator itself was given, but the more specific viewpoint for the research was chosen more freely by the researcher, nonetheless so that it serves the purpose of the calculator and aims to shed more light into some of the more problematic areas that were still uncovered. Hence, in this case study, the opinions, experiences and thoughts of using the SUSLA calculator in relation to its users' perceptions on behavioral change towards more sustainable habits were discovered. The research focuses only on users that live in Finland, as it was a natural way to delimit and narrow the scope of the research to become country specific. In addition, as the extent of CFCs can differ widely, conducting a research on a specific calculator is much more convenient and beneficial as all participants get to use the same tool and therefore, the collected data is better comparable. In addition, as SUSLA is a calculator without an existing user base and it is still in the development phase, the research aimed to discover potential user needs for the development process.

3.2.1 Background information about SUSLA

A research project called The Sustainable Lifestyles Accelerator (SLA), which comprises of seven different organizations in seven different countries, is focusing on creating a CFC as a webtool that is aimed for households (*About SLA*, 2021; *Project Aim*, 2021). In Finland, the coordinating company for the project is D-mat ltd. which specializes in carbon and material footprint calculations. Other participating organizations come from Germany,

Denmark, Spain, Switzerland, India and Mexico. The project started in 2018 and the core idea of the accelerator is to provide consumers guidance on more sustainable lifestyles and choices. In order to succeed, they are developing a CFC called SUSLA that is aimed for consumers in different countries to help them evaluate their consumption habits. In addition to calculating the users' carbon footprint, the calculator also calculates their material footprint and has a large variety of different sustainable solutions and suggestions that the users can implement in their everyday life in order to reduce their carbon footprint. The ultimate goal of SUSLA is to guide its users towards 1,5 degree lifestyles (*Carbon Footprint*, 2021). In order to better understand the details and timeline of the project the CEO of D-mat ltd., Michael Lettenmeier, was briefly interviewed.

The accelerator is divided into three different rounds and five tasks (Figure 1). On each round, the aim is to include more and more households to participate in the accelerator and further the development of the webtool, i.e. SUSLA. For the first round the goal was to include five to six households per country, whereas for the second round the amount is already in 500 households per country. By the third and final round, the accelerator should have attracted already 10 000 households to participate in each of the seven countries.

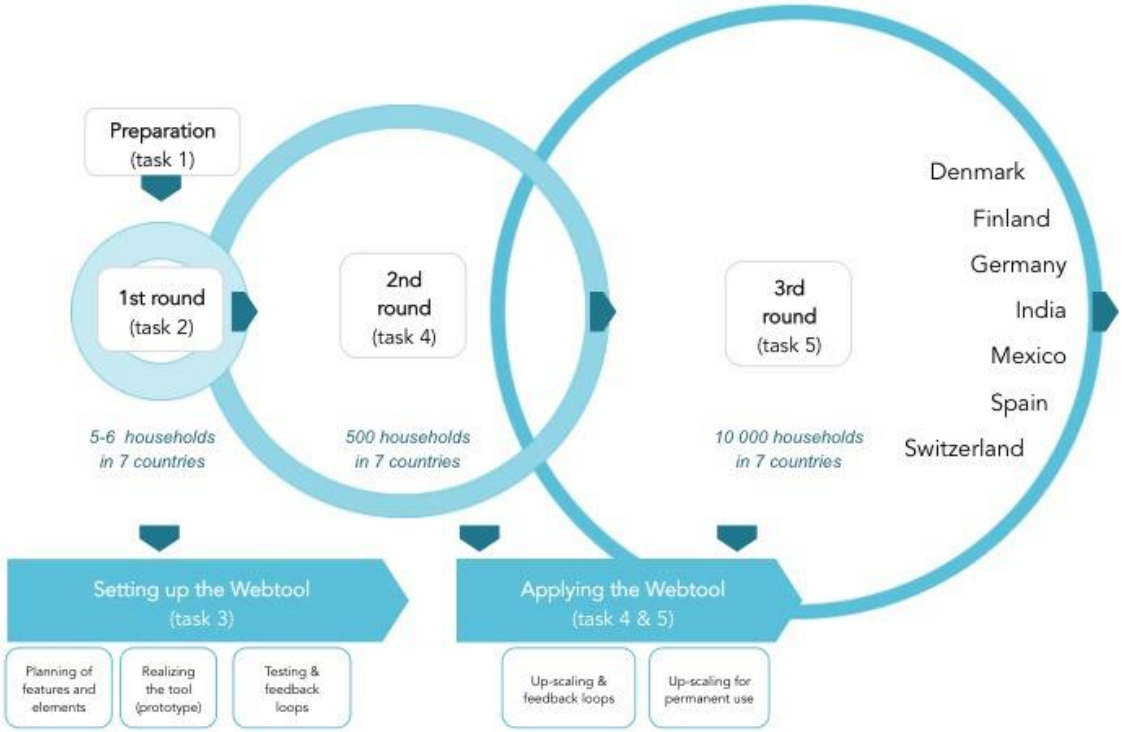

Figure 1: Project design (screenshot from: suslife.info)

As can be seen, the use of SUSLA started during the second round as it was still being developed on the first round. During the start of the accelerator and the first round in 2018, the development of the tool began and the first tool used to reduce household carbon footprints was called 1.5 Degree Puzzle, nowadays Climate Puzzle (Figure 2). The puzzle was created together by Sonja Nielsen, Viivi Toivio and Michael Lettenmeier in the context of both the 1.5-Degree Lifestyles project (Akenji et al., 2019) and SLA (S. Nielsen, 2020). During the first and second round, it was used for different types of events held by D-mat ltd. where the participants, typically households, got to calculate their carbon footprint, plan how to reduce it with the Climate Puzzle and then experiment with different low-carbon options for one month. The voluntary participants mainly took part in a SLA workshop where they met with each other, used the Climate Puzzle to plan their carbon and material footprint reductions and after this, started a one-month test period with some of the low-carbon options. After the test period, the group met again in an event called the Future Workshop in order to receive data on their final reductions they had achieved during the test period and discuss how they had succeeded in overall.

Figure 2: The Climate Puzzle (Picture by Sonja Nielsen, D-mat ltd.)

The Climate Puzzle itself is a physical tool and it functioned as a starting point for the digital tool. The puzzle can be used either individually or e.g. by households or groups, and it comprises of a board and different types of actions for low-carbon lifestyles (Figure 3) that are divided into four domains which are living, mobility, nutrition and leisure and consumption. The actions are square shaped pieces and their size and color represents the different domains and the amount of carbon footprint reduction achieved: The bigger the piece, the bigger the reduction. The process starts with first calculating the player's carbon footprint and then marking it on the board with two pieces. As the puzzle itself cannot be used to calculate the player's carbon footprint, another digital tool was used for this purpose. After marking their carbon footprint on the board, the player gets to choose from multiple different actions the ones they wish to implement in order to reduce their footprint to 2,5 tons. This is done by using the different actions to fill in the gap between the player's own carbon footprint and the target footprint. Finally, on the other side of the board, the player gets to plan their chosen actions on a roadmap in order to implement them all by 2030.

Figure 3: The sustainable actions (Picture by Salla Lahtinen, D-mat ltd.)

What comes to the use of SUSLA, the footprints the tool calculates comprises of five domains (*User Instructions*, 2021). Just as in the Climate Puzzle, the domains represent different types of consumption sectors, which are living, mobility, nutrition, leisure and consumption (Figure 4). In addition to the carbon footprint, the user's material footprint is also calculated. Both of these calculations are based on a questionnaire called the Footprinting Test, which includes at least 30 different questions that the user will first need to answer. The scope of the questions differ to some extent, as some can be answered extremely precisely whereas others more vaguely. In addition, some questions require the user to type the answer themselves, e.g. km travelled with bus per year, whereas others have predetermined answers, e.g. the amount of clothing bought from second-hand shops. Once finished, the calculator gives the user their carbon and material footprints (Figure 4). In addition, the tool gives the user suggestions on how they could live more sustainably by providing the user altogether 40 different actions on how to improve their daily, weekly, monthly and even yearly habits in order to decrease their footprint. However, as the actions are personalized based on how the user has answered the questionnaire, not all users will see every action. With the different actions, the user can test how much their carbon and material footprint would drop by choosing to implement it. Some of the actions also give

the user the option to choose themselves how much they want to reduce or increase a specific action, as the scope of some of the actions can be modified. For example, the user can decide how many cups of coffee they want to reduce from their daily intake. Moreover, the user can choose an action either on their roadmap in which case the action will be saved in order to be done later or as an experiment, meaning that they can try the action for one, two or three months, after which the calculator asks if the user succeeded in the experiment or not.

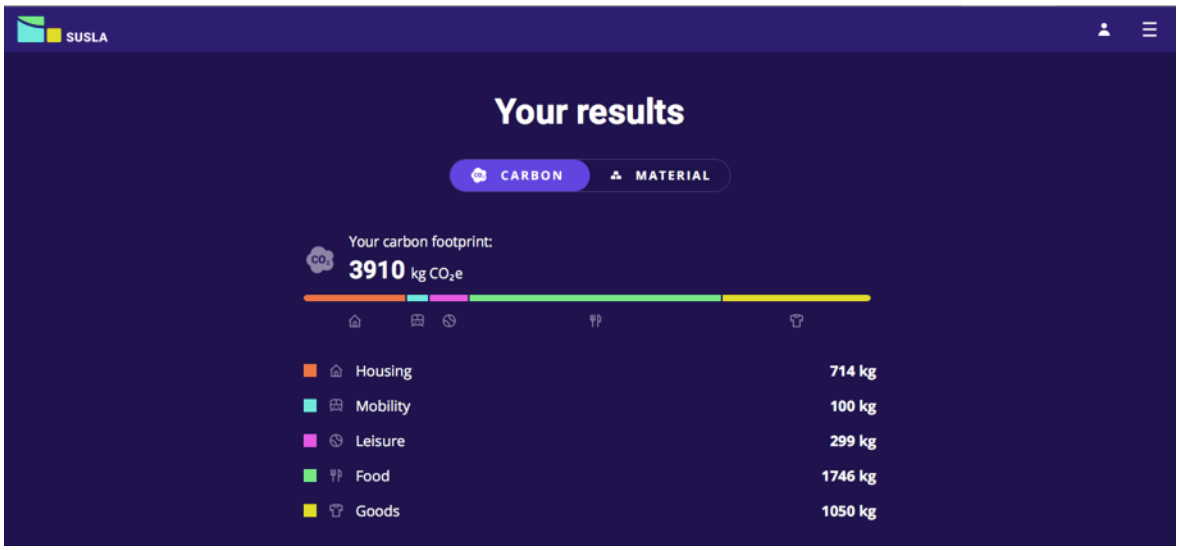

Figure 4: Carbon footprint from SUSLA divided into five domains

The main difference between SUSLA and the Climate Puzzle is that SUSLA is a digital tool that includes the carbon footprint calculation itself and the Climate Puzzle is a physical tool without the calculation functionality. Nevertheless, both tools still have the same overall goal of reducing their user's carbon footprint to 2,5 tons. In addition, SUSLA is a tool that is designed to be used individually, whereas the Climate Puzzle is typically used during workshops where the participants are guided through the process of choosing the sustainable actions and setting them on the roadmap. Therefore, the social situation in which both tools are used is very different. In order to shed more light on how the interviewees perceive the tool in comparison to each other, those interviewees who had also used the Climate Puzzle were asked to give pros and cons for both tools and estimate which one they would prefer.

In the end, the Climate Puzzle was used for the first two rounds during 2018 and 2019, after which the raw version of SUSLA came in the beginning of 2020 for the third

round. However, due to the prevailing COVID-19 situation, the schedule of the whole SLA project was delayed to some extent starting from spring 2020. Fortunately, the development of SUSLA was started on time already during spring 2019 and became usable in the beginning of 2020. It was first tested by only a small amount of users who were given access to the tool while it was still in the early development phase. The basic functions of the tool were working, such as calculating both of the footprints, but the very first users couldn't yet get access to all of its upcoming features, such as the actions. In this thesis, the test users are from the third round of the project, i.e. they are the very first people to test the SUSLA tool.

3.2.2 Semi-structured interviews

When choosing between different types of qualitative data collection methods, semi-structured interviews became the best alternative. This method gives the possibility to ask follow-up questions between the predetermined ones and hence go deeper into the subjects that seem most important to the interviewer (Silverman, 2011). In addition, what comes to case studies, interviews in general provide the opportunity to get data directly from the target group (Yin, 2009). Therefore, it gives the possibility to truly understand the issues and problems the interviewee has and to analyze them from different perspectives (Silverman, 2011).

A semi-structured interview can also be seen as more of a discussion between the interviewer and interviewee (Silverman, 2011). However, it will never become a pure discussion, as the interviewer has the responsibility to guide the conversation and keep it on the desired subject. Nevertheless, this aspect can also help the interviewee to relax during the interview and by so provide more comprehensive answers. Another key point in choosing interviews altogether is the preparation that can be done beforehand (Wilson, 2010). The interviewer can make sure that all important aspects related to the research subject will be covered and even test the interview on someone before the actual interviews. Moreover, interviews can be recorded making it easy for the researcher to return to the material later on if any problems or additional questions arise.

3.3 Data collection

All interviews were done either face to face or via Skype or Zoom in Finnish. Each interview was recorded in order to enable revising the material. After the interviews, the recordings were scripted open. The interview questions mainly focused on the interviewees

previous knowledge around the subject of calculators, carbon footprint and in general their thoughts on sustainability related subjects. Moreover, their technological skills and usage were discovered in order to get more insights of their technological know-how and by so identify any potential lead users.

By starting the interviews with more casual questions related to their background, e.g. studies, jobs and family, the interviewees were able to slowly let go of any tension that was present during the beginning of the interview. Simultaneously, important background data was collected for the research. The same atmosphere was maintained by moving on to asking first more relaxed and general questions on their technology usage and interest towards sustainability topics. With easier and more routine related questions, the thoughts of the interviewees were in a way prepared for the upcoming more in-depth questions. Therefore, after most of the interviewees were clearly more relaxed, open and talkative, the more challenging questions related to their own experiences and views on SUSLA were asked. Lastly, they were requested to describe their ideal carbon footprint calculator in all ways imaginable. The main focus of the interview was in discovering the users' thoughts, ideas and the potential regarding CFCs in general in addition to their thorough user experience with SUSLA. Unclear or vague answers were mainly clarified by further questions. All interview questions can be found in appendix A.

3.3.1 Sample size and diversity

In research, a sample of a population is always needed to represent the whole (Van De Ven & Oxford, 2007). Determining the sample size and scope is one of the major challenges in research, as there is always a limited amount of resources available. Typically, the sample size also represents only a specific geographical region, making it impossible to generalize the results of the study for a larger range of people. For the purpose of this thesis, the sample population should ideally consist of as heterogeneous as possible user base in order to get a comprehensive sample of the whole population and their different opinions, needs and experiences.

In the end, the sample consisted of interviewees that came through the official test round in addition to other interested volunteers who tested the calculator afterwards. Those interviewees who ended up participating from the official round were first contacted by the company. They were provided an email invitation for the interviews and those who were interested contacted for further information and to schedule the interview. However, not enough volunteers participated from the official test round hosted by the company. Hence,

the rest of the sample consisted of volunteers who were contacted by the interviewer, who were willing to test the calculator on their own time and be interviewed afterwards.

The interviewees consisted of users of different ages, gender, educational background, employment status and home city. In addition, their IT skills and interest towards both technology and environmental issues varied to some extent. However, the majority of the users were concerned with sustainability topics. The users had the opportunity to test the application for approximately one week between February and June. The interviewees ran the test 1-5 times during the test period. As mentioned before, during this time, the calculator was still being developed and therefore all test users didn't get to use the exact same version of the calculator. All the basic functions of the calculator were working, including the background questions, answer fields and end results, but some functions were not accessible for those who tested the application back in February (two interviewees), such as the actions. Moreover, there might have been some other minor changes after the actions were implemented, either in the content or features. The first interview was done on February 19th 2020 and the last on June 30th 2020. Due to the prevailing COVID-19 situation and geographical distances between the interviewer and interviewee, only two interviews were conducted face to face. The rest were interviewed via Zoom or Skype.

Table 3: Summary of interviewees

Interviewee	Status	Age	Gender	City
Interviewee 1	Student	24	Female	Helsinki
Interviewee 2	Student	24	Female	Mikkeli
Interviewee 3	Working at private sector	24	Female	Espoo
Interviewee 4	Working at private sector	26	Male	Espoo
Interviewee 5	Student / Working at private sector	28	Female	Helsinki
Interviewee 6	Working at private sector	31	Male	Helsinki
Interviewee 7	Student	31	Male	Helsinki
Interviewee 8	Working at private sector	42	Female	Espoo
Interviewee 9	Working at private sector	61	Male	Kokkola
Interviewee 10	Working at public sector	67	Female	Lappeenranta

3.4 Data analysis

Once the interviews were completed, each of them was transcribed from recordings to text for easier analysis. As all interviews were done in Finnish, also the transcriptions were in Finnish language. The decision to not translate them into English was done based on the huge amount of gathered material. Translating the interviews would have taken a lot of time and would have not been efficient, as not all material was used. Hence, the data was collected and analyzed in Finnish after which relevant data was translated into English in to the Findings-section.

The analysis of data in this thesis was done based on a thematic approach. It is a qualitative data analysis method used mainly for analyzing text (King & Brooks, 2018). The key idea in a thematic approach is to look for common themes that arise from the data and gather the data together under the identified themes. It is typically an iterative process where the researcher goes through the material several times (Silverman, 2011). In this paper, a thematic approach was taken already when designing the interview questions, as they included such themes that are essential for this specific research and its objectives.

However, when using semi-structured interviews it is very likely that the interviewees will bring more topics and insights into the interviews and hence broaden the scope of potential themes (Silverman, 2011).

Following the thematic approach, once the interviews were transcribed, they were transported to a qualitative data analysis software called ATLAS.ti in order to be analyzed and categorized under themes (Friese, 2019). Each interview was analyzed individually and the themes were selected based on the topics of the interview questions in addition to themes that arose during the interviews in such way that they contribute to answering the research question. All similar content was coded under an initial heading. Once finished with the data coding software, all interview themes were converted into separate files and analyzed further theme by theme. From these files, even more precise themes and similarities were looked for in order to answer the research question, such as preferences for the calculator background color. Finally, all relevant material was gathered under appropriate headings and sub-headings based on the interview content and the analytical framework in the Findings-section.

3.5 Research ethics

One of the most important aspects regarding qualitative research is ethical behavior and practices. It is easy to forget that the material for the research are real people who should not be exploited in any ways. Therefore, serious ethical points of view have been taken into account when handling and processing the interviewees' personal information and interview material based on the Aalto University code of conduct (*Aalto University Code of Conduct*, 2021).

All interviewees were handled anonymously in order to secure their personal information, opinions and identity. All participants were asked to approve and sign an informed consent form before the interviews took place to inform them about the aim of the research, how the data will be stored and handled, and to what extent and how their information and answers will be used in the study. The form also gives them the opportunity to retreat from the research at any point before publishing with a simple notification to the interviewer. In addition to informing the interviewee about their rights, the form also provides the interviewer the acceptance for processing both their personal information and the material from the interview questions. This was to achieve mutual understanding and acceptance of how and what information will be used in the study in order to make the research more transparent for the participating party. All in all, in order

to ensure ethical research practices, all participants were made anonymous and any type of personal information that could possibly reveal their identity was left out. No exploitative aspects were included and all interviewees participated voluntarily in the study.

4 Findings

In this section, the findings from the interviews will be discussed in themes based on the predetermined questions in addition to other topics that arose during the interviews. Each theme includes both the interviewees thoughts on their experience with the calculator in addition to their suggestions and ideas on how to further improve it. The interview results are categorized under the different phases introduced in the analytical framework.

4.1 Data type

According to the interviewees, some of the questions seemed to be unnecessarily detailed. One of the most often mentioned questions that were found difficult to answer due to their high detailedness were related to the amount of waste that builds up during a week (Figure 5) and transportation kilometers (Figure 6). In addition, similar difficulties were also present when assessing electricity usage. Some interviewees said they didn't have any clue on the amount of electricity consumed and had to use the average option in the questionnaire (Figure 7). As the questions were so specific, some of the interviewees felt obnoxious to give guesses or approximate answers as it affected the accuracy of the final result.

"I don't know if a regular trash bag is 40 liters, I assume that it is as it was used as an example, but I didn't really know what to say there, that how much."

Interviewee 1

"When asking about mobility, I didn't completely understand why I had to estimate how much I walk during a day as it doesn't produce any emissions when I walk out there."

Interviewee 1

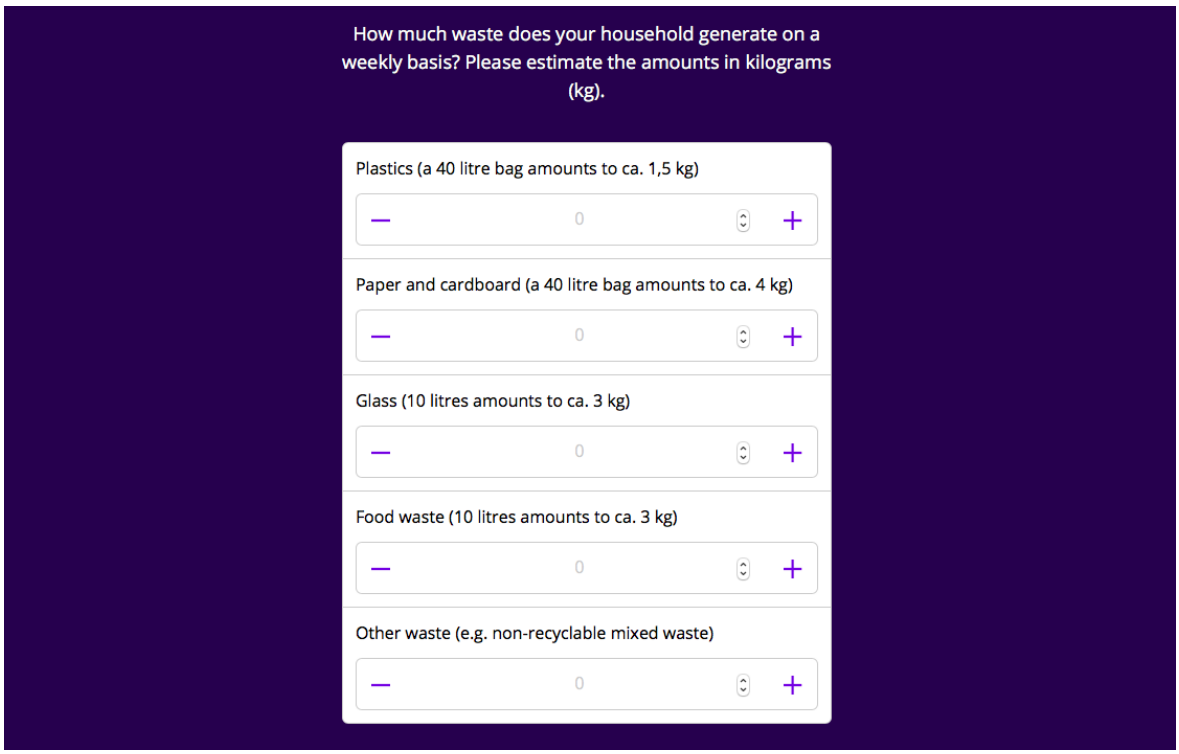

Figure 5: Household waste

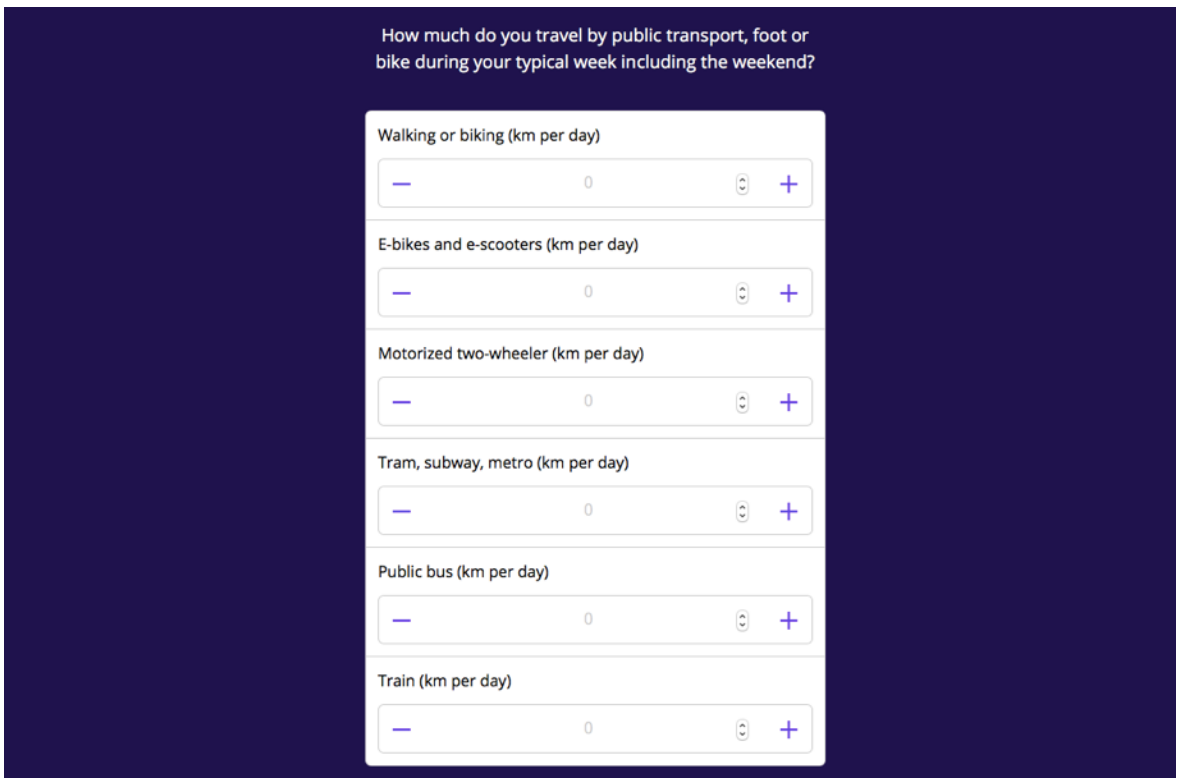

Figure 6: Weekly kilometers travelled

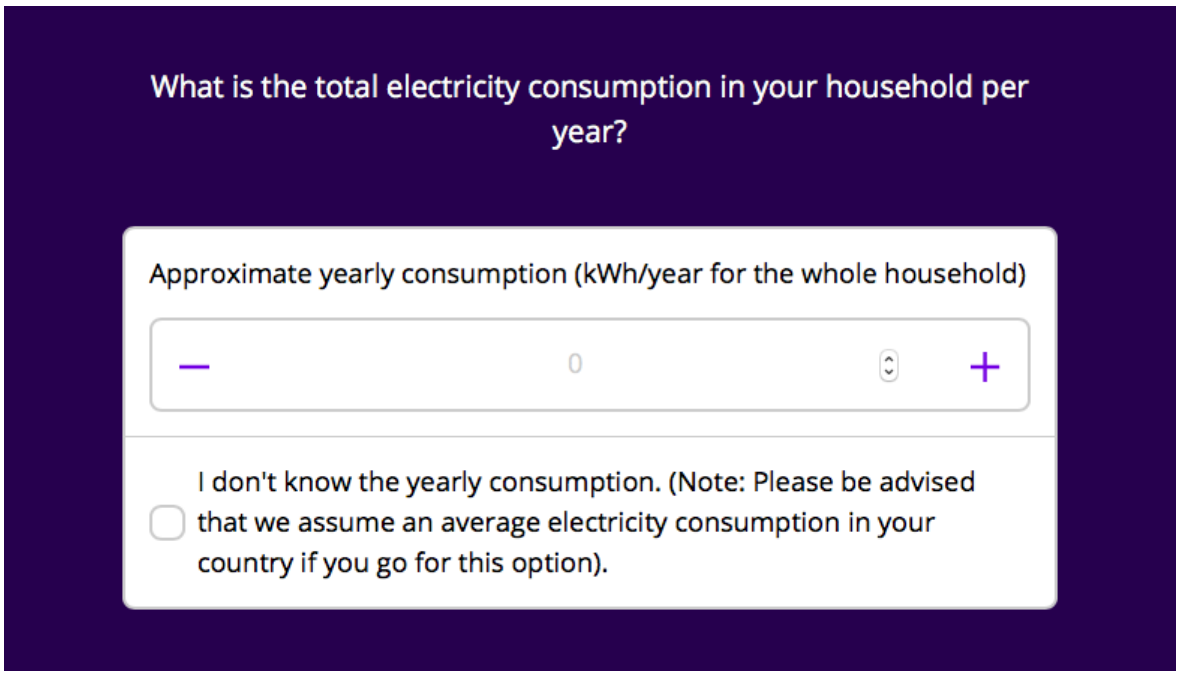

Figure 7: Approximate yearly electricity consumption

In addition to detailedness, some questions seemed to have rather confusing phrasing, e.g. “How do you spend your leisure time” (Figure 8). The question is related to hobbies and free-time activities and the carbon footprint they produce. Some users didn’t understand why the question was asked altogether or had trouble in specifying what is included in free time and hence found it difficult to answer. In addition, they felt weird to assess their time spent at home e.g. reading, as hinted in the question, as they couldn’t find the link between carbon footprint and this type of leisure activity.

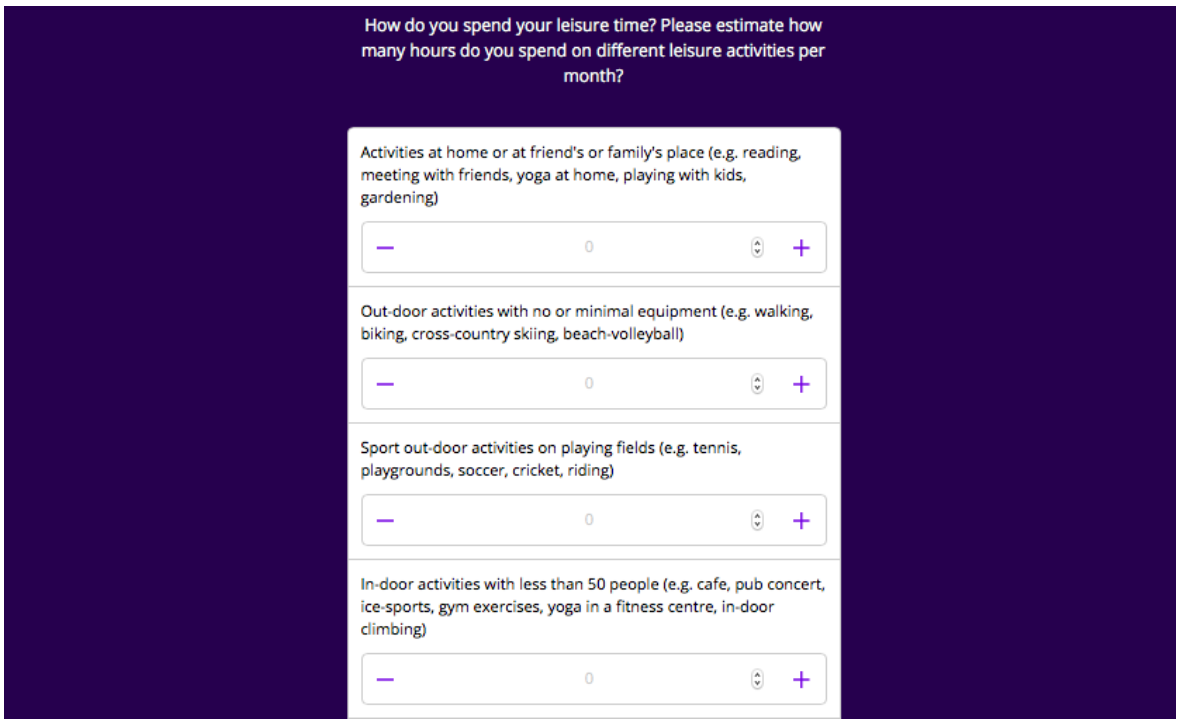

Figure 8: Time spent on leisure activities

What most interviewees did enjoy was related to the scope of the questions asked. They felt that it was nice to have a comprehensive analysis on their behavior with most consumption sectors represented in the results and appreciated the fact that the calculator didn't have a narrow focus on only a couple of sectors, but took into account a wide variety of different type of consumption. In addition, some mentioned enjoying the rather detailed nature of the questions. Surprisingly, a few interviewees felt that there should have been even more questions, as they felt that some parts of consumption were still left out. Subjects that were mentioned were pets, recycling habits, clothing and food. One interviewee even felt that the questions were unequally distributed between the different domains and wished for a more even division between them.

"I think that the calculator had taken well into account different sections."

Interviewee 7

All in all, the test users would mainly prefer a single calculator that would collect and provide them all required information on their carbon footprint. This meant that the calculations should be based on the user's actual consumption data, such as their transportation kilometers, exact purchases from grocery stores and electricity consumption.

4.2 Data collection

Regarding the device used for SUSLA, most of the interviewees ended up using their smart phone (Figure 9) for the test rounds, but a few also used their computer (Figure 10) and one person even both devices in addition to a tablet. However, all interviewees would prefer to use the calculator from their smart phone, as it is more convenient than using it from a computer. Moreover, when using the calculator from their phones, having it as an actual downloadable application was the most popular option, as currently it is only a web application and hence, doesn't have the same possibilities as a mobile application. One interviewee even thought that the calculator should also be available to use in a smartwatch.

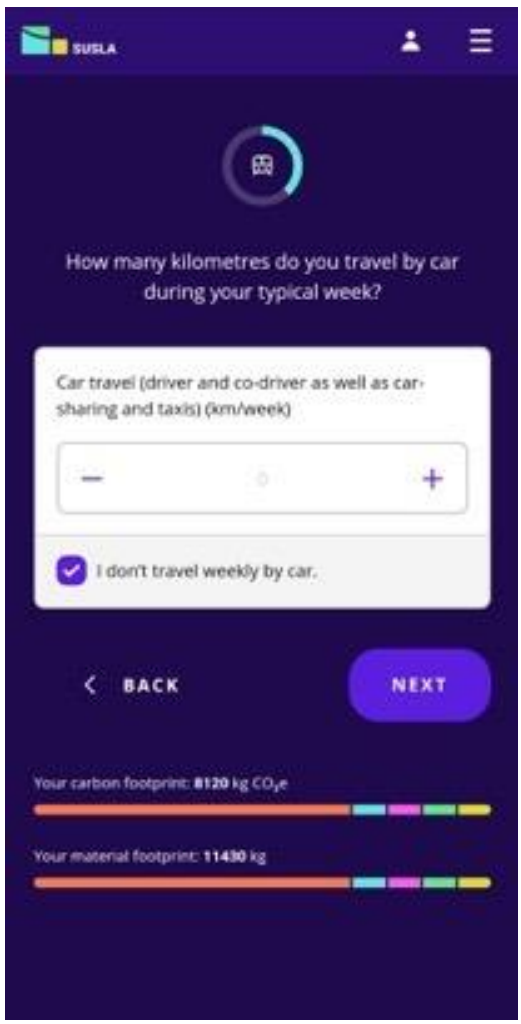

Figure 9: SUSLA on smart phone browser

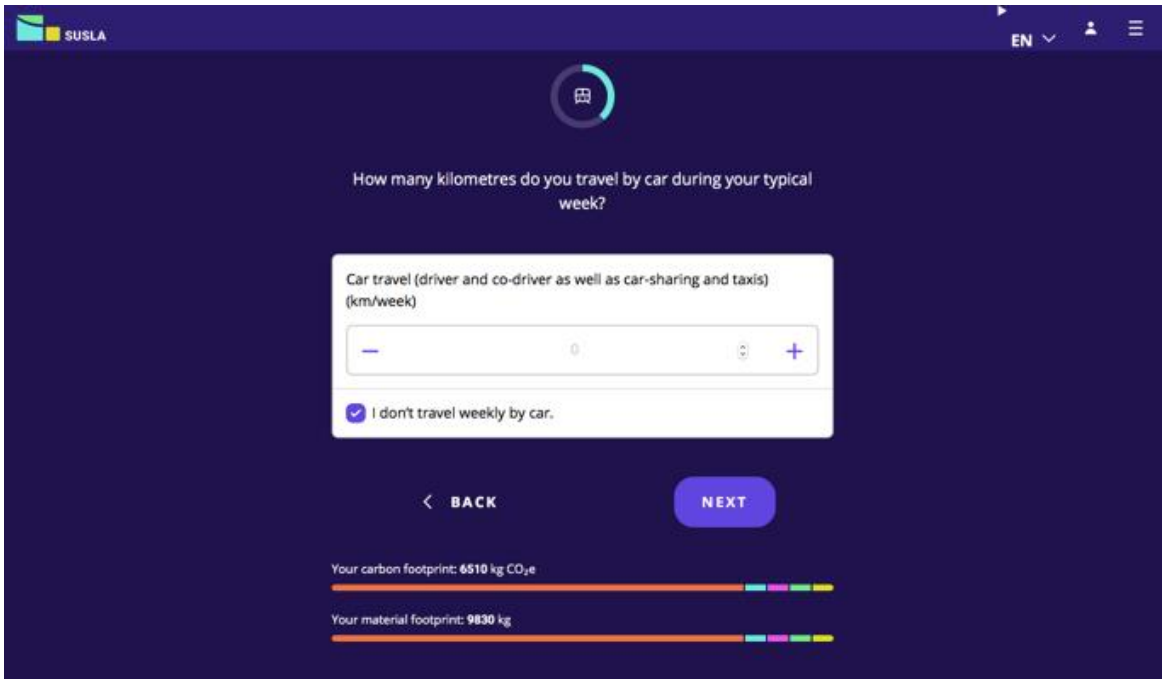

Figure 10: SUSLA on computer browser

What comes to main difficulties with data collection, the detailed questions combined with changing time measurements, answering the questionnaire felt tiring, difficult and laborious. Moreover, the amount of questions was perceived quite high and filling them out took more time than some had expected. The change in the time span in some questions confused many users and made it even more difficult to answer them, as they had to readjust their thinking from time to time. The time span varied between one hour and a year, mostly changing from weekly to monthly estimation. According to the interviewees, it would have been easier to use either or in most questions but preferably the weekly option. This due to week being a shorter time period and hence making it easier to analyze, as the user still has most events in their fresh memory.

Another aspect that frustrated one of the interviewees was that when they had problems in answering a question and there was no average-option available, they couldn't skip the question. Hence, they had to make a guess, which would then affect their carbon footprint and its reliability. However, in such cases where the average-option was available and the respondent had trouble in answering, some of them enjoyed having the option of choosing the average as it gave them the possibility to give at least some kind of an answer. In overall, the bigger problem seemed to be the unawareness and lack of

preciseness in the interviewees' own consumption habits rather than the length of the questionnaire.

"The fact that you could use the average option, for example in some parts of the living domain, that helped."

Interviewee 1

Therefore, for those who had trouble finding answers to the questions, one interviewee suggested having a question mark icon on each question in case the user gets stuck and needs additional information on what the question is about and where they could look for further advice. Also, in general, the average -option (Figure 7) was perceived as something that should have been more frequently and diversely present in the questions. Regarding the length of the questionnaire, another interviewee suggested the idea of having two different questionnaires, a shorter and a longer one. Those who would be interested in doing the full, more comprehensive test could use time to fill this questionnaire, but those who would prefer using less time on a questionnaire could opt for the shorter version.

However, in the most ideal situation, the calculator would be able to fill its own questionnaire by getting access to all of the user's transportation kilometers and different areas of consumption. This would take the burden of filling the questionnaire off of the user, especially as the interviewees wished that the calculator would be able to collect the data continuously and consistently. The data collection could be done by either the calculator itself or via integration to other applications. To name a few, the interviewees mentioned HSL, Kesko and Google, which could all provide very accurate data on the user. Some were even interested in integrating their bank card to the calculator as a source for data. Then again, another question that arose when discussing an integrated calculator was privacy issues. Although most interviewees wished for a calculator that would require a minimum amount of effort regarding answering and updating, and that information retrieval would happen by getting the data from other apps and companies, they also felt contradictory of giving all this data for one operator. The interviewees' thoughts bounced between being reluctant to give such data and then again assessing the privacy level of the data and would they actually mind the operator knowing that much about their consumption habits and transportation.

4.3 Feedback type

There were some differences in how the interviewees felt about the final results of the calculator i.e. the feedback. Some felt that they were clear and provided them everything they had expected, whereas others felt they were too vague and were disappointed especially with the carbon footprint they received. Next, the different types of feedback from SUSLA and the test users' thoughts on them will be presented.

4.3.1 The footprints

Those who were satisfied with both of the footprints said that the visual interpretation was nice and informative and helped visualize the five domains in relation to each other (Figure 11). In overall, they were not expecting the results to be very accurate but instead more approximate. On the other hand, those interviewees who weren't that satisfied with the results would have wished for a more elaborate explanation of the results and reasons behind their carbon footprint. More precisely, they would have wanted a more thorough explanation on the factors in their behavior that cause their carbon footprint. Especially as the questionnaire was so comprehensive, the users felt that the results were way too concise. Some negative feelings were also caused by the amount of their carbon footprint, but these were aimed more towards the user itself for causing such a big footprint. However, the bigger-than-expected footprint arose curiosity and thoughts on what is the biggest factor in causing their huge footprint, which for some users led to a disappointment towards the calculator when they couldn't get more precise information on specific domains. What comes to the material footprint (Figure 12), one interviewee felt that its presentation and meaning wasn't clear in the beginning. However, for some users it was a pleasant surprise to also get more precise information on their material consumption apart from their carbon footprint, especially when they had to see no extra effort in calculating it. All in all, the material footprint was found to be an interesting addition next to the carbon footprint.

"What I liked was that there wasn't just the carbon footprint, but also the material footprint."

Interviewee 7

Figure 11: Carbon footprint

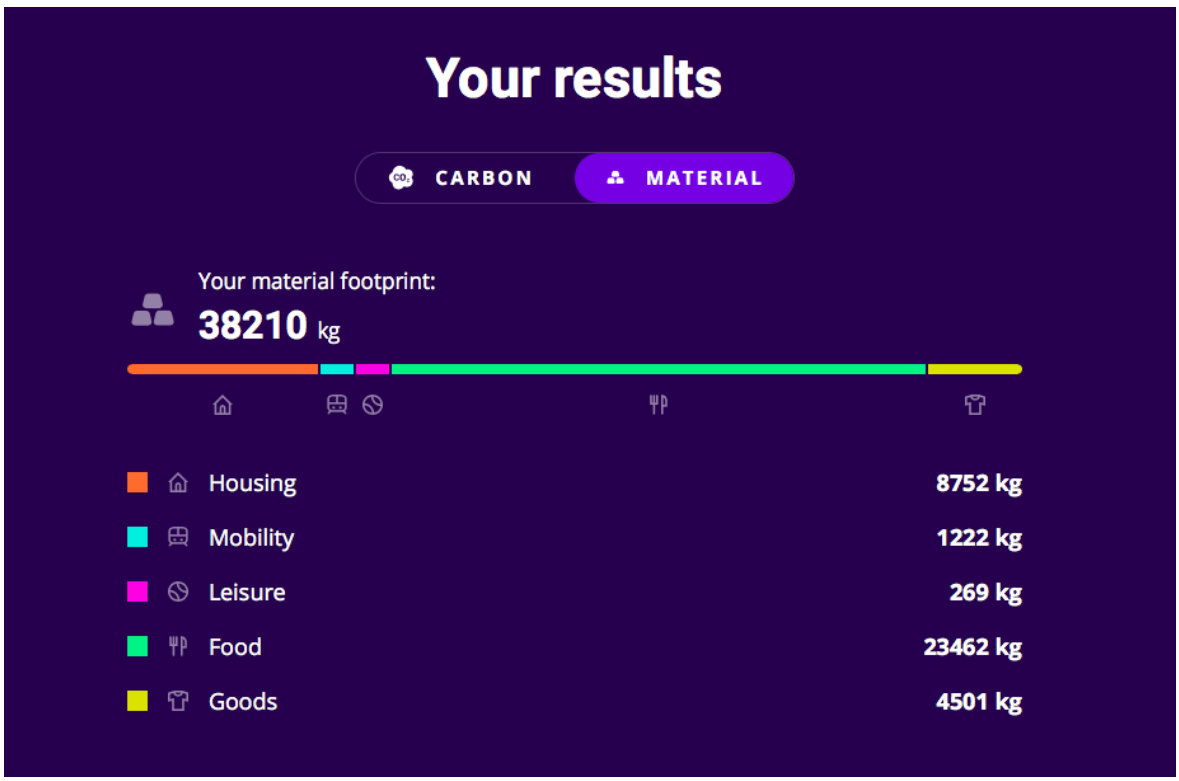

Figure 12: Material footprint

Regarding the country specific, average national carbon footprint (Figure 13), some interviewees felt disappointed with their results as they were higher than the average Finnish carbon footprint. Especially one student interviewee felt to some extent overwhelmed by this, as they perceived living a rather sustainable life specifically due to their student status, which usually automatically means a smaller apartment, use of public transportation and rather limited spending potential. Then again, other interviewees enjoyed it and felt that the average footprints from different countries (Figure 14) expanded their views and thoughts on a more global level and in overall was a fun addition to the calculator.

Figure 13: National average footprint for Finland

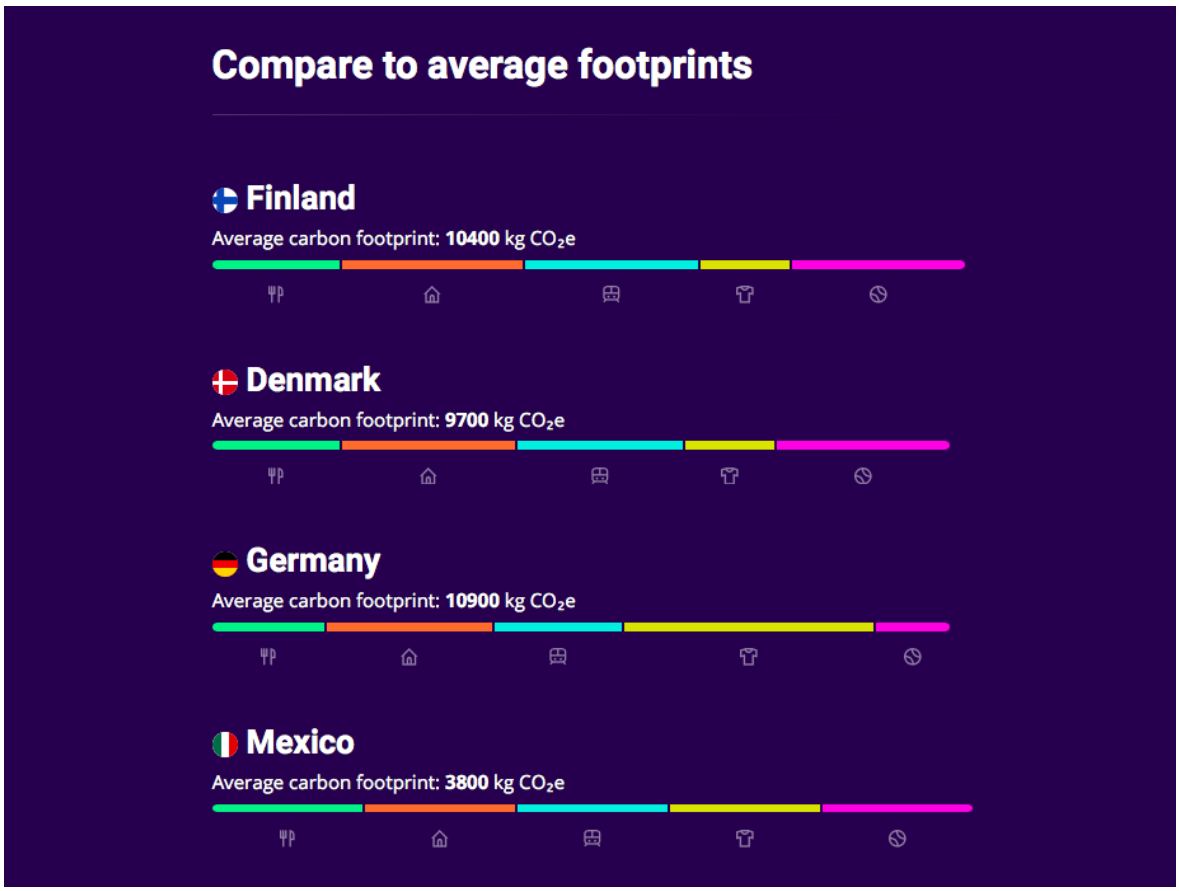

Figure 14: International average footprints for Finland, Denmark, Germany and Mexico

All in all, the interviewees were left hoping for more information on the results, the reasoning behind such different national footprints between the different countries and other interesting and relevant information related to both their personal carbon footprint and sustainability in overall. Some ideas for additional content included short trivia, educative videos or animations and more detailed information on e.g. different energy forms. In addition, a more thorough breakdown on the different domains and being able to see what the user had answered in the questionnaire would have shed more light on where the biggest problems are in addition to being able to compare the results later on. For example, a couple interviewees were left thinking what type of energy is the most sustainable option or whether having 100% renewable energy plays a big role in decreasing their carbon footprint.

In addition, one interviewee would have wished for even more different kinds of footprints, e.g. a social footprint. What comes to the already existing footprints, the visualization of the interviewees' own and the national footprints received a few improvement ideas. A few interviewees said they like viewing data from different kinds of

infographics and comparing them to averages. Hence, a more graphical presentation was a desired addition. They also thought that graphs could be used to consistently track the users performance and show the direction of their carbon footprint in a cumulative way when implementing the different actions. Another interesting idea for the final results was getting a short summary that could be then shared among friends either by sending a link or sharing it as a post in one's social media.

"I get motivated by all sorts of graphs and such."

Interviewee 1

4.3.2 Action list

Unfortunately, not all interviewees got to fully experience the calculator due to being interviewed before the action list, roadmap and experiments (Figure 15) were implemented into the calculator. Out of those who did have access to it, some users felt confused on how to further access the features or if it required an account in order to be able to view the whole content. Therefore, a few users who would have wanted to view the actions didn't end up accessing them because of the mandatory registration. Especially one interviewee didn't feel comfortable creating an account due to the lack of knowledge on where their information would end up to and what type of a quarter would be able to access it. Moreover, another interviewee felt registering to the site as repelling due to the fact that it is linked with Facebook and Google, which they wouldn't prefer due to privacy reasons. They were also a bit confused why such a sustainably oriented calculator is associated and linked to the aforementioned companies who have a slightly questionable reputation regarding privacy protection.

"Why sort of, this type of a sustainable application gets added to that type of companies which have to some extent questionable reputation."

Interviewee 5

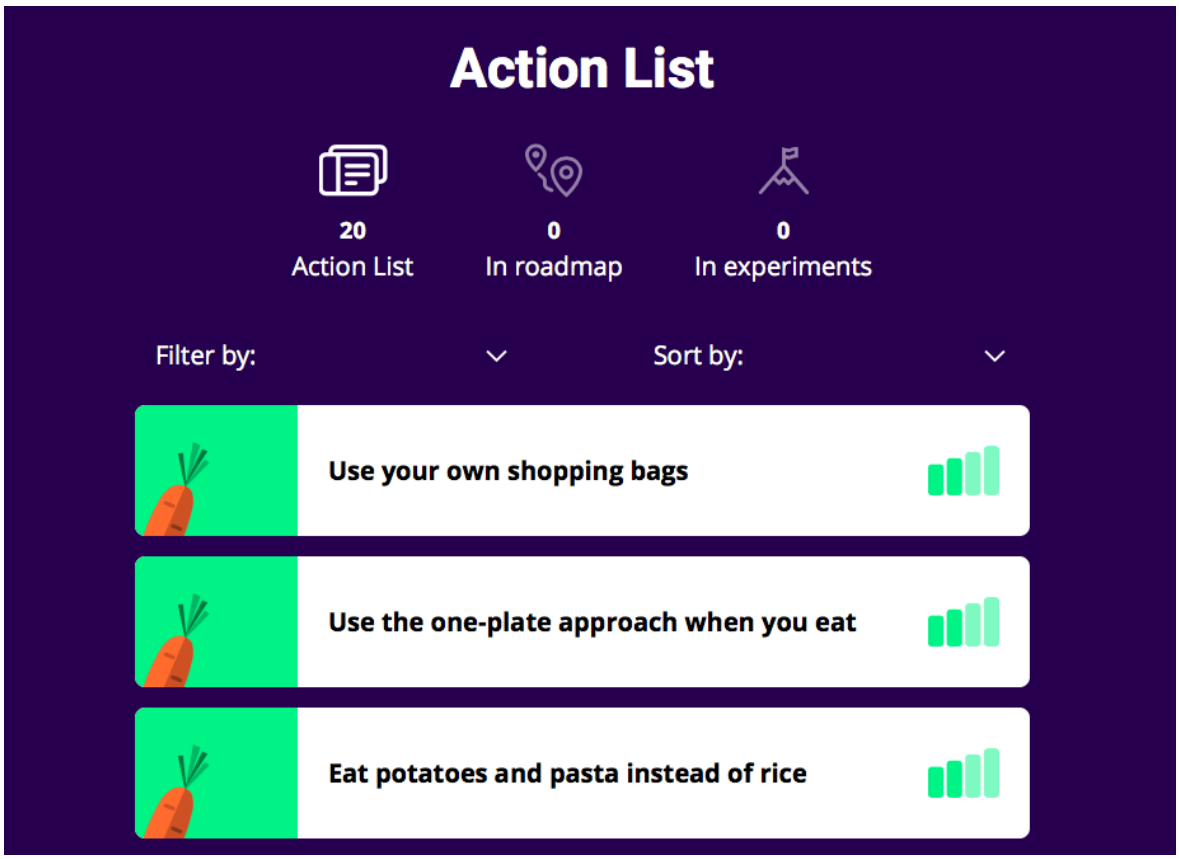

Figure 15: Action list

Out of those interviewees who got to view the actions, some felt that they were too vague and general, and would have wished for more detail and personalization. Then again, some interviewees preferred for the actions to be rather simple in order for them to be easily implementable for the user so that the changes would maybe become actual habits in the long term. One interviewee also wished for more elaborate explanations on why the actions are more sustainable alternatives compared to their current habits in order to motivate them to keep doing a specific action. They felt that increased amount of information would make the calculator more interesting to use and provide the user more reasons and more in-depth knowledge about the subject in order to continuously return to it. Moreover, they craved for some kind of deeper engagement with the calculator to get a feeling that they have truly set themselves a challenge, such as leaving meat out of their diet. Then again, for some interviewees, the actions were perceived as clear, simple and rational. The fact that the actions show how much the carbon footprint drops by implementing them to the user's everyday life (Figure 16) was also seen as a nice feature. Unfortunately, there were no comments regarding the experiment function, which offered the users to try out the different actions for one, two or three months (Figure 17).

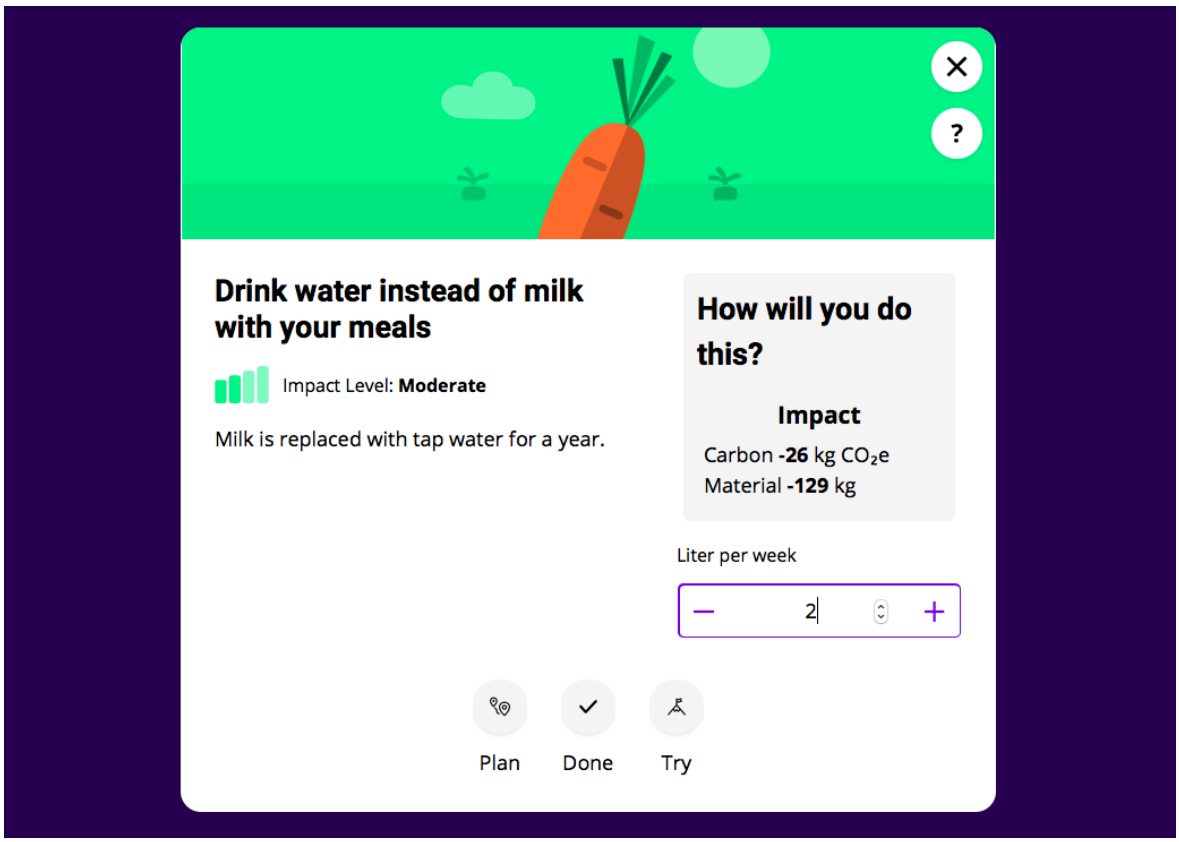

Figure 16: Details of an action

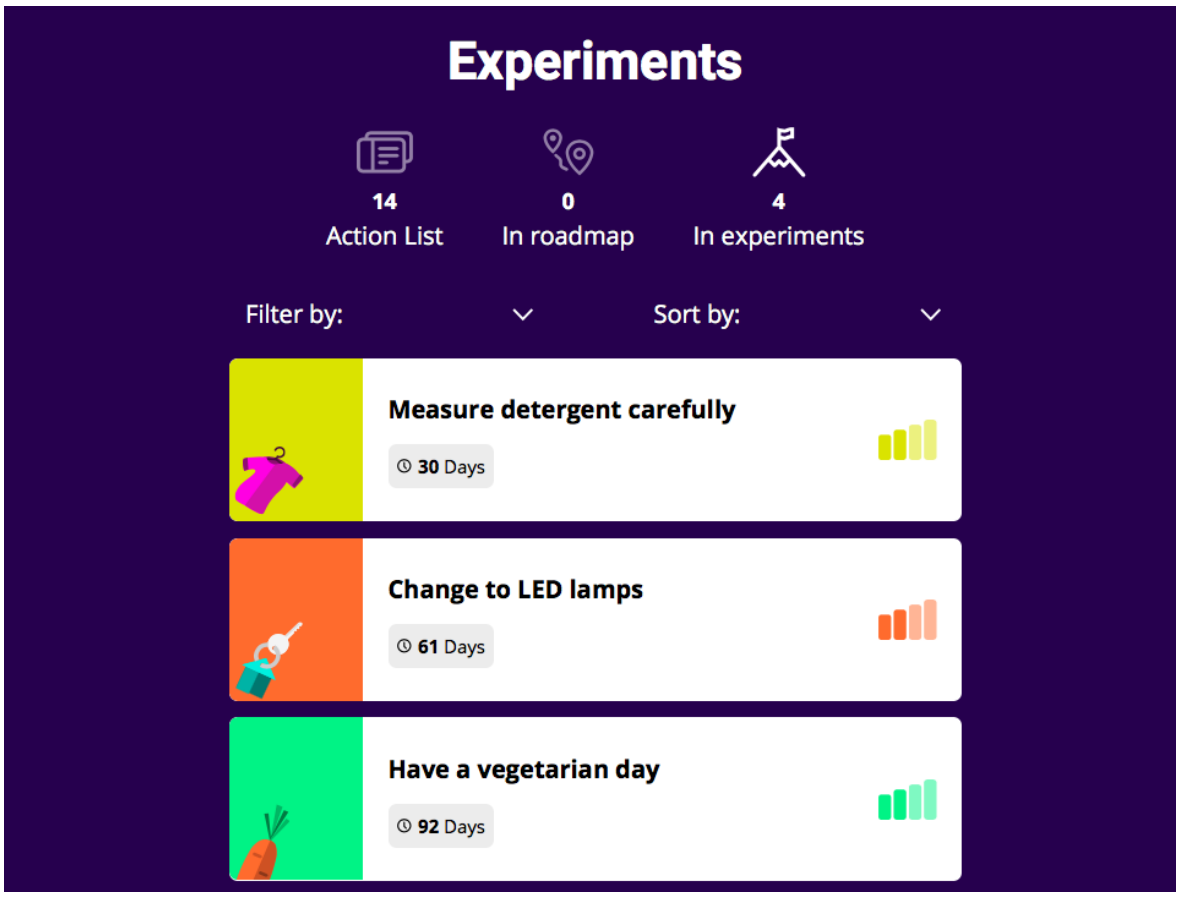

Figure 17: Experiments

One suggested solution for making the calculator more engaging was to implement some sort of gamifying aspects to it that would make the user repeatedly return to it. Another idea that would increase the users' interest towards implementing the actions and getting more out of the calculator in overall would include having some local companies as part of the actions. In other words, by having concrete solution providers for e.g. repairing broken shoes or clothing. In addition to companies, the actions could include some kind of a rating system and comment section where the users could discuss how they implemented a specific action into their everyday life and if they have any tips or thoughts for others. The interviewees seemed to have to some extent a need for some type of a user community where the users could share knowledge and experiences with each other.

4.4 Feedback delivery method

Most of the interviewees said they would like to receive some sort of notifications or guidance on how to reduce their carbon footprint. This thought was based on the idea of further developing the calculator so that it would be able to collect real consumption data from its user e.g. via their credit card purchases. Therefore, also the notifications or guidance would be based on their actual consumption data. One person even described such calculator as follows:

"Like there are Siris and Alexas etc. then it would be sort of a personal assistant to a sustainable life."

Interviewee 7

Except for one interviewee, who mentioned not being the target group for applications in overall and was not interested in using the calculator that frequently in their daily life, most interviewees liked the idea of receiving notifications and felt that it would bring more to the calculator and also remind to use it and revisit the actions the user had planned to implement. However, in order to willingly get notifications, the interviewees had clear criteria for them. The notifications should be highly personalized, realistic and time-bound, meaning that the user could either choose the topics themselves or the notifications would be very tightly related to their actual consumption data. In addition, the tone of the notifications should not be too aggressive or shaming, but more encouraging and framed positively.

"If it some kind of a tracking functionality then I would be a lot more interested in it."

Interviewee 4

On the other hand, one interviewee felt that too much of personalization could be also bad for the user. In case the user gets to decide what the notifications are related to, they might close their eyes from some domains that they would most benefit of making changes in. Then again, another interviewee saw personalization as an opportunity to really focus on the domains that the user is personally interested in and once they get started with changing their behavior on one domain, maybe later on start paying attention also to the domains that they do not feel so comfortable with.

4.5 Feedback timing

When using SUSLA, the users receive their carbon and material footprints in addition to other feedback immediately after filling in the questionnaire. The feedback from the footprints is provided right away and only once. If the user wants to keep their results, they need to create an account. Otherwise, the results will disappear and they have to answer the questionnaire again if they end up revisiting the website.

The scope of when to receive the feedback varied to some extent as many interviewees mentioned the frequency or timing of the feedback when discussing their own ideas for the calculator. For one interviewee, the best possible timing for the feedback would be literally on the second they are making a decision, e.g. in a grocery store when they are about to choose an unsustainable product. The idea was that they would immediately receive some kind of feedback from the calculator regarding their purchase so that they could react to the feedback and make the decision to not buy the product.

"If you think that 2030 was the target year then it should be such that it is directional when it comes to decision making, for example in a store when you are grabbing a light bulb, it gives you an electric shock or starts screaming 'Keep your hands off, you were supposed to take the other ones!'"

Interviewee 9

Another interviewee said they would like to get approximately daily feedback on their daily actions as some kind of a notification on their phone or to be able to follow their

carbon footprint from e.g. widgets that are available on at least most Android smart phones. In fact, many users were more interested in knowing their daily or weekly carbon footprint to better see how their daily and weekly actions affect their footprint through some sort of notifications in order to better understand the effects of their daily life. Receiving only one comprehensive feedback after filling in the questionnaire felt too abstract to understand what daily routines actually cause their yearly footprint.

When discussing notifications more thoroughly with the interviewees, their ideas included getting some kind of weekly tips and frequent reminders for using and updating the calculator based on the user's chosen actions or just simply their weekly carbon footprint broken apart into the five different domains. In any case, the notifications should occur frequently, as the yearly footprint was too vague in order to understand the effect of their daily and weekly habits.

4.6 Additional thoughts on SUSLA

This section discovers all other relevant aspects regarding the calculator use and its UX that the interviewees talked about which didn't fit well enough under the headings of the analytical framework.

4.6.1 Calculator interface and visual appearance

Regarding navigation, some users wished for it to be clearer as they had problems in going from one place to another. For example, for one interviewee, the actions they had already done were difficult to find again. In addition, when filling in the questionnaire, if the user went back to a previous question their answers got deleted and they had to do it again. Moreover, once completed with the questions, if the user wanted to change some of their answers, they had to reset their whole footprint by starting from the very beginning and complete the questionnaire again. However, in overall, most users found using and navigating in SUSLA a rather easy experience. Most of the users were more positively surprised by the calculator and its features, especially as they knew it was still in the development phase. In addition, the more the users tested the calculator, the more familiar they became with the interface and the easier it was for them to use it.

"In my opinion it was rather easy to use."

Interviewee 4

What comes to the visual image of SUSLA, some users wished for more animations or images, whereas others thought it was bright enough with its current ones. One interviewee thought the different icons were a cute addition and made the calculator more approachable, where another felt that they could've been more interesting and that in the actions section the icons should've matched a specific action better (Figure 18) as currently there is only five icons, one for each domain. Someone even thought that the carrot icons were annoying. What's more, the color scheme received quite divided opinions. Most users felt that the purple background color was too dark and some users described it even heavy, boring, bland and intimidating or aggressive. Some also thought that it didn't match with the sustainability theme. All in all, although the color didn't please some of the users, they still thought that in overall the calculator was simple and even stylish. However, those who didn't criticize the background mainly didn't care of the colors that much or thought that the color was beautiful. Although dark, those who liked the color felt that it was still nice and didn't take anything away from the calculator. One interviewee even said they usually prefer darker color schemes as the lighter ones hurt their eyes. Therefore, they felt the overall look was clear and readable.

"In my opinion, it was visually nice. – The color was a very beautiful purple."
Interviewee 3

"Maybe something more fresh, but it (color) wasn't bad though."
Interviewee 2

Figure 18: Actions with different icons

In overall, a more consistent and easier navigation was wished for in addition to some general guidance on where and on what stage the user is in the calculator e.g. when filling in the questionnaire. One of the interviewees suggested having more visual indicators to clarify the navigation and to better tie together the different stages of the questionnaire, actions, experiments and the roadmap, and their function at each stage. In other words, the user hoped to be guided better when they are moving from e.g. the first step to the second step. Other remarks were related to the roadmap, which was hoped to be clearer and contain more colors. One interviewee hoped for the roadmap to be visualized in a different way (not downwards going) and for the different domains to be visualized better with different colors. On the questionnaire side, one interviewee would have wished for more automation in a way that when selecting the answer, there would be no need to click the next-button, but the page would move on to the following question automatically. What comes to the colors of the calculator, a couple of interviewees suggested having a green background to fit with the sustainability theme. There were also multiple wishes for a lighter color scheme in general or the possibility to choose between a darker or a lighter background, or even a specific color. One interviewee proposed the idea of having different colors behind the different domains in order to indicate the shift from one domain to the next one.

4.6.2 Trust and credibility

There was a rather clear divide in the test group regarding trust towards the calculator and its results. Especially those who personally knew some of the company employees had

stronger trust towards the calculation methods and results. The trust was based on the users knowing that professionals who have educated themselves regarding the topics of carbon footprint and calculators have been part of the project group providing the SUSLA calculator. All in all, the interviewees were mainly not concerned with their privacy when using the calculator and feeding their (consumption) information. Some who first were a bit cautious changed their mind rather quickly when thinking further on e.g. what Google already knows about them.

"Then again, nowadays you do trust all sort of applications. There is already so much ongoing tracking that I guess I wouldn't mind if there would be even more of it."
Interviewee 4

What comes to the carbon footprint itself, most interviewees who had tried a CFC before and remembered the details of it, got a bigger footprint from SUSLA than the ones they had used before. Some weren't bothered by this as the previous calculators hadn't been that comprehensive, whereas some felt that there must be something wrong with SUSLA for giving a lot bigger footprint and hence heavily questioned the accuracy of the results. Moreover, one respondent criticized the inaccuracy of the average -function. On their first try, their carbon footprint had been much larger when selecting the average option for electricity consumption when compared to their second try with the actual consumption. They felt this was a rather radical solution as it can affect the overall carbon footprint quite a bit. Related to the topic, another interviewee disliked the grouping of apartment building years (Figure 19), as it felt too general and simplifying to them.

"The apartment where I live is built in -78 and the gap the application has was from -36 to -79, so my apartment goes to the same category as the ones built in the 30's. – It (SUSLA) can never be thought of as completely accurate (or) trustworthy."
Interviewee 4

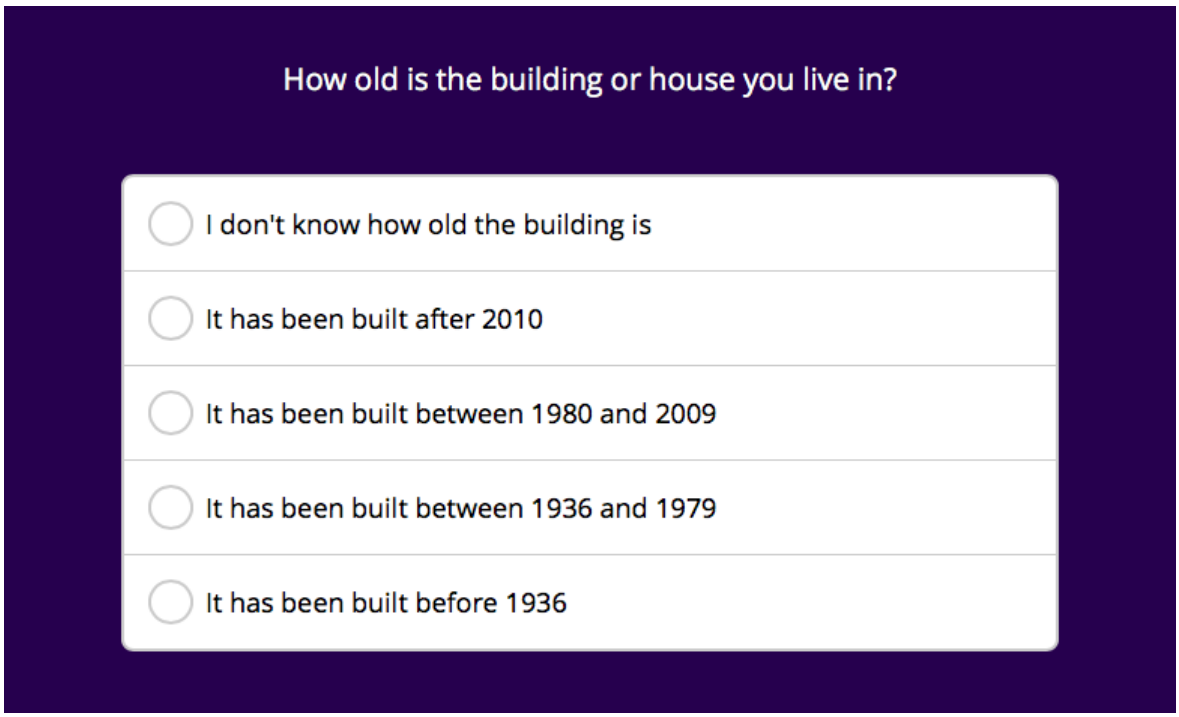

Figure 19: Selecting the age for a house or building

Ideas that would increase the interviewees trust and reliability towards both the calculator provider and the results would include links to some external resources where the user could find more information on e.g. the calculator provider, the calculation methods and research on what the results are based on. Another more direct way to provide and present information to the user would be some kind of a pop-up screen that would appear immediately when entering the calculator. All in all, more transparency and clarification was requested especially regarding the calculations of the carbon footprint. Many interviewees felt that this was rather relevant information that was for some reason missing from the calculator. Some users also would have wished for some sort of certification or other externally achieved proof of reliability for the calculator. In overall, better justification was seen as a way to make the calculator become more trustworthy.

4.6.3 Frequency of use

The interviewees were asked how frequently they would like to use the calculator, if at all, in its current form. To start with, none of the interviewees were interested in answering the calculator's questionnaire from scratch daily, weekly or some even monthly. Apparently, at the moment, most users felt that SUSLA lacks such aspects that would make it nice and convenient to use e.g. on a weekly basis. They did not think that it provides enough material in order to be used frequently.

For some interviewees the calculator was mainly such a tool that they enjoyed using only once, rather than something they would consider using in the long term to achieve a more sustainable lifestyle. Reasons for such thoughts varied. For one of the interviewees, the subject was already familiar through their studies and they felt that their level of awareness was already quite high. Hence, they found no use for the calculator. Another interviewee said that once completed with the calculations and scrolling through the results and actions, they felt that the calculator didn't have anything more to give. Meaning that they couldn't find any further use for it and it didn't provide any further informational content to them. On the other hand, some interviewees who had not used such a calculator beforehand said they became more curios on the topic after completing the questionnaire and seeing their footprint. Moreover, one user felt that the results pushed them to think if they should really start acting more sustainably. However, neither of these interviewees still saw themselves using the calculator any frequently or consistently than the other interviewees.

"It could be taken easily into use for a couple of weeks, but in order to take it into frequent use then it would already maybe require a bit more functionalities than what it currently has."

Interviewee 4

4.6.4 Comparison with the Climate Puzzle

A few interviewees had previously experienced with the puzzle version of SUSLA, i.e. the Climate Puzzle, and were asked to compare it to the digital tool, providing pros and cons from both experiences. To start with, the puzzle got positive feedback for being able to more concretely present the effect of the different actions and the player's overall situation. One of the reasons for this was that the size of a single puzzle piece reflects the size of its carbon footprint. In addition, the planning possibility in the puzzle was a very liked functionality, as it gives the possibility to plan all chosen actions to be done in the future, between now and 2030, which the digital version lacks. Although SUSLA also has a roadmap, it does not function in a way that the user cannot plan to implement an action during a specific year (Figure 20). Last but not least, the puzzle enables communicating and socializing with other participants as it is used in groups in addition to being a very physical experience.

”And then the puzzle’s appearance is visually beautiful and it is in a way nice to play and it is nice to fiddle with the pieces, the physical experience in it is also pleasant.”

Interviewee 8

“You can’t plan to do something in 2025”

Interviewee 6

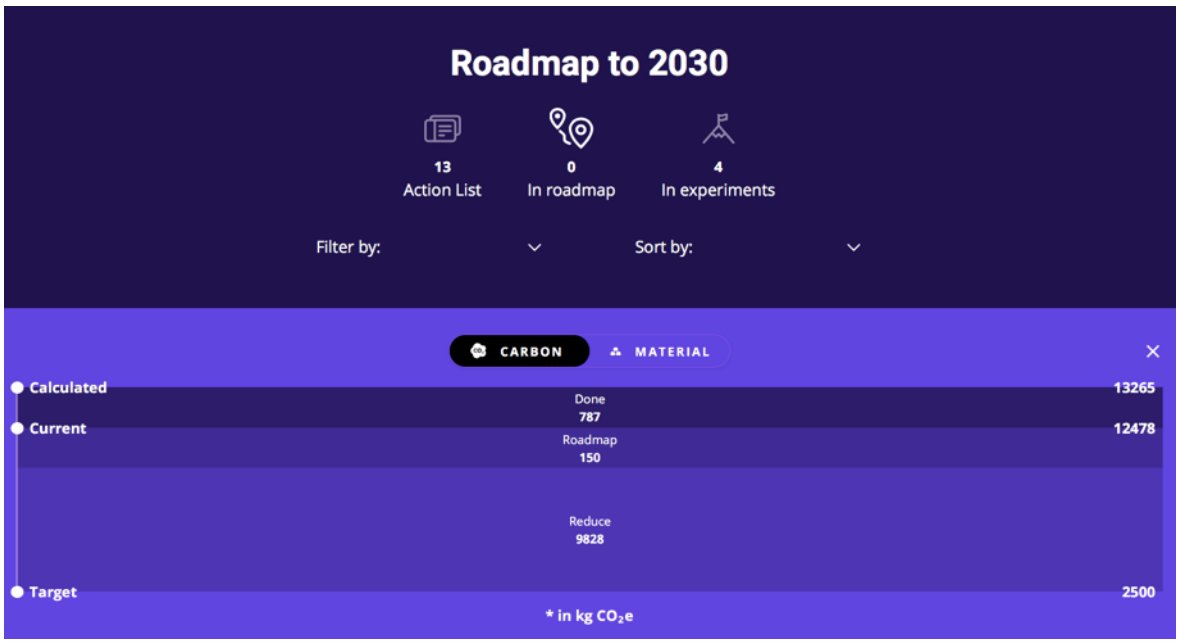

Figure 20: SUSLA roadmap

Then again, the digital calculator was said to be faster to use and it has no need for external facilitation of the testing situation, which the puzzle requires. Hence, it is much more convenient to use, carry and return to for the users. Moreover, the user could better define when they are done with the test, whereas with the puzzle the pieces can be changed and shifted for as long as they simply wish to. In addition, the digital version got good feedback on how it shows immediately the reduction in one’s carbon footprint when choosing an action and marking it as Done. As someone mentioned, the digital tool suits better individuals whereas the puzzle is nice for educating groups.

“Surely the digital one is easier.”

Interviewee 10

All in all, the interviewees preferred the digital tool for more consistent and individual use. However, many of them wished for some of the features of the puzzle to be implemented also into the digital version. One of the ideas was related to the planning phase, as in the puzzle the player can choose from multiple different actions the ones they will implement in order to reach their carbon footprint goal by 2030, i.e. reduce their carbon footprint to 2,5 tons. After choosing the actions, they will then set them on a timeline and decide when they will implement them in real life. Neither of these features can be seen in the digital version and one of the wishes was to be able to do such analysis and planning also on the digital platform. One of the interviewees even mentioned copying the puzzle as far as making the digital one look like the puzzle and enabling the user to drag the actions -pieces on a computer screen.

5 Discussion

In this thesis the goal was to gain insights on the test users' UX with the SUSLA carbon footprint tool and better understand what the tool currently succeeds in, is still lacking of and what the users expect and want from it altogether. Through these themes the aim was to shed light on how the UX of a CFC could be used to build better tools that succeed in both increasing its user's awareness and shifting their behavior towards more environmentally friendly habits in addition to increasing their commitment to following these habits. Therefore, this section will further discuss and analyze the previously presented interview data from the test user interviews. Specifically related to the case study calculator, the study also provides appropriate design implications that are based on existing research and the data from the case study interviewees. The design implications do not take into account financial, timely or legal restrictions. The main themes that arose during the interviews revolve around different pain-points the users had while testing the calculator in addition to solutions that would potentially make using the tool easier, more enjoyable and the results more accurate. When analyzing the interview material, i.e. the UXs the interviewees had, it is important to return to the research question in order to keep the focus of the study.

How can UX be used to increase user commitment and shift behavior towards a more sustainable lifestyle and decisions?

Regarding the current state of user commitment of the SUSLA test users, the results do not seem to indicate a strong interest towards continuous use. Although the actual use of the calculator was perceived rather smooth and easy, there seems to be a very low commitment among the test users which in turn damages the overall objective of shifting their behavior towards a more sustainable direction. Hence, the results suggest that the UX with SUSLA has not been completely successful. However, although a UX wouldn't be perfect, a user who is more persistent in using the application can become better at utilizing it by time (Goodhue & Thompson, 1995). Nevertheless, this should definitely not be the mindset when designing a product or service (Garrett, 2011). In overall, SUSLA doesn't seem to be able to completely fulfill some of the basic requirements for a pleasant UX. Therefore, revisiting the principles of a successful UX, such as user needs and

expectations and goals which were also discussed in the literature review, is essential in order to go on a more detailed level with the calculator's UX analysis.

What comes to the user needs and expectations, based on the interviews, the SUSLA calculator is not successfully meeting all needs and expectations that the users have. Currently, it provides a one-time calculation to discover one's carbon and material footprints in addition to giving somewhat relevant suggestions on how to reduce them. This doesn't necessarily disappoint the users, but very clearly there is room for improvement as most of the users seem to want a more comprehensive and continuous tool to be used. Based on the interviews, the following general assumptions related to needs and expectations can be made from the test users as a whole:

Table 4: SUSLA users' needs and expectations

User expectations and needs	Example
User expectations: Get access to more detailed and extensive data regarding the user's footprints.	*Average weekly consumption of cheese is 1,25 kg. Your cheese consumption causes the biggest footprint in your diet and when compared to an average Finnish consumer, it is 32 % higher.*
User needs: Receive more personalized and timely content that is based on the user's actual consumption data.	*This week you have consumed 500 g more cheese than you do on average. Check our suggestions for replacing cheese in every-day cooking for different meals throughout the day!*

In order for the calculator to better match with these user needs and expectations, they need to be further analyzed in order to enhance the existing functionalities of the calculator and to implement new ways how to answer user needs and expectations. In other words, the overall utility of the calculator should be improved and made more suitable for the users in order to increase the overall usefulness of the tool. Especially when the calculator's usability seems to fulfill the basic needs, as it didn't receive that much negative attention from the users, its utility appears to be the more critical factor in improving the overall UX.

The overall goal for most of the test users is to better understand how big their carbon footprint is, what it comprises of and how to decrease it. However, all test users didn't identify with each of the aforementioned user goals, but in general the three goals sum up the main end results the test users were looking for from using SUSLA. Moreover, different users were also expecting to achieve the goals in different scope, as some were looking for lighter guidance.

5.1 Data collection

Based on the interviews, the kind of calculator the test users want to use is such that provides the user everything they are looking for in their consumption data. In other words, they want to access all of their consumption data from one source. A single calculator that collects the data for the user from reliable and relevant sources was the ideal tool regarding both data collection and type. Being able to access this kind of a calculator seemed to be one of the main drivers behind increased interest and potentially more frequent use of such tool. Going on a more detailed level with the data type and collection, the main problems in SUSLA are the amount of time spent on individual questions in addition to trying to come up with the most accurate answer. These problems seem to stem from the changing time span in the questionnaire and too precise questions. In other words, the questionnaire seems to lack consistency and clarity that would enable seamless and efficient answering.

Regarding the chancing time span, based on the interviews a week seems to be a time span that is the easiest to assess for most, as the user still remembers quite well what they have done and what has happened during the week, e.g. how much different type of trash has built up. Month, on the other hand, can be a very difficult time span to estimate such often occurring tasks. Then again, if asked about the amount of flying and buying clothes that has occurred during one week, many users would most likely end up answering zero if they typically travel once a year and buy new clothing once a month. Therefore, suggesting to use only one expression of time would be ideal, but rather problematic. When aiming to formulate the questions so that they best serve the majority, i.e. the average user or citizen, the questions do seem to require different time spans in order for the user to be able to answer the questions accurately enough. As there is high variety in peoples' habits depending on e.g. whether they live alone or with a family, finding the balance for some questions might be very difficult and making compromises is mandatory. Hence, finding a solution to the problem requires more extensive research in addition to more thorough

understanding on the calculation method behind the questions in order to provide realistic and useful suggestions.

However, related to both too high detailedness and time span of the questions, these problems could partially be solved with the integration ideas the interviewees suggested. The main idea behind the feature was to make the data collection easier, more accurate and in general more automated. This would fit well with the user needs, as for the users to actually use the calculator, its use has to be as simple and effortless as possible. This means that using it shouldn't take a lot of time, as the more its use requires time, the less likely the users are to become permanent and consistent users. If the use becomes too straining or time consuming, the chances are that the user will sooner or later give up with using the calculator altogether, which became rather clear from the interviews, especially when it comes to filling in the calculator questionnaire. Therefore, the calculator should be as automated as possible. All sort of filling in of data should be minimized in order to avoid mistakes that could arise from the user's misinterpretations in addition to minimizing time used for the calculator.

Partnering with different organizations could be very beneficial, especially when it comes to bigger operators who have larger market shares. This could include food stores e.g. Kesko and S-group, electricity providers, different kind of transportation providers and other service providers that are relevant for the calculator. If it would be capable of collecting the data independently of all required sources that the user gives their permission to, it would shorten and possibly also clarify the questionnaire. Then again, questions related to the different amounts of trash produced can be difficult to answer in other ways than the user typing it in manually. Therefore, alternative solutions for including such questions in the tool should be discovered or alternatively, such questions should be left out completely. In addition, putting the time and effort to integrate the calculator to different service providers wouldn't pay off it the calculator wouldn't turn into an application that aims to frequently collect data from its users.

Moreover, integrating the calculator to outside sources also has its own risks. When the data comes from outside the calculator provider, the calculation technique might, or even will, be very different based on who provides the data, what the data is and how comprehensive it is. Some calculations might require a lot of background information in order to be accurate enough and if the data comes from an outside source, the calculator providers might not be able to know what the data consists of. Therefore, accessing data from multiple different sources could make the calculations even more inaccurate and

incomparable amongst each other. In addition, with such decisions, the privacy protection of the calculator should be very strong as it would hold huge amounts of very personal and detailed information of its users. Assuring that the user data will not be mistreated in any circumstances and that it would be stored appropriately is vital, especially if the data would be handled between different companies. Hence, analyzing thoroughly the risks behind the approach should be done before making any further decisions. However, at least the test users were rather eager to give the calculator access to their personal information and the lack of trust was based more on the fact that only a couple of interviewees knew anything about the calculator providers. For those who didn't personally find out what the organizations behind SUSLA were had clearly lack of trust towards it and wondered to whom their information would end up to. Therefore, the data collection in itself doesn't seem to be the problem, but rather the lack and confusion towards who would be processing and using it. The problem, however, is easy to overcome by providing enough background information to the users and by so making the calculator use more transparent.

5.1.1 Design implication: Transform SUSLA into an application

In its current form, the calculator most likely will not be able to provide its users the features they are looking for, such as notifications, at least not in the best possible way. In addition to being somewhat inconvenient, expecting the users to update their actions on a website doesn't seem to match with the functionalities that the users are looking for in SUSLA. Although some improvements can be implemented easily also to the browser version, the future of the calculator should definitely be in a downloadable version as an application that is easily accessible for all users from their smart phones and other devices.

5.1.2 Design implication: Integrate SUSLA with other service providers

Cooperate with relevant service providers from different fields in order to collect user data on their consumption habits. Potential partners could include supermarket chains, electricity providers, transportation providers or even banks. In the beginning, the focus could be more on the bigger companies in order to see how the integration starts working, after which smaller and more local companies could also be included. Such functionality provides the user insights on their actual consumption habits and its effects on their carbon footprint. At its best, the integration could allow for the users to track their consumption almost in real time and see how their carbon footprint builds up during the year. Moreover, this would allow for the users to see how different service providers affect their footprint.

What comes to the domains, the current existing ones are function well for categorizing different consumption data. In addition, the users' consumption data could be categorized based on the Footprinting test's questions and those that do not fit under any of the existing questions or categories could go under the category of 'other'. However, in order to get as exhaustive as possible categorizing, currently missing consumption should be included in the categories, such as pets. Moreover, to implement the integration legally, relevant laws should first be studied regarding the integration possibilities. the user needs to be first requested for their permission on handling their data.

5.2 Feedback

Based on the test user opinions, it is clear that SUSLA doesn't provide enough content and information to its users in its current form. The feedback satisfies them to some extent, but the users are left wanting more thorough consumption data in addition to more personalized tips and functionalities on how to shift their behavior. It even seems like the users want the tool to support them on their decision making and become some sort of a digital guide who helps them in the transition to a more sustainable lifestyle. The results could be interpreted as a sign of having a need for more profound help in shifting their behavior and that vague results and suggestion for behavior change aren't enough for the users. The current feedback doesn't push them to actually make a change, although the feedback SUSLA provides technically does give the base for changing behavior. Nevertheless, the users do not seem to be satisfied with the current version but instead want something more from the calculator.

When discussing the feedback on a more detailed level, the presentation of the carbon footprint and related data in its current form provides the user approximately what they expected to receive, but there is a need for more comprehensive results and data visualization. For many, the calculator is perceived as a larger source of information and the user needs and expectations go much further than just receiving their carbon footprint and different suggestions on how they can reduce it. They perceive the calculator as a tool to educate themselves and the users want more extensive information on sustainable lifestyles in general. In addition, they want to be able to break their carbon footprint into more detail, not just the existing five domains, and learn what it actually consists of. For some users, this went as far as getting access to the actual calculation data.

What comes to the material, carbon and national footprints, presenting data in an understandable way especially for such a large variety of users can be very difficult

(Gemignani et al., 2014). Some of the interviewees found different kinds of graphs a useful option in addition to the current presentation, which doesn't come as a surprise as visualizing the data can decrease the user's cognitive overload compared to e.g. a list of different numbers (Döbler & Großmann, 2020). When using suitable graphs for certain type of data, they can enormously increase and ease the interpretation of the data. In addition, graphs enable comparing results more conveniently. Especially if the actions could be integrated to the graphs, the user would be able to easily see how their carbon footprint is shifting based on the changes they implement. What's more, such feature would bring a new way of tracking for the users and could potentially get them to use the calculator more frequently.

Other forms of expressing the results are also needed in order to take better into account the large target group. According to Fischer (2008), who studied research on household electricity consumption, having multiple feedback options results more likely on behavior change. Therefore, in addition to graphs, offering the users a more thorough version of the footprint data could give them more advanced insights on their consumption and behavior. For example, providing the option of selecting a specific domain and being able to access its data more comprehensively. This type of an approach of breaking down the data to a more detailed level was also found successful (Fischer, 2008). In the mobility domain this could mean that it is separated into kilometers and emissions that come from car driving, flying, public transportation etc. All in all, for the users to be able to better understand what are their most critical unsustainable habits, they must be given comprehensive insights in a way that are easy to understand and get a grasp of.

What comes to the national footprints, they seem to give a good perception to the users on a larger scale. According to research, social aspects in feedback that tie the individual user into a bigger group of people result in longer commitment (Allcott & Rogers, 2014), such as comparing the individuals carbon footprint to national average. With SUSLA, none of the test users found the national averages to be of very high importance to them, they just perceived it as a nice addition to see how the rest of the world consumes in contrast to their personal footprint and the Finnish national footprint. Nevertheless, it seemed to be one of the aspects that succeeded rather well as it got mainly positive feedback and led the users to analyze their footprints on a larger scale.

One of the aspects that the interviewees talked about but what thus far lacks from the calculator, is some kind of a thought sharing platform. Such feature would enable the users to discuss the actions, their personal goals and sustainability in overall. In addition, some

sort of a community aspect could also make the calculator more interesting, as it would bring a social aspect to its use and provide the users peer support. This is also supported by Lin (2017), who suggests implementing some kind of a social platform in order for users to share their experiences and discuss the subject. Such platform could be integrated in many different ways and could also be seen as an additional source of information, as the users could then share knowledge with each other, depending on how the functionality would be implemented to the platform. On the other hand, a social platform would require constant administration in order to avoid hate speech and other negative effects that typically come along with such platforms. Moreover, the more versatile communication methods the platform would allow, the more difficult its administration would also become. Therefore, implementing a social platform on the calculator depends on what type of resources the calculator providers have regarding administration.

What comes to the actions, what is interesting in SUSLA is that although it goes further than typical CFCs by guiding its user with different personalized suggestions that are good for the environment, this functionality doesn't seem to completely satisfy the users but instead create a new need for them. It seems that this functionality doesn't live up to its expectations in its current form, although it is much more than the average CFC provides its user. This scenario raises an interesting thought on whether the calculator's UX would actually be more successful without the actions, as then it wouldn't be one of the functionalities that disappoints the users. Although the actions were sort of a surprise element in the calculator and most users didn't have any expectations towards them as they didn't know about their existence, some of the users were still left disappointed once they came across them and most users had clear ideas on how to further improve them. This phenomena is most likely related to the fact that each additional task, step or function always adds a new chance for failure in UX (Garrett, 2011). Therefore, the function of the actions to the users should be revisited and analyzed in order to provide them to the users in the most utilizable way. One suggestion from the interviewees was to access the actions through notifications. In case receiving notifications would be voluntary, as they typically are in applications, their existence could make the role of the actions more interactive especially if the user could choose when and what they want to be notified of. However, the content and the tone of the notifications should be analyzed very thoroughly, as the way of e.g. sending reminders of implementing the actions can go easily wrong if the tone of the reminder is too oppressive or negative. In addition, as the target group is so wide, choosing such tone that best suits the whole target group can become very difficult. For

example, a younger audience might enjoy a more modern, friendly and personal way of approaching, whereas the older audience might find this forbidding or weird.

5.2.1 Design implication: Add more versatile and thorough content

In order to give the calculator users a clear and more thorough image of what their carbon and material footprints consists of, provide them the possibility to view their data more diversely and thoroughly. Enable the users to see the data behind each domain in order to pinpoint their most unsustainable habits. This can be done by e.g. showing them the carbon and material footprint for each individual domain question in order to be able to see what habits mainly affect their footprints. In addition, provide graphs for those who want to see their data in some other form as numbers. Graphs are an easy way to visualize one's consumption in addition to comparing it to e.g. national averages or other countries. In its current form, the calculator could provide at least one graph per domain. Moreover, with the help of the integration, the user could compare their data e.g. from one week to the previous one and see how their consumption has changed between different domains.

For users to find the calculator interesting, it should always provide them something new when they visit it: Data on their current consumption, educative or entertaining content on sustainability themes, new actions or even completely new features in the calculator. Including educational videos and text posts will bring more versatile and informative content to the calculator. The stories could include topical information, such as tips for reducing the amount of trash, explaining the differences between alternative energy forms or even interviews with experts on specific sustainability topics. Flo, a period application designed for women, gives a great example of this type of content. They provide its user relevant, timely and versatile content on periods and women's health in general (Figure 21). They have both educational videos in addition to articles on specific themes, such as hacks for dealing with period pain. SUSLA could also provide its users similar type of content within topics related to sustainability.

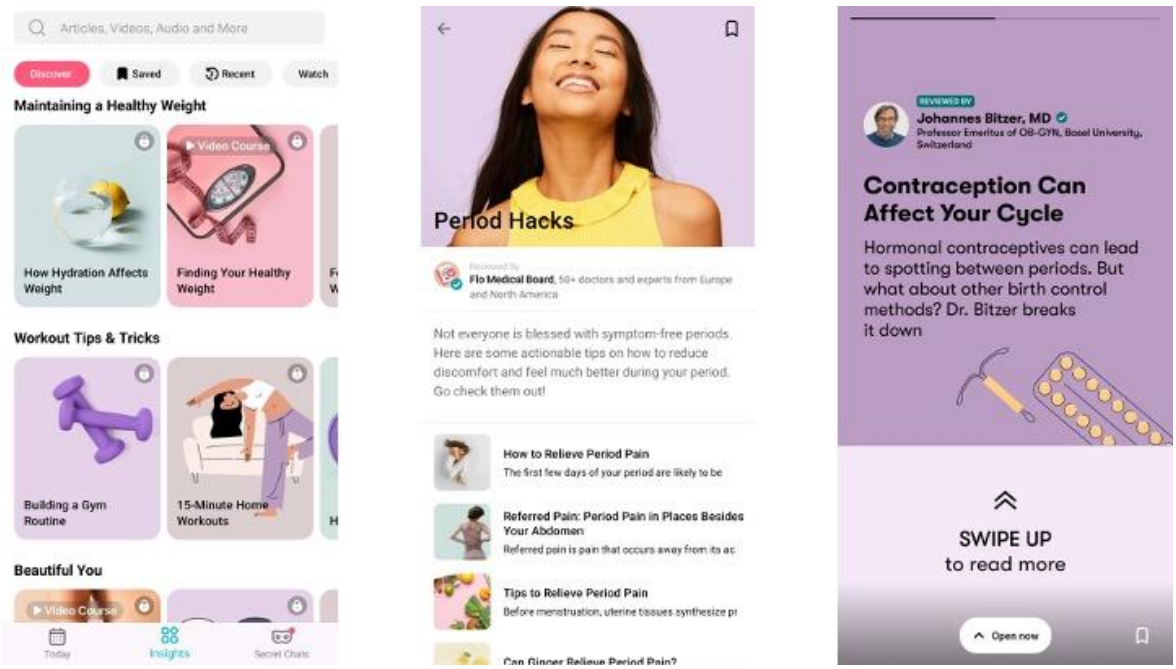

Figure 21: Screenshots from the Flo application insights, topical articles and short stories

Another way to bring more content is to cooperate with different organizations and stakeholders and provide the calculator users seasonal offers. The offers could include discounts for e.g. changing to greener energy or using rental cars. Seasonal or limited time discounts would also bring more varying and timely content to the calculator and potentially get its users to revisit it more frequently. This could also provide a financial incentive to using the calculator in addition to being a good marketing strategy for SUSLA, if SUSLA and the participating companies were to promote each other on their behalf regarding their partnerships.

5.2.2 Design implication: Implement notifications

Implement notifications into the calculator so that the user can further customize their experience. The content and frequency of the notifications should be rather broad so that the user can better personalize the product for their needs and preferences. The notifications should include at least frequent reminders on actions the user themselves has chosen to get reminders of e.g. decreasing the amount of meat and dairy products. The user should be able to decide when and how frequently they want to get notifications as some actions can be very time-bound, whereas for others the timing isn't that vital. They should be able to decide both the time and date when they personally prefer to receive the notifications, such as in alarms and reminders that most smart phones have. The timing of the notification should also be available as a random-option so that the calculator itself

decides when the user will be notified. However, this should not be during the night time, as it is a rather inconvenient time to receive notifications.

For those who wish to, the tool should also be able to produce real time notifications on e.g. the user's purchases or transportation kilometers in order to provide immediate feedback on their actions, which could be possible through integration with different service providers. The notifications could include e.g. the material and carbon footprint of their supermarket purchases or kilometers travelled with a car. In order to better understand the impact, the material and carbon footprints could be compared either to the user's previous similar consumption or to national averages. All in all, in a nutshell, the user gets to decide what they will be notified of, when they will be notified and how frequently.

However, as everyone will not be interested in customizing their notifications, the calculator should also have preset notifications. It should be able to automatically create such notifications that are relevant for the user and are delivered in an appropriate time. Once again, the notifications could consist of the actions that are suggested for the user based on their footprint calculation. The frequency of the notifications should depend on the action itself that the user is being notified of, as not all actions require multiple notifications. For example, diet related actions can be notified of more frequently than moving to a smaller apartment. Here are a few concrete examples of what the preset notifications could be like on smart phones:

Table 5: Examples of preset notifications for SUSLA

Examples of SUSLA notifications
8.00 AM SUSLA: Have you ever been on a vegetarian diet? Give it a try this week for three days and see for yourself how it feels!
8.30 AM SUSLA: The amount of food waste can be decreased by avoiding impulse purchases and planning meals in advance. This week, aim to plan your groceries beforehand and stick to your list when shopping.
7.00 PM SUSLA: Did you know that electricity consumption can be reduced up to X % simply by changing to LED lamps?

Moreover, as there will also be users who do not want to receive any type of notifications, declining of receiving them has to also be an option. In case some of the other design implications will be utilized for the calculator, they can also provide content for notifications. For example, if the calculator will provide information on sustainability more thoroughly, the notifications could include short trivia related to sustainability themes or new topics that are being introduced in the calculator.

5.3 Visual design

Although the overall appearance of SUSLA was seen as clear and modern, the purple background received both positive and negative feedback. It doesn't come as a surprise that some users suggested green as the new main color for the calculator, as green is typically associated with e.g. nature and is used by brands that identify as environmentally friendly (Marshall, 2021). Purple on the other hand is associated with e.g. luxury, authenticity, quality and power (Cherry, 2021; Marshall, 2021; van Braam, 2020) and industries that frequently use it consist of design, tech and luxury (Marshall, 2021). Moreover, purple is known to divide opinions (van Braam, 2020), which became also visible from the test user interviews.

One option would be to change the background color to a completely different one, however, this would require quite a bit of work with the whole visual design of the calculator. Then again, the calculator could provide the possibility to choose from e.g. two different colors, in which case the current color could be kept as one of the color options. The other color could then be a lighter one to suit those who find the current purple color scheme too dark or simply don't like the color itself. However, some things to take into account when choosing the main colors are the moods and feelings the colors evoke in addition to psychology behind using different colors, as mentioned with green and purple. In addition to keeping in mind the organization brand and what it represents, different colors should be analyzed from the users perspective, as different colors have different psychological meanings.

Another solution especially for those users who complained about the background being too dark could be to have a dark and light mode, as for applications it is becoming a presupposition for users because it is already a default in many devices, especially in Apple's iOS (Budiu, 2020). Although the calculator is not currently an application, most users tested it on their phone, meaning that it would most likely be the device they would be using also outside testing circumstances. Furthermore, as the calculator is designed to be used for people of all age, it is vital to take into account the visual preferences of both younger and older audiences and their potential constraints, such as bad eyesight. Hence, for the background to be customizable either into a darker or lighter mode by e.g. phone default settings, or different colors that can be chosen from the calculator itself could increase its usability for a larger group of people.

5.3.1 Design implication: Implement different colors and modes

Provide the calculator users the possibility to choose either dark or light mode in addition to other background colors to increase customizability. Customizability is relevant for especially those websites and application which seek frequent users (Budiu, 2020), as SUSLA does. The current color scheme of the calculator could be utilized as one color option for the background, as it was liked by some of the interviewees. However, for those who found it too dark or simply didn't like the color, SUSLA should have other background color options. These could include e.g. more traditional color schemes for sustainability related applications, such as different shades of green and blue (Marshall, 2021). However, with the new background colors, also the other colors of the current version should be reconsidered to better match with the new background colors. These new

color palettes need to function without decreasing the tool's usability, e.g. the colors can't blend into each other too much and they need to be in harmony with each other. Moreover, they need to be suitable for both dark and light modes. For the users to utilize the different modes, the option for the dark and light mode and the different background options should be easily discoverable from e.g. the navigation bar.

5.4 The future of CFCs

It is relevant to identify, that the users' expectations and needs towards a CFC are very high and in order to become successful, CFC providers need to be able to answer to these expectations and needs. However, for a single calculator to guide its user's behavior so drastically that their overall mindset regarding their decisions and purchases revolves around and is based on the most sustainable option is truly a difficult task. In order to succeed, the calculator needs to completely revolutionize its users thinking patterns. It needs to make decision making easy for them and enable making sustainable decisions in their everyday life as convenient as possible. It needs to make choosing the sustainable option the best option. However, is this something a calculator is capable of or is it even the best tool for such purposes? The burden of continuously making sustainable decisions in one's daily life that is put on individual consumer's shoulders doesn't seem to be the most efficient way to tackle the global climate crisis in overall, as leaving the consumer to shift their behavior out of their own free will is a very difficult task (Büchs et al., 2018). The requirements for a single calculator become excessively high and still, there is no guarantee that its user will shift their habits towards more pro-environmental direction, as also visible from previous research.

Especially when it comes to consumers who are most in need of even slight guidance when it comes to sustainable choices, the tool doesn't have many chances in impressing its user, as they might have very negative expectations towards the calculator. This, on the other hand, makes providing a successful UX to them even more difficult than for the average user. As also discussed in the literature review, those consumers who are the least informed or interested in environmental issues are the ones who would most need such a tool in order to shift their behavior, but indeed are unfortunately often the most difficult to engage in such activities (Biørn-Hansen et al., 2020). Therefore, reaching this target group is a very difficult task, not to talk about getting them to frequently use such a tool and actually succeed in changing their behavioral patterns. Hence, the shift towards sustainable lifestyles should come more strongly from e.g. governments and other big stakeholders,

such as influential organizations, as they can more efficiently drive the shift on a larger scale and enable the change and decision making to become easier and more convenient also for individuals.

Nevertheless, the role of EFTs and CFCs doesn't need to become completely useless, as some sort of tracking of one's habits could still be useful. Where CFCs might not be the solution to the climate crisis, they can act as a supporting tool for consumers. Especially as there seems to be a continuous increase in consumer interest towards all sort of tracking tools for different sectors of life, such as fitness and sports (Fortune Business Insights, 2021), there could be potential for also CFCs to become more popular if they are able to develop more into the direction of other feedback technologies. To mention one, the Finnish company Oura is a very good example of how a feedback technology can become very successful by combining great design with innovative technology. In a nutshell, the Oura Ring does everything that a user needs and both gathers and provides the data to its user in an easy and understandable way in addition to being customizable (*Less Stress, More Energy*, 2021). It is a great example of how a small tool can collect a variety of different type of data and provide it to its user in a meaningful way in addition to the ring itself being simple and elegant. They describe the ring on their website as follows:

> *"Oura combines advanced sensor technology and a minimal design with an easy-to-use mobile app to deliver precise, personalized health insights straight from the most reliable source: your body."*
>
> (*Meet Oura Ring*, 2021)

Therefore, Oura might be the perfect example of a successful feedback technology. If SUSLA, or any other CFC, could reach this level of automation, accuracy, reliability and even desirability, it could succeed in gaining an active and reliable userbase. In such case, SUSLA would become the forerunner of CFCs and even EFTs. However, even in such an ambitious situation, reaching those who have no interest towards environmental issues would be difficult, as the calculator would still lack some sort of an interesting aspect for this target group.

All in all, in order to become successful, SUSLA should aim to increase its usability and utility through automation, integration and added content in addition to identifying different user segments in order to further understand the different needs of its current and potential users and by so be able to better answer to them. There is a serious need to

revolutionize the whole concept of CFCs in order to provide the users the best possible tool for behavior change. What's more, taking into account the fact that even the best CFC will not be found and used by the majority if it isn't marketed well enough to the consumers. The calculator cannot expect for users to show up themselves, but instead it needs to have a clear strategy on how to find the consumers and increase its awareness amongst them. In addition, it needs to make very clear to the consumers what type of possibilities it has to offer to them. The solution needs to be delivered to the consumers without them needing to look for it and it needs to outweigh their expectations towards it.

6 Conclusions

Through a case study research on a CFC, this thesis has shown the success points and shortcomings of a specific EFT tool by discovering the UXs its test users have had with it. In order to provide CFC users a successful UX and affect their behavior, the tool needs to be very advanced in order to fulfill its users' needs and goals. The results of the research indicate that although the test users seem to have more or less interest in making more sustainable decisions, it still seems to be very laborious through the use of a CFC. In SUSLA's case, the tool should evolve somewhat from what it currently is in order to evoke more interest towards using it continuously and shifting behavior towards more pro-environmental habits. It should become more automated, integrated and have more content in order to both better answer its users' needs and keep them interested in it.

This study contributes to the field of Green IS by filling in the research gap when it comes to EFT, and specifically CFC, design and considerations for successful UX. The research provides a case study of a CFCs UX and sheds light on the different experiences the SUSLA users have had while using the calculator in addition to discussing how to better answer to its users' needs and goals. The use and application of the analytical framework gives an example for those planning to design and implement a CFC or EFT in general. In addition, the study sheds more light on the relevance of paying attention to UX in CFCs, which has so far gained only a little attention, but which is highly important to take into account when designing CFCs. This research emphasizes the role of successful UX in the context of behavioral changes and EFTs in addition to introducing some of the most important aspects when aiming to achieve a successful UX with similar tools.

The concrete design implications that aim to enhance the UX of the calculator provide insights on what is important when considering to design a CFC in addition to providing some basis for further research regarding their applicability on a more general level with CFCs. All in all, this study provides a great outlook into what should be considered and taken into account when designing a CFC in addition to providing insights on what the users of CFCs expect from the calculator.

6.1 Limitations

There are several limitations to this study that should be taken into account when analyzing the results. First of all, the scope of the case study research focuses only on Finland and Finnish households. Due to cultural differences, all findings might not be relevant outside

Finland. Secondly, although the sample is rather diverse regarding age and gender, most interviewees were expected to have an interest towards sustainability issues, as participation to the test period and interview were voluntary. Lastly, although some questions in the interviews were broader, the research is mainly designed to acquire answers related to CFC's and more specifically to SUSLA. Hence, applying the design implications or findings to other EFTs should be done with consideration. Moreover, as UX is a rather large topic, only a small fraction of it was discovered in this study in order to achieve narrow enough focus for the research. Therefore, some important topics worth consideration were left out, such as research on user motivation, which is an important factor when it comes to the user's needs and goals and the reasons behind them. All in all, further research on the topic is needed in order to build on the study conducted in this thesis.

6.2 Considerations for future research

The main issues with existing CFCs include lack of user interest towards continuous use and effect on its users' behavioral patterns, too vague data and lack of personalization and content that would invite the user to visit the tool frequently. There is a clear need for further understanding what are the users' needs and goals for CFCs and EFTs in general and what is the motivation behind using or not using the tools. It seems that existing research doesn't pay enough attention on user needs, as most studies used in this research analyze the tools based on how much they affect its user's behavior and what type of feedback works best etc. In order to better understand what the users really want and need from an EFT or whether it even is something they want in their lives or find beneficial, more research should focus on the tool and its utility for its users. The design of EFTs should heavily shift to become more user centered and the decisions made regarding the tools should be more heavily based on what the users want and need.

Therefore, further recommendations for especially SUSLA include conducting usability testing with actual users would be very beneficial in order to further discover pain points in the calculator use with a bigger and more versatile sample. Especially in case the calculator will be further developed, it is very vital to include also the users in the development process (Moran, 2019). This type of research can shed light into problems or aspects of using the calculator that might be otherwise difficult to find. Following the test users close by and analyzing their behavior with the calculator when they are actually using it could bring completely new insights and aspects to its development. In addition, as

psychology plays a big role in understanding and changing human behavior, consulting or hiring e.g. a cognitive psychologist would help bring new aspects to both understanding the user and use of the calculator.

Moreover, it would be interesting to see how an integrated CFC works and whether it results in more continuous use or increase in its users' awareness and actions towards more sustainable choices. In other words, does the type of calculator that the interviewees wished to have actually make any difference in their lives compared to the current version of SUSLA. Building a very intelligent and automated calculator, a sort of a smart CFC, and testing it with a very versatile user group for a long period of time, e.g. two to five years, would bring very concrete answers and insights into what type of a tool works or whether such tools have any effect on their users'. Therefore, a more comprehensive research on the users' habits with the calculator would shed more light into how the calculator gets implemented into daily or weekly life in different types of households, or whether it does at all. In addition, a longer study could also reveal whether a well-integrated and automated calculator would actually gather more consistent users and whether it has any effect on its users' behavior. What comes to different types of consumers and their preferences, the focus in future research should definitely be more heavily also on the most difficult target groups, i.e. those consumers who have little or no interest towards sustainability topics and changing their behavior. The key findings would be to further discover why these consumers do not find the global climate crisis interesting or relevant, how they could be educated regarding the topic and how they could be motivated to shift their current unsustainable habits.

In addition to more traditional CFCs, discovering completely new ways how to design a CFC would be very beneficial for future CFC developers. For example, could a smart watch be a more convenient device for a CFC? By taking a completely new approach for the CFC design and aiming to build the calculator so that decision making and shifting habits is as easy and convenient as possible could result in completely new ways to implement and use CFCs for the consumers. Looking into feedback technologies outside the sustainability context, such as health and fitness, could bring new insights.

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Appendix A: Interview Questions

Henkilötiedot

1. Nimi, ikä, sukupuoli
2. Koulutus
3. Työnkuva ja työnalue
4. Asuinkaupunki ja asuinmuoto
5. Onko sinulla perhettä/lapsia samassa taloudessa?
6. Muita hiilijalanjälkeen vaikuttavia tekijöitä?

Teknologinen tausta

7. Kuvaile teknologiankäyttöäsi tavallisena päivänä:
    a. Mitä käytät?
    b. Milloin ja mihin tarkoitukseen?
8. Millaisena koet teknologian käytön?
    c. Miksi?
9. Auttaako/haittaako teknologia sinua päivittäisessä elämässäsi?
    d. Miten?
    e. Miksi?
10. Luotatko teknologioihin ja/tai niitä valmistaviin yrityksiin?
    f. Miksi?
11. Millaisena teknologian käyttäjänä pidät itseäsi: kokemus suhteessa muihin / käyttömäärä ikäisiisi verrattuna?
    g. Perustele vastauksesi lyhyesti.

Hiilijalanjälki

12. Kuvaile tapojasi hiilijalanjäljen pienentämiseen ja elämäntapojen muuttamiseen kestävämpään suuntaan
    h. Oletko kiinnostunut aiheesta?
    i. Mitä olet tehnyt aiheeseen liittyen?
    j. Mitä suunnittelet/haaveilet tekeväsi?
    k. Onko muutos ollut helppoa/vaikeaa?
    l. Mikä on edistänyt/haitannut muutosta?
        i. Miten asuinpaikka/perhe/työnkuva on vaikuttanut tähän?

m. Minkälainen apu olisi mielekästä muutoksen tukemiseksi?

13. Oletko kokeillut vastaavanlaisia hiilijalanjälkisovelluksia tai -laskureita aikaisemmin?
    a. Kuinka aktiivinen ja säännöllinen käyttäjä olet?
    b. Onko niistä ollut sinulle hyötyä?
        i. Millaista/Miksi?
    c. Onko tällainen teknologia auttanut sinua muutoksen tekemisessä?
        i. Miten/Miksi?
    d. Mikä niissä oli hyvää/huonoa?
        i. Mikä auttaa tai haittaa muutoksen tekemisessä?
    e. Mikä sovelluksissa voisi oikeasti auttaa sinua tekemään muutoksen?/Mitä toivot niiltä?
    f. Riittäisivätkö ne vai kokisitko tarvetta käyttää useampaa vastaavanlaista sovellusta yhtäaikaisesti?

Taustakysymykset: SUSLA

14. Mitä puhelinta ja/tai laitetta käytit sovelluksen testaamiseen?
15. Oletko testannut SLA testiä jo aikaisemmin (palapeli)?
16. Jos KYLLÄ:
    g. Mikä analogisessa on erilaista/parempaa/huonompaa?
    h. Mikä digitaalisessa on erilaista/parempaa/huonompaa?
    i. Kumpaa haluaisit käyttää ja miksi?
        i. Miten digitaalisesta saisi yhtä hyvän?

Kokemus: SUSLA

17. Minkälainen kokemus sovelluksen käyttö mielestäsi oli?
18. Minkälaisia tunteita sovelluksen käyttö herätti?
19. Miltä sovelluksen käyttö tuntui?
20. Mitkä ominaisuudet sovelluksessa miellyttivät sinua eniten?
21. Mitkä ominaisuudet eivät miellyttäneet?
22. Mitä jäit kaipaamaan sovellukselta? / Minkälaisia lisäominaisuuksia olisit kaivannut?
23. Mikä sovelluksen käytössä oli kaikista ärsyttävintä?
24. Mikä sovelluksen käytössä oli vaikeinta/haastavinta?

Ulkonäkö: SUSLA

25. Mitä pidät sovelluksen ulkonäöstä?
26. Millaisena koet sovelluksen värimaailman?

Tulokset ja käyttö: SUSLA

27. Koetko vastenmielisyyttä tuloksia lukiessa/analysoidessa? / Minkälaisia tunteita sovelluksen antamat tulokset/ehdotukset sinussa herättävät?
28. Luotatko tuloksiin? Luotatko mittarin valmistajaan?
29. Minkälainen mittarin tulisi olla/tehdä/näyttää?
30. Mitä haluaisit tietää mittarista, jotta voisit luottaa siihen ja oikeasti muuttaa toimintaasi sen perusteella?
31. Riittäisikö sinulla kiinnostusta käyttää sovellusta joka päiväisessä elämässäsi/ottaa sovellus käyttöön osaksi arkea?
32. Miten haluaisit käyttää sovellusta osana arkeasi?
33. Oliko sovelluksen tuottamat tulokset selkeät? → Oliko tulokset muotoiltu niin, että tapoja on helppo muuttaa, eli tiedät mitä tehdä ja missä määrin?
    j. Jos EI → mitä puuttui ja mitä pitäisi tehdä paremmin?

Kehitysideoita: SUSLA

34. Kuinka sovelluksesta saisi mielestäsi helppokäyttöisemmän?
35. Miten sovelluksesta saisi kiinnostavamman?
36. Miten sovelluksesta saisi kaikista käyttäjäystävällisimmän?
37. Kuvaile ”täydellistä hiilijalanjälkimittaria”: millainen se olisi, mitä se tekisi, miten se vaikuttaisi elämääsi?
38. Mitä odotat mittareiden tulevaisuudelta?