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Changing Food Waste User Behavior through User-Centered Design

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Abstract

Planet earth is currently facing many environmental issues and the term global warming is a well-known term today. Carbon dioxide emissions are contributing to global warming, and there is a need to perform research on how to reduce this in various areas. In Norway as well as in other countries around the world, food waste is a source of emissions that are damaging the environment.

Research indicates 30-50% of all food that are being produced, are never consumed by a human [2]. This study proposes an approach to investigating and positively affecting food waste behavior through merging a sustainable design approach, within a user-centered design process. The proposed study also draws on the research field of behavior change theory, in order to design interventions aimed at affecting the identified negative target behavior. By researching how user-centered design and qualitative research methods may contribute to changing human behavior of food waste, this study contributes to 1) understanding waste behavior and identifying target behavior, 2) determine intervention types, design and evaluate interventions, 3) prototype a methodological approach to changing user behavior through user-centered design.

In this research study, user-involving methods such as interviews and diaries are used to measure and understand food waste behavior. Next, the behavior change wheel is used in order to determine intervention types to be used in a design. Further, Gamestorming is used instead of regular brainstorming when generating ideas of concepts. Finally, the intervention design is iteratively designed and tested by using methods such as guerilla testing and regular user testing before measuring the effect of the proposed intervention design.

Based on the qualitative data from interviews and diaries, negative behaviors were mapped out, linked to A) Leftovers, B) Taste and feel and C) Food safety. In addition, it is hypothesized that a family's economy is linked to food waste. Key behavior to target is identified as: (1) leftover food, (2) food turned bad and (3) expiring date.

Based on gathered insights on negative behaviors and from behavior change theory, it was deemed likely that the intervention type education should be efficient for influencing this target behavior. The results indicate that such a designed intervention has the potential to change food waste user behavior through user-centered design.

Sammendrag

Jorden står foran mange miljøutfordringer, og begrepet global oppvarming er et kjent uttrykk i dag. CO₂-utslipp bidrar til global oppvarming, og det er behov for å utføre forskning på hvordan man kan redusere dette på ulike områder. I Norge, så vel som andre land rundt om i verden, er matavfall en kilde til utslipp som er skadelig for miljøet.

Forskning indikerer at så mye som 30-50% av all mat som produseres, aldri blir konsumert av et menneske [2]. Denne studien foreslår derfor en tilnærming ved å undersøke hvordan man kan påvirke matavfallshåndtering på en positiv måte ved å slå sammen en bærekraftig designtilnærming, sammen med en brukersentrert designprosess. Denne foreslåtte studien er basert på forskningsområder innenfor atferdsendringsteori, ved å se på hvordan atferdsendringstiltak kan påvirke den identifiserte negative måladferden. Ved å undersøke hvordan brukersentrert design og kvalitative forskningsmetoder kan bidra til å endre menneskelig adferd av matavfall, bidrar denne studien til 1) forståelse av avfallshåndtering og identifisere måladferd, 2) velge intervensjonstyper, designe og evaluere intervensjoner, 3) prototype en metodologisk tilnærming til endring av brukeradferd gjennom brukersentrert design.

I denne forskningsstudien brukes brukermedvirkende metoder som intervjuer og dagbøker til å måle og forstå hvorfor folk kaster mat som fortsatt kan spises. Videre benyttes behavior change wheel for å bestemme hvilke intervensjonstyper som er mest hensiktsmessige å benytte i et design. Videre brukes gamestorming i stedet for vanlig brainstorming når man genererer ideer om konsepter. Til slutt blir intervensjonsdesignet iterativt utformet og testet ved bruk av metoder som guerilla testing og vanlig brukertesting før måling av effekten av det foreslåtte intervensjonsdesignet.

Basert på kvalitative data fra intervjuer og dagbøker ble negative atferder kartlagt, disse ble knyttet til A) Matrester, B) Smak og lukt og C) Matsikkerhet. I tillegg er hypotesen at en familiens økonomi er knyttet til matavfall. Nøkkelatferder for endring er identifisert: (1) Matrester, (2) Mat som har blitt dårlig og (3) Utløpsdato. Basert på samlet innsikt på negativ atferd og fra atferdsendringsteori, ble det ansett sannsynlig at utdanningstiltaket skulle være effektivt for å påvirke den målte adferden. Resultatene indikerer at en slik utformet intervensjon har potensial til å endre brukerens oppførsel av matavfall gjennom brukersentrert design.

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1 Introduction

The environment is changing, and global warming is threatening our environment and ecosystems. There has been a lot of focus on carbon dioxide emissions the last 10-15 years, and research into how these are contributing to hurting our planet. Still, the global carbon dioxide emissions have increased by 75% from 1980 to 2012 [1]. Politicians and various industries understand that measures against this must be established. One of the issues at hand is the amount of food being thrown away. The Global Food Waste Report states 30-50% of all food that are being produced in the world is never being eaten by a human being [2]. Food that is wasted is not only polluting the environment, but also wasting resources used to produce the food. Therefore, current negative food waste behaviors are not sustainable in the long run.

Oestergaard and Boks overview the field of sustainable design for food waste reduction and present different research methods that have been used to understand *why* people are wasting food [3]. Through their findings, Oestergaard and Boks address that more knowledge is needed on which human behaviors to target and explore how design interventions may lead to behavior changes [3]. Thus, there is a call for more use of qualitative methods in waste reduction research aimed at providing more in-depth understandings on behaviors related to food waste, and what measures that should be taken in order to target and change problematic behavior.

User-centered design can be seen as one research method that can help understand people's behavior related to food waste. There has so far been little research investigating how user-centered design can be utilized in order to facilitate user behavior changes [3]. The assumption is user-centered design may be increasingly utilized within the field of sustainable design. In light of this, this study explores user-centered design methodology with regards to sustainable design and investigates how interaction designers can affect and change user behavior with the use of user-centered design methods. In the sustainable design field, Zachrisson developed a six-step process for changing environmental user behavior [4]. Drawing on knowledge on proposed approaches to sustainable design as well as behavior change theory, this study prototype an approach to utilizing sustainable design approaches within user-centered design.

The study focuses on how food waste behavior may be positively affected by design. The prototyped approach aims at understanding people's behaviors towards food waste, identifying negative environmental target behavior and iteratively prototype and design possible intervention

solution that may affect target behavior. The approach also proposes a way to measure and track waste behavior, in order to evaluate if interventions influence or change behavior and reduce the amount of food that are being wasted.

The contributions of this study are threefold: 1) understand waste behavior and identifying target behavior, 2) determine intervention types, design and evaluate interventions, and 3) prototype a methodological approach to changing user behavior through user-centered design. First, through extending the largely quantitative knowledge in the field of waste with qualitative and user-involved research methods one may get one step closer to understanding why people are wasting food, and which negative behaviors are likely to be affected by designed interventions. Second, any benefit of being able to identify and positively influence unsustainable food-waste behaviors is viewed as a contribution to reducing carbon dioxide emissions and ultimately a contribution to reduce global warming. Finally, more knowledge on how to utilize qualitative and user-centered approaches to influence inexpedient user behaviors is useful for the field of user-centered design.

1.1 Research questions

The following research questions are formulated:

1. What insights into target food waste behavior can be gathered through a user-centered design approach?
2. In what ways do merging behavior change theory with a user-centered design approach contribute to intervention design and evaluation?
3. How can user-centered design approaches be utilized for changing unsustainable user behavior?

1.2 Definitions

Food waste behavior is behavior related to food and how people see food as part of their daily life. One contribution in this study is **insights** into understanding waste behavior from a user-centered perspective. Another contribution is identifying **target** behavior. Target food waste behavior is negative behavior that based on the analysis are viewed as likely to be affected by design interventions and thusly targeted in design interventions.

In a **user-centered design approach** the designer base his/her design decisions on user requirements. User requirements are in focus throughout the design process, and users are often involved in the design process. User requirements can be what the user needs, different tasks that need to be performed to reach their goals and the environment in which this takes place. In this study, a user-centered design approach refers to understanding food waste from the perspective of the user and how this knowledge can be used in a user-centered design process aiming to change user behaviors in a way that is experienced natural and satisfying.

Within the field of psychology, there are established theories on how to change behaviors with the use of interventions. An **intervention** can be a single strategy or strategies aimed at behavior change. Examples of interventions are policy changes, awareness campaigns, marketing campaigns or education campaigns. **Behavior change theory** is used in order to understand why behaviors change and will be used together with a user-centered design approach to design interventions related to food waste behaviors. By **merging** behavior change theory into the process of designing interventions, the aim is that the user-centered designer is supported in his/her decisions. By studying potential intervention types and designs from more than one standpoint, a better understanding of the design possibilities for food waste behavior may be reached.

In this research study, an intervention is aimed at producing increased sustainable behavior through changing **unsustainable behavior**. Unsustainable behavior is defined as a type of behavior that weakens nature's survivability in the long run by using more resources than needed. Based on the identified sources of behavior related to food waste, the **intervention design** is how to approach an unsustainable behavior by incorporating established intervention techniques, such as education, persuasion or incentivization.

An intervention would have to be **evaluated** in order to identify the effect of the proposed intervention design. Thus, the study also has to propose a way to measure and track waste behavior as part of the unsustainable user behavior intervention impact evaluation.

Finally, the study will discuss the successfulness of the prototyped user-centered design approach on understanding, designing and influencing unsustainable food waste behavior, and the perceived potential of utilizing user-centered design approaches for changing user behavior.

2 Background

This chapter presents previous contributions related to the research area of reducing food waste. First, an overview of research on food waste is presented. Next, research on how to change user behavior is briefly covered, focused on recommended methods and approaches.

2.1 Food waste reduction research

In the report, *Food waste reduction, an overview of the field*, Oestergaard and Boks review the current state of research when it comes to understanding food waste [3]. Of the overview that the researchers tell in their report shows that there has not been much research involving users.

Wever et al. claims in their research article there is a need to involve users when creating sustainable products [5] [6]. However, the impression is that even though the researchers use a user-centered study, they seem to gravitate towards the use of quantitative research methods when addressing food waste. As such, there seems to have been done more quantitative research of how much food that is wasted, while there has been little research of interacting with consumers [3] [6].

Williams et al. performed a research study involving both a qualitative and user-centered research approach to investigate food waste, looking into whether food packaging was the cause of food waste [7] [6]. The British researchers asked 61 participants to note their food waste in a diary – what and why – over a period of seven days [7] [6]. Graham et al. also conducted a qualitative and user-centered study, where semi-structured interviews were used [8] [6]. In this research study, 15 different households in the UK were interviewed. Graham et al. found four core barriers for reducing food waste: 1) a ‘good’ provider identity, 2) minimizing inconvenience, 3) lack of priority and 4) exemption from responsibility. In a related study, Graham et al. used questionnaires to collect data on behavior that cause food waste [9] [6]. The collected data was then compared to a developed framework in order to identify behaviors. In 2016, Stancu et al. have also investigated food waste behavior by conducting user-centered research using surveys [10] [6]. Data from as much as 1062 participants were gathered to understand the psychological factors and food-related routines to food waste [10] [6].

2.2 The behavior change wheel

Today, there are many frameworks that are developed with the intention of guiding when developing behavior change interventions. However, due to the vast number of frameworks to choose from, it has not been clear how these frameworks serve its purpose. Therefore, in 2011, Michie et al. evaluated these frameworks by performing a search in electronic databases and consulting with behavior change experts. This research led to the development of a new framework, the behavior change wheel model. This model aims at fixing their weaknesses and incorporating all theories and strategies into one model [11].

The behavior change wheel draws on established theories on how to change behaviors with the use of interventions and established intervention types. Further, strategies and techniques, such as education, persuasion or incentivization, policy changes, awareness campaigns, marketing campaigns or education campaigns.

There is a consensus between psychologist and health researchers that in order to change behavior, a problem behavior and what affects negative behaviors need to be identified. The behavior change wheel was developed with the help from 30 different researchers in the health psychology field [11]. The behavior change wheel is a way of understanding behavior in its context and then linking that with intervention functions. The model consists of an inner circle with three main sources of understanding behavior in context. For a behavior to occur three conditions need to happen and somebody or people need: 1) Capability to perform the behavior, 2) they need to be motivated, and 3) have the opportunity. Around these three behaviors, nine intervention types are positioned, with the outer circle consisting of seven categories of policy for these interventions to happen [11]. By identifying 33 theories and 128 constructs of behavior, it led to the development of the behavior change wheel model (see Figure 1). This model can be used to define a problem, choosing a behavior and identifying what behaviors that need to be changed.

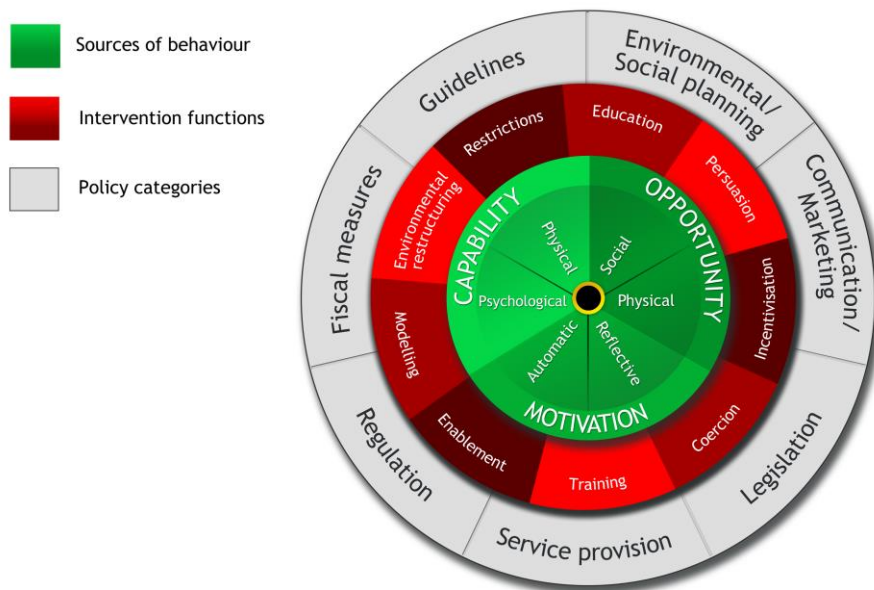


Figure 1 - The behavior change wheel [11]

HAPA which is the abbreviation for health action process approach is an approach that is used within the field of healthcare [12]. This approach is used when trying to change behavior that is impacting users in a negative way, i.e. alcoholics and smokers. By having a pre-intentional motivation process and a post-intentional process this model aims to both change a behavior, and more importantly maintaining a positive behavior, over time [12].

Nikki Pfarr, a former Ph.D. student at NTNU, developed behavior change strategy cards aimed at helping designers influencing behavior through design [13]. One of the reasons of why these cards were made, were because insight in these fields is often buried in academic papers or conference proceedings. Often, because of time constraints in a design process, one do not have time to include research results found in research papers. Therefore, these strategy cards feature multiple strategies related to behavior change and illustrate examples of how these strategies can be used quickly in the design process.

2.3 Sustainable design

Within the design disciplines, sustainable design emerged as a result of the growing environmental concerns in the 1960's [14]. The research trends within the design discipline have been solar, wind power and recycling. The sustainable design contribution of minimizing food

waste has mostly been in the direction of quantitative research and surveying amounts of waste. There has so far been little research investigating how user-centered design can be utilized in order to facilitate user behavior changes [3]. Zachrisson proposes a process that follows six distinct steps in order to create a product that supports sustainable behavior in his doctoral thesis on informing design for changing environmental user behavior [4]. The steps are:

0. Task: design a product
1. Study and measure the baseline practice
2. Identify which behavior to change
3. Identify what affects the behavior
4. Select types of principles to use
5. Generate ideas
6. Evaluate and select ideas

2.4 User-centered design

From the field of human-computer interaction (HCI), user-centered design developed as a popular framework of processes used to understand the user, focusing the design process in user needs, tasks and goals. To obtain an understanding of the user, users are involved throughout the design process. Further, the goals of involving users in the design process are to avoid a designer's personal assumptions to wrongly influence design [15]. There are various techniques that are utilized as a part of user-centered design, for instance as to the measure of direct contact with users and the level of user contribution. Common strategies used in UCD are interviews, observation, focus groups, ethnography and user testing [15].

3 Methods

This study approaches the topic of food waste from a user-centered, qualitative and intervention based stance, and can be classified as a mix of an exploratory real-life study where observations and surveys are used to get an accurate description of a phenomenon, and an experimental study where the effect of designed interventions are measured [16]. The study uses methods from user-centered design combined with qualitative research methods to measure baseline practice, understand and identify target behavior and prototype and evaluate interventions. By researching the topic of food waste, this can be classified as design research, with the intention to produce knowledge of this topic [17]. Further, it can also be classified as research through design, where this study tries to change a behavior from its current state to a preferred state [17]. In order to determine and design intervention types, user-centered design methods are also combined with user behavior change theory.

This study outlines five phases for investigating and changing food-waste behavior through user-centered design. These five phases are based on the proposed stepwise approach from Zachrisson [4]. The aim and methods in these phases are outlined in the next sections, in addition to legal and ethical consideration.

Through these phases, a user-centered design process, including user-involved qualitative high-contact methods, is combined with real-life evaluations in researching how to reduce food waste. Though there seems to be an overall lack of user-centered and qualitative studies in relation to waste reduction [3], some examples are identified. Williams et. al. [7], Graham et.al. [8], Zachrisson [4] and Wever et. al. [5] prototype how diaries, interviews, surveys and user-involved design evaluations are relevant qualitative methods for data collection in user-centered studies.

Zachrisson's recommended stepwise process approach is used as a scaffold and integrated into a traditional iterative and user-involved user-centered design process. Drawing on the experiences from the study, the study also explores to what degree Zachrisson's recommended stepwise design approach can be merged with an iterative and user-centered design process.

3.1 Phase 1: Measuring baseline practice

Without a baseline, it would be challenging to calculate the impact of proposed design interventions on behavior. Thus, the aim of Phase 1 was to create a baseline reference point to

evaluate any intervention effect against later on. To be able to measure the baseline practice of what and how much food waste a family waste during one week, a one-week diary was used.

The use of diaries was successfully used in the study conducted by Williams et al. when investigating food waste and if food packaging were the cause [7]. The reasons for choosing this approach in this master thesis were because of the unobtrusiveness of a diary and the fit to gather data for one whole week.

Recruitment: Participants were recruited with the use of virtual snowball sampling [18], by making a Facebook post, asking for families that could be interested in participating. Five families reached out and showed their interest in this research study. Ethical benefits of using this method are that it was seen as unobtrusive since participants that would want to participate would do this entirely voluntary by taking the initiative of contact. Five different families reached out and said that they would be willing to participate. Even though five families were a small sample size, it gave valuable data to work with and it was possible to get an overview of the baseline practice related to food waste. However, e.g. a sample size of ten families could reveal more information due to some families were experienced to be less active taking notes during the baseline week.

Design: When developing diary forms for the participants to note down in, there were several considerations to take into account. The goal was to make the families complete a whole week of keeping a food waste diary, and as detailed as possible. Thus, keeping the diary should be easy. The first idea was that the participants would take pictures of what food that they were throwing away in addition to taking notes. Having the participants taking pictures of all food was discarded due to the additional workload for the participants. Instead, each family's task was to note down what food they were throwing away, the reasons for this and to note down each time a garbage bag of food were disposed of for one week (Appendix A). To be able to establish trust, so that the families would be willing to be fully open about their food waste practices, a consent form was handed out which thoroughly explained the diary experiment (Appendix B). When the week of keeping a diary ended, the diaries were collected from the families and debrief interviews were conducted, again explaining what the data would be used for.

Analysis: After having collected baseline data from the diaries (Appendix C), a content analysis was applied to categorize and quantify findings. Each diary was first digitalized. Next,

information on food waste data and reasons for food waste were used in a bottom-up approach to create categories. This is called an emergent coding approach, where the categories are established on-the-go when conducting a content analysis [19].

3.2 Phase 2: Understanding waste behavior and identifying target behavior

The aim of Phase 2 is to investigate current behaviors related to food waste and get a more in-depth understanding of what influences or triggers these behaviors. Further, to identify target behaviors to change and build assumptions from the data as to what affects these behaviors. From a user-centered design approach, it makes sense to investigate these two steps iteratively as part of the same phase, rather than step by step as proposed by Zachrisson. Qualitative research methods are applied to understand underlying reasons for certain behaviors. Interviews and diaries are the primary methods chosen.

Recruitment: An interview study into waste behavior was conducted prior to the thesis study, as a part of IMT4882 Specialization II. Here, 10 participants were interviewed, 5 living within family units and 5 living alone. Semi-structured interviews were used and included questions related to the topics of procurement, usage, situations and assumptions related to food and food waste. This thesis study draws on the results from the interview study in Phase 2 and extends the study with further interviews and the diary data. The interview study is extended in this study through interviewing participating families upon collecting the diaries used for baseline measuring.

Design: The semi-structured interviews were conducted with the aid of an interview guide (Appendix D). The interview guide covered the following topics: a) food procurement, b) food usage, c) food waste situations and d) assumptions related to food and food waste. Before starting a conversation, written information about the study was handed out and a signed consent was obtained before performing the interviews (Appendix E). When performing the interviews, audio recording was not used; instead, it was decided to use extensive notes due to previous experience in relation to the additional workload of transcribing audio-recorded interviews.

It is recommended to continue qualitative interviews as long as new data is revealed [16].

Extended interviews will thus continue until no new information is revealed when compared to information already gathered from the interview study [16]. Data from previous interviews,

diaries and new interviews is treated as coherent information based forming in-depth assumptions and understanding upon completion of the phase.

Analysis: In IMT4882 Specialization II the interviews were analyzed by establishing categories based on the interview guide and then looking for coherences/themes of what every interviewee said. In this research study, the extended interviews apply the same thematic content analysis approach, first using the SC categories as a-priori codes and categories and applying these to the data, next taking an emergent approach to identify if new information appears in new interviews (and if the a-priori categories do not fit the new data from families). This approach is called a multi- or mixed method research, where both quantitative and qualitative methods are combined to address research questions [20].

Table 1 shows the a-priori categories from the interview study in IMT4882 [21].

A-priori categories	Description
Procurement 1: Shopping list	Using a shopping list when planning what to food to buy
Procurement 2: Planning	Planning their food consumption
Procurement 3: Preference	Want different food each day
Usage 1: Desirability	Too much food related to their daily needs
Usage 2: Buying too much	Not being able to eat it up before it expires or turns bad
Usage 3: Taste and feel	Food judged on its taste and feel
Situation 1: Stress	Wasting food because of stress
Situation 2: Economy	Wasting food based on economy
Situation 3: Leisure time	Wasting food in weekends/holidays
Assumption 1: Availability	Availability of food
Assumption 2: Economy	Strong economy among people in Norway
Assumption 3: Expiration	Expiration date on food products
Assumption 4: Non-environmental focus	Economy vs environmental emissions
Assumption 5: Culture	Norwegian culture related to food

Table 1 - A-priori categories gathered from the interview study in IMT4882 Specialization II

With regards to diary data, the diaries also contain qualitative information about reasons for food waste. The interview data gathered in IMT4882 were analyzed by counting the occurrences of how many times the statements above were mentioned in all the interviews. The practices identified in the interview study were then compared to the emerging diary data results.

3.3 Phase 3: Determining intervention types

In the third phase, the aim was to identify what may affect the selected target behaviors, select types of principles to use and prioritize the target behaviors and possible interventions related to these. Next, determining possible fitting intervention types, and researching behavior theory that originates from psychology, like the behavior change wheel.

Design and analysis: After having identified the target behaviors of food waste, there was a need to consider what may affect the selected target behaviors in order to be able to design as effective interventions as possible. Therefore, the identified target behaviors discovered in Phase 2 were used together with the behavior change wheel in order to explore what type of interventions could be most effective to change the unsustainable behaviors.

3.4 Phase 4: Designing interventions

Finally, in Phase 4 the study iteratively designs and tests intervention solutions with users, exploring the ability of the interventions to change user behavior and create positive environmental impact reductions.

From a user-centered design perspective, the aim is to gather as much information as needed to form assumptions and inform design. Through early sketching and prototyping assumptions are tested, and discrepancies, unsuccessful design ideas and misconceptions are likely to be detected. Moving from user research into early design phases is recommended, and design ideas created based on user research data can then be evaluated through user involvement in early testing. The output from early testing further informs the design and user knowledge.

The study thus applies an iterative process model to structure the design research process, with multiple increments along the way towards a final delivery of a prototyped intervention solution and study completion. As this project is aimed at being user-centered, most of the time will be engaging with real users, interpreting qualitative data and designing and testing interventions in a user-involved manner. As such, the process is iterative and tentative in nature – iterating back and forth between methods and phases until either an effective intervention solution is arrived at, or the allocated project time is up and the exploration and design process must be ended.

3.4.1 Gamestorming

After having identified behaviors, what affects this and determined intervention types, an idea generation method called gamestorming was used to generate ideas of concepts [22]. This can either be done with users in form of workshops or focus groups. By doing this one can develop ideas by facilitating an idea session with participants and let participants evaluate the concepts they believe most in. The aim of using gamestorming was to generate concepts of ideas related to the interventions that were determined in Phase 3. Since gamestorming makes the use of games when generating ideas, it was crucial to choose a game that would fit the generation of ideas based on a preset of established topics, in this case, intervention types. The decision landed on ‘3-12-3 *Brainstorm*’ for idea generation and ‘*Dot voting*’ to let users select the ideas they like or believe in [22]. ‘3-12-3 *Brainstorm*’ refers to the amount of time each activity should last. First, 3 minutes are used for generating a pool of ideas, next 12 minutes are used to develop concepts from the generated ideas and finally, 3 minutes are allocated to presenting each concept to the rest of the group. In order to recruit participants, virtual snowball sampling was used.

3.4.2 Sketching

The aim of paper sketching was to get ideas down on paper, rather than quickly jump to designing digital prototypes. The paper sketches were not tested on any users, as would have been preferred, but they would inform the design of the digital prototype later in the process.

3.4.3 Prototyping

Before starting designing a digital prototype, different ideas generated through gamestorming were sketched on paper (Appendix F). The aim of paper sketching was to get ideas down on paper, rather than quickly jump to designing digital prototypes. The paper sketches were not tested on any users, but would inform the design of the digital prototype later in the process. When satisfied with paper sketching, a digital prototype was developed with the use of the prototyping tool Adobe XD.

3.4.4 Exploratory concept testing

When the design of the digital prototype was seen finished, an exploratory concept test was conducted. To be able to get quick and useful feedback on whether the selected design concept was understandable, the digital prototype was tested on the streets in Gjøvik (Appendix G). This approach is often named guerilla testing. Participants are not recruited, but instead approached in

public places and asked to look at the design [16]. Data gathered from guerilla testing is often qualitative, and can give rich and valuable data.

3.4.5 Expert testing

Based on feedback obtained from exploratory concept test, the work of developing a working intervention was furthered utilizing iterative testing. The iterative testing was conducted by thesis supervisor Miriam Begnum and myself. This way of testing can be referred to as expert testing, where people that have more experience than the average population test the design while trying to discover usability issues and design discrepancies such as interface flaws, confusing use of words, use of layouts and colors [16].

3.4.6 Usability testing

In order to discover and fix major usability flaws prior to intervention, the intervention design also goes through one round of traditional usability testing with users (or user representatives). Krug, Rubin and Chisnell recommend there is no need for more than 3-4 users to test a design in order to discover the main usability flaws [23] [24]. Therefore, four participants were seen as sufficient. The usability testing script, consent form, and notes can be seen in (Appendixes H, I and J).

3.5 Phase 5: Measuring intervention effect

When the quality and usability of the intervention design was seen as acceptable, participants from the first baseline week were contacted in order to re-measure behavior and test the intervention design. The aim was to measure the effect of the proposed design intervention on behavior using the proposed way to measure and track food waste behavior from Phase 1.

3.6 Ethical and legal considerations

Since this research project aims at including users through user-centered design methods, recruiting participants is essential in order to get data to perform analyses and to draw results from. Due to the nature of this project, qualitative research will mean that participants would have to be recruited and maintained. When working with real users, there is a need to look at the ethical and legal considerations.

There are also some ethical considerations when it comes to changing user behavior through a design. Considerations to be made are that user should have a desire of changing behavior, meaning that it should be voluntary. When interacting with participants both in the initial phase of the project and the final phase, it should be to make the participants feel safe and so that they can express their feelings and motivation freely. This can help discover topics that are interesting to take a closer look at.

It has been investigated whether data collection in this research study is notifiable or not notifiable, but as this research study does not collect direct or indirect personal data, this research study is not required to report to NSD (Norwegian Social Science Data). However, even though food waste and the amount of waste being disposed of are not usually seen as confidential, participant's data is anonymized and consents for participating in the research study is obtained. Data gathered is stored safely and treated securely.

4 Results

This chapter presents results obtained in the 5 study phases. Results related to understanding behavior and identifying waste target behaviors are presented in 4.1 and 4.2. Next, results relating to determining intervention types, the iterative intervention design process and the final measuring of the effect of the designed intervention are presented in sections 4.3 through 4.5.

4.1 Phase 1: Baseline practice results

Based on results gained from the baseline week, food waste categories were created as they were coded. The goal for this was to see if any new information would surface in understanding reasons for food waste in a household. Further, reasons for waste in category were assigned (Appendix C) and mapped to practices.

Food waste category	Reasons for waste in category	Mapped to practices
Throwaway	<ul style="list-style-type: none"> Leftover food is thrown due to stress/non-planning 	<ul style="list-style-type: none"> Procurement 1: Shopping Situation 1: Stress Assumption 1: Availability
	<ul style="list-style-type: none"> Leftover food not desirable to eat 	<ul style="list-style-type: none"> Usage 1: Desirability Procurement 3: Preference Assumption 5: Culture
	<ul style="list-style-type: none"> Accumulated quantities 	<ul style="list-style-type: none"> Procurement 2: Planning Usage 4: Dried goods
Taste and feel	<ul style="list-style-type: none"> Turned bad 	<ul style="list-style-type: none"> Usage 2: Buying too much Assumption 2: Economy Situation 3: Leisure time
	<ul style="list-style-type: none"> Decreased quality due to age 	<ul style="list-style-type: none"> Usage 3: Taste and feel Situation 2: Economy Assumption 2: Economy
Food Safety	<ul style="list-style-type: none"> Expiring date 	<ul style="list-style-type: none"> Assumption 3: Expiration
	<ul style="list-style-type: none"> Forgotten 	<ul style="list-style-type: none"> Usage 2: Buying too much
	<ul style="list-style-type: none"> Poor preparation 	<ul style="list-style-type: none"> Assumption 4: Non-focus

Table 2 - Categorized reasons for food waste

Table 3 show the identified reasons for waste in category, and the number of times a reason for food waste is mentioned as well as how many families mentioned this during the baseline week of writing a diary. During the analyses and coding of the diaries, the aspect of the time of day when people throw away the most food emerged as being interesting to look closer at. As can be seen in Figure 2, food waste was found to occur throughout the day, but results indicate that most of the food is wasted during breakfast and dinner time.

Food waste category	Reasons for waste in category	Times mentioned	Families
Leftovers	Leftover food thrown due to stress/non-planning	4	1
	Leftover food not desirable to eat	16	5
	Accumulated quantities	5	2
Taste and feel	Turned bad	16	5
	Decreased quality due to age	3	2
Food Safety	Expiring date	9	5
	Forgotten	3	3
	Poor preparation	3	2

Table 3 - Number of times and number of families mentioning reasons for waste during Baseline week

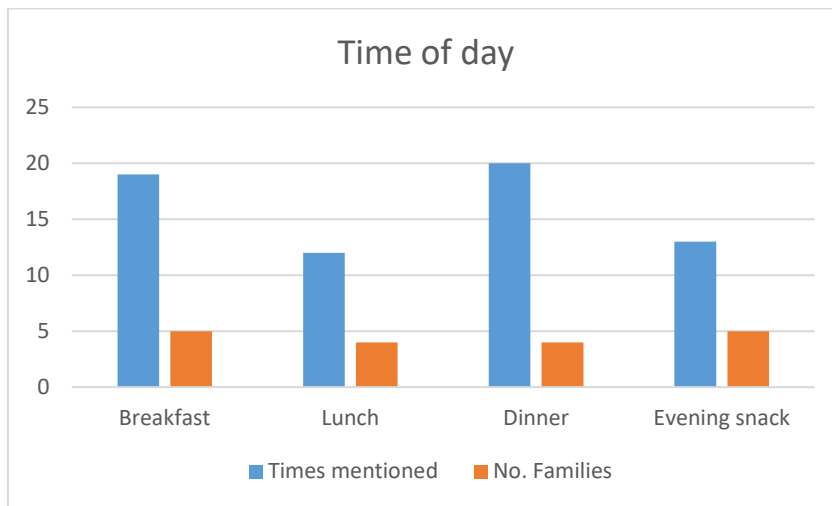


Figure 2 - What kind of meal and times of families mentioning waste during Baseline week

Next, if there were any differences to weekdays compared to weekends was looked into. Figure 3 illustrates the distribution of food waste during a week. Food is found to be wasted more during weekends and Monday.

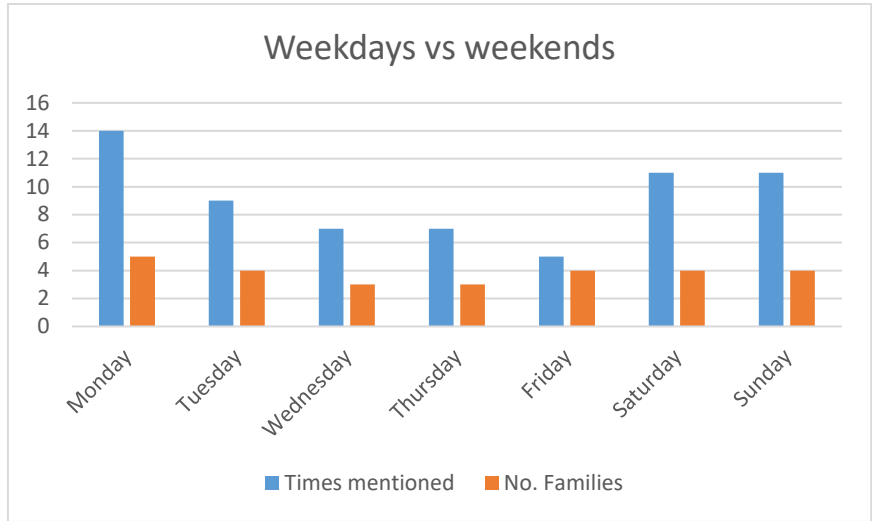


Figure 3 - Weekdays versus weekends of when families mentioning waste during Baseline week

Figure 4 show the different product categories that were being mentioned as waste. Results show that bread, vegetables and fruits were the most common product categories that were wasted during baseline week.

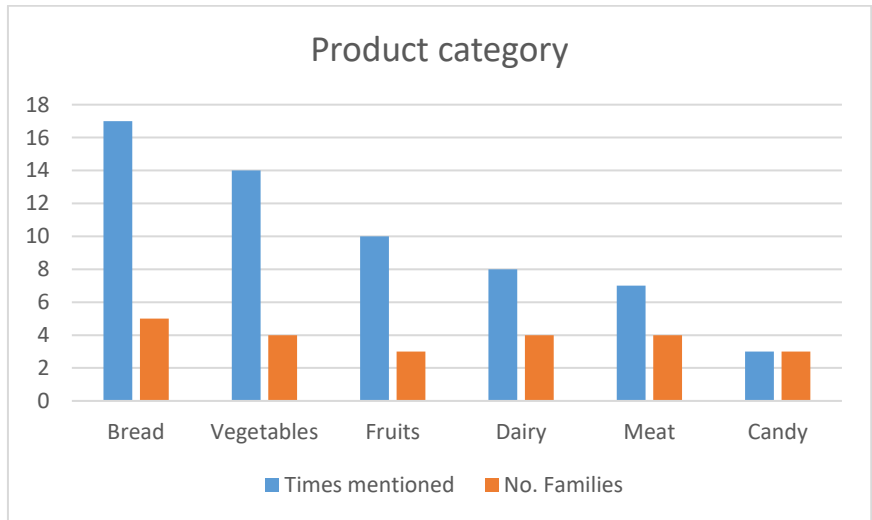


Figure 4 - What kind of product and times of families mentioning waste during Baseline week

Finally, results from the baseline week showed that the average family disposed of 3,5 garbage bags of food waste every week, see Table 4. One bag equals 1 kilogram and for one whole year, this means that the average family disposes 182kg of garbage bags of food waste, see Figure 5. According to WRAP the average UK household generates 160kg of food waste each year which equals 0,62 tons of CO₂ emissions [25]. Based on the baseline week, Figure 5 thus estimates that

the annual emissions due to food waste for the average study sample family is about 0,7 tons of CO₂ per year.

	Garbage bags of food waste
Family 1	6
Family 2	4
Family 3	3
Family 4	2
Family 5	2
TOTAL:	17

Table 4 - Number of garbage bags of food waste thrown away during Baseline week

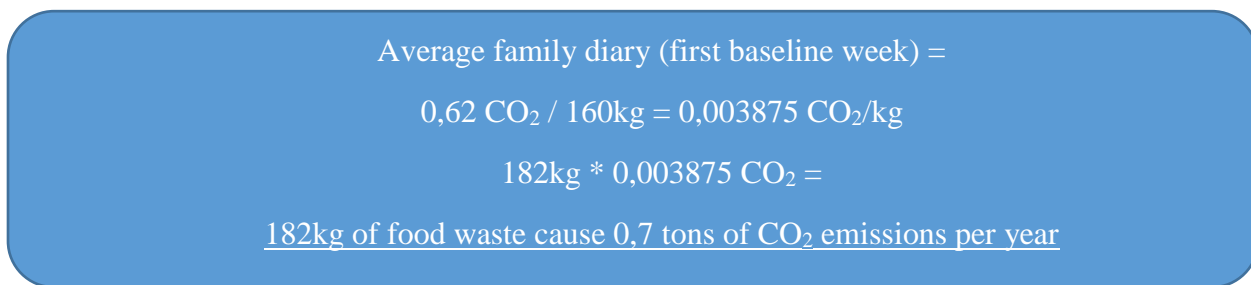


Figure 5 - Average family annual emissions found during Baseline week

4.2 Phase 2: Understanding waste behavior and identifying target behavior

In order to get a better understanding of food waste behavior, ten interviews conducted in IMT4882 Specialization II and three follow-up interviews performed when collecting the diaries were analyzed [21]. Data gathered from interviews were in the form of handwritten notes. These were digitalized and organized prior to analyzing the interviews in order to find themes and coherences within each of the four pre-defined sections of the interview guide (Appendix D). Findings discovered which relates to procurement, usage, situations and assumptions are explained below [21]:

Procurement

The meeting began with making inquiries of how they secure and arrange the food that they would eat. Three coherences were found:

1. Shopping list

Most of the interview participants utilized a shopping list when arranging what food to purchase. The individuals who did not utilize a shopping list, purchased more than they had initially arranged "in their mind". For the families that sat down together and arranged their acquisition of

nourishment got the inclination that they didn't discard as much food as they would on the off chance that they were not making a shopping list.

2. Overall planning

When it boils down to how individuals were arranging their sustenance utilization, a few participants were shopping food consistently, while some were getting ready for days and even weeks. The individuals who bought food consistently were the ones that were discarding more food than the individuals who planned for a more extended term.

3. Preferences

In this interview study, it was found that youthful participants had diverse nourishment inclinations contrasted with older participants. The older participants communicated that they could have a similar supper the following day, while the more youthful participants communicated that they might want something other than what's expected every day. The youthful participants subsequently discarded scraps.

Usage

Related to the general usage of food, four different coherences were discovered where participants throw away food:

1. Leftover food

Most participants communicated they normally made excessively food identified with their everyday needs. The food was consequently discarded; as it was either not convincing to eat the remaining food the following day, or that it was insufficient food left to make a new entire meal.

2. Buying too much

The participants were purchasing excessively nourishment identified with their requirements. With not having the capacity to eat it up before it expires or turns bad (e.g. gets moldy), the participants would discard this food.

3. Taste and feel

The food was judged based on its taste and feel. Participants communicated that they were regularly discarding bread because of it getting to be plainly dry or hard, and that it would wind up noticeably dry before they would have the capacity to eat it up.

4. Dried goods

Dried products were additionally observed to be a noteworthy reason of food waste. Participants communicated that they would collect dry merchandise, for example, flour. The reason for this was they would not check that they as of now had dried goods at home, and would wrongly expect they were out. They would in this manner acquire new merchandise at the store, and while putting it away at home, they would understand that they had acquired this type of products. By having amounts of dry merchandise gathered over the long run, they would after some time feel compelled to discard these products.

Situations

In this part of the interview, the intention was to check whether there were particular circumstances that affected the conduct of discarding food. Every one of the thirteen interviewed communicated that they didn't prefer to discard food, yet all participants did this in some way or another. Some did discard a considerable amount, while some were more waste-mindful.

1. Stress

There was cognizance that individuals would discard food when they would have little time to arrange as well as when their day by day life was upsetting.

2. Economy

Participants were not generally excessively concerned in regard to the environment, however, they would concentrate on their economy, and how they could spare money on discarding less. At the point when participants had recently received their paycheck and additionally when their own economy was better, there appeared to be a higher probability that they would discard more food.

3. Leisure time

In the ends of the week and on vacations, participants expressed that they would have a more casual disposition towards food and that they would like to enjoy themselves. They communicated that this situation made them purchase more food than they had time and probability to eat. Further, if leaving for an occasion, they would overlook food stocks and would need to discard these when returning from the holiday, predominantly because of expiring dates.

Assumptions

Related to assumptions on why participants think other people throw away food, the results show five coherences or themes:

1. Availability

Because of huge accessibility of food stores in Norway, the participants felt that it didn't cost much push to go to a store in the event that one was requiring something.

2. Economy

The participants saw the economy among both families and singles in Norway as good, and the ones interviewed felt that the solid economy is likely a reason of why individuals are discarding eatable food.

3. Expiring date

Because of the recent media focus, and the strict controls towards the expiring date, expiring dates appears to have turned to be a reason of why individuals are discarding food. Participants said that, despite the fact that an item has expired, a few food items are as still eatable. Be that as it may, because of lacking information of which items are safe to eat after expiring date and which are not, they would toss all expired food items.

4. Non-environmental focuses

The participants expressed that other individuals couldn't care less about the earth, or how food squander influence discharge emissions. Instead, they believed that customers' spotlights are on eating food that is nutritious, and on how the food influence their economy.

5. "Throwaway" culture

At last, the participants saw Norwegians as rather spoiled; needing food assortment and therefore having desire to have something else to eat (e.g. for supper) consistently. They expressed that Norway has turned into a "utilization and disposable" society.

The analysis done in this master study by counting occurrences in the interviews revealed several reasons as to why people throw away food that is still edible. This would inform what behaviors to target. Identified reasons are categorized and presented in Table 5.

Reasons for food waste	Description
Procurement 1: Shopping list	8/13 uses a shopping list on regular basis
Procurement 2: Planning	8/13 are not planning before shopping
Procurement 3: Preference	9/13 were wanting something new every day
Usage 1: Desirability	12/13 have leftover food after each meal
Usage 2: Buying too much	11/13 are buying too much
Usage 3: Taste and feel	13/13 said that food was based on taste and feel
Situation 1: Stress	8/13 waste food because of stress
Situation 2: Economy	13/13 said their economy is more important than the environment
Situation 3: Leisure time	8/13 said that there was an increase in food waste in weekends and/or holidays
Assumption 1: Availability	11/13 thought that the availability of food was one reason other people waste food
Assumption 2: Economy	13/13 meant that the strong economy among people in Norway is one reason
Assumption 3: Expiration	10/13 meant that expiration date on food products caused other people wasting food
Assumption 4: Non-environmental focus	11/13 meant that other people are not concerned about environmental emissions
Assumption 5: Culture	9/13 viewed Norwegians as spoiled

Table 5 - Results by analyzing interview data from IMT4882 Specialization II

Next, based on number of times and number of families mentioning reasons of why they waste food during baseline week were identified. From each food waste category, see Table 6, there were three behaviors that were understood to have the largest possibility for a positive environmental impact reduction and that were mentioned most times as reasons for people wasting food.

Food waste category	Reasons for waste in category	Times mentioned	Families
Leftovers	Leftover food thrown due to stress/non-planning	4	1

	Leftover food not desirable to eat	16	5
	Accumulated quantities	5	2
Taste and feel	Turned bad	16	5
	Decreased quality due to age	3	2
Food Safety	Expiring date	9	5
	Forgotten	3	3
	Poor preparation	3	2

Table 6 - Number of times and number of families mentioning reasons for waste during Baseline week.

4.2.1 Selecting potential target behaviors

By analyzing both the diary data, follow-up interviews and the interviews conducted in IMT4882 Specialization, it gave a better understanding of waste behavior and what potential behaviors to target. To decide on what potential behaviors to target, the interview and baseline data were compared. Behaviors that were mentioned the most times in both the interviews and baseline week, were selected as potential target behaviors.

A second criterion for choosing target behaviors was to select at least one behavior from the established food waste categories Leftovers, Taste and feel or Food safety (Table 6). The first potential behavior that was decided to target was **Behavior 1 - leftover food**. This behavior was discovered both in the interview study and mentioned the most as being a reason for food waste during baseline week. In addition, results related to product category showed that bread and vegetables were wasted because participants did not have enough knowledge on how to use it in a new dish. It was also found in the interviews that dried goods would accumulate over time and was believed to a source of food waste. Based on these findings, this behavior was decided to be the main target behavior.

Further, the next behaviors to target, **Behavior 2 - turned bad** and **Behavior 3 - expiring date**, were also found both in the interview study and baseline week to contribute more to food waste than other discovered behaviors. In addition, because of the high response related to the economy as to why people waste food in the interview study, the economy as a reason for food waste was not discarded but brought along through the next phases.

Finally, at the end of Phase 2, it was now clear what potential target behaviors to focus on and bring along to Phase 3. The three potential target behaviors and justifications for selection are listed below:

Behavior 1 – Leftover food

Interview study: Usage 1: Desirability, Procurement 3: Preference, Assumption 5: Culture. (12/13 families said that leftover food was one reason for food waste)

Baseline week: 16 times mentioned and by 5 families.

Behavior 2 – Turned bad

Interview study: Usage 2: Buying too much, Assumption 2: Economy, Situation 3: Leisure time (11/13 families said they were buying too much food in relation to what they would eat.)

Baseline week: 16 times mentioned and by 5 families

Behavior 3 – Expiring date

Interview study: Assumption 3: Expiration (10/13 families said that they would throw away food products that had expired)

Baseline week: 9 times mentioned and by 5 families.

4.3 Phase 3: Determining intervention types

The three potential target behaviors identified in Phase 2, Behavior 1 – Leftover food, Behavior 2 – Turned bad and Behavior 3 – Expiring date were used together with the behavior change wheel in order to better determine what intervention types that could be used. When deciding on what intervention types to use, each behavior was placed onto the behavior change wheel model. This resulted in choosing five potential intervention types:

1. Social opportunity – **Education** and **persuasion**.
2. Physical opportunity – **Incentivization**.
3. Reflective motivation – **Coercion**.
4. Physiological capability – **Modeling**.

Table 7 and 8 show the various sources of behaviors for the potential target behaviors to occur and maps these to the identified practices.

Source of behavior	Behavior to target	Mapped to practices	Intervention
Social opportunity	Leftover food	<ul style="list-style-type: none"> • Usage 1: Desirability • Procurement 3: Preference • Assumption 5: Culture 	Education (increase knowledge or understanding)
Social opportunity	Expiring date	<ul style="list-style-type: none"> • Assumption 3: Expiration 	Education (increase knowledge or understanding)
Social opportunity	Leftover food	<ul style="list-style-type: none"> • Usage 1: Desirability • Procurement 3: Preference • Assumption 5: Culture 	Persuasion (use communication to induce positive or negative feelings to stimulate action)
Social opportunity	Turned bad	<ul style="list-style-type: none"> • Usage 2: Buying too much • Assumption 2: Economy • Situation 3: Leisure time 	Persuasion (use communication to induce positive or negative feelings to stimulate action)

Table 7 - Reasons for intervention type selection

Physical opportunity	All	<ul style="list-style-type: none"> • Usage 1: Desirability • Procurement 3: Preference • Assumption 5: Culture • Usage 2: Buying too much • Assumption 2: Economy • Situation 3: Leisure time • Assumption 3: Expiration 	Incentivization (create an expectation of reward)
Reflective motivation	All	<ul style="list-style-type: none"> • Usage 1: Desirability • Procurement 3: Preference • Assumption 5: Culture • Usage 2: Buying too much • Assumption 2: Economy • Situation 3: Leisure time • Assumption 3: Expiration 	Coercion (create an expectation of punishment or cost)
Physiological capability	All	<ul style="list-style-type: none"> • Usage 1: Desirability • Procurement 3: Preference • Assumption 5: Culture • Usage 2: Buying too much • Assumption 2: Economy • Situation 3: Leisure time 	Modeling (create an example for people to aspire to or emulate)

	<ul style="list-style-type: none"> • Assumption 3: Expiration 	
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Table 8 - Connection between source of behavior, behavior to target and intervention type

Finally, at the end of Phase 3, the intervention types that was believed to influence the potential target behaviors were selected. The intervention types were: education, persuasion, incentivization, coercion and modeling. The selected intervention types were then brought along to Phase 4 where an intervention solution was designed.

4.4 Phase 4: Designing interventions

In this chapter, the process of iteratively designing, prototyping and user testing intervention solutions is presented.

4.4.1 Gamestorming

To generate ideas based on the chosen intervention types and target behavior, gamestorming were used. Gamestorming is quite similar to regular brainstorming, but incorporates three different phases and use games to generate ideas [22]. The three distinct phases are opening, exploring and closing. In the opening phase, players are encouraged to generate ideas, without any restrictions. Next, in the exploring phase, players use multiple ideas generated in the opening phase, to generate one idea. Finally, in the closing phase, players vote on the ideas that they like the most or ideas that they believe most in.

Six participants were recruited to this idea generation session. The six participants were grouped into three groups, on which they would cooperate with the other participant generating ideas. The gamestorming game ‘3-12-3 Brainstorming’ were chosen based on the small time limit each participant would have when generating ideas. The participants were instructed to hold no ideas back and that no ideas were too dumb. For the first 3 minutes, each player wrote down one idea per sticky note. For the next phase, all ideas were placed into one pool, with the ideas placed down. Then, each team would pick two sticky notes. Based on the picked sticky notes, each team had 12 minutes of generating ideas of concepts. Lastly, each group presented their concepts and the “best” concept was decided on by using ‘Dot voting’. This meant that each player could draw maximum five dots next to the ideas each player liked the most or believed most in. Table 9 shows all conceptual ideas generated at gamestorming.

The participants voting resulted in the following design scores, see Table 10. Based on these results, the intervention design could be a website where people could get educated on how to make the use of different food ingredients, recipes based on leftover food and some functionality that would show the users how much money they would save on wasting less food, by giving them some sort of reward. From the five potential intervention type that were brought along from Phase 3, there were now two intervention types that were decided on, which were education and incentivization.

Intervention type	Behavior	Generated concepts
Education	<ul style="list-style-type: none"> • Leftover food not desirable to eat • Expiring date 	<ul style="list-style-type: none"> • How to make the use of different food ingredients • Recipes based on leftover food
Persuasion	<ul style="list-style-type: none"> • Leftover food not desirable to eat • Turned bad 	<ul style="list-style-type: none"> • By throwing away less food you are saving the environment.
Incentivization	<ul style="list-style-type: none"> • Leftover food not desirable to eat • Turned bad • Expiring date 	<ul style="list-style-type: none"> • Save money to be used for a better meal or something else • If you throw less than a certain amount, you will get a reward. “By doing well, you have saved...”
Coercion	<ul style="list-style-type: none"> • Leftover food not desirable to eat • Turned bad • Expiring date 	<ul style="list-style-type: none"> • If you throw more than a certain amount, you will get a penalty • Leaderboards across families
Modeling	<ul style="list-style-type: none"> • Leftover food not desirable to eat • Turned bad • Expiring date 	<ul style="list-style-type: none"> • Create role models at home, kindergarten, school • Play on emotions. There are other people in the world that do not have access to food. • Famous persons proceed by example

Table 9 – All conceptual ideas generated at gamestorming

Intervention type	Behavior	Generated concept	Score
Education	Leftover food not desirable to eat	How to make the use of different food ingredients	1
Education	Expiring date	Recipes based on leftover food	2

Incentivization	Leftover food not desirable to eat	If you throw less than a certain amount, you will get a reward. “By doing well, you have saved...”	3
	Turned bad		
	Expiring date		

Table 10 - Final concepts after performing ‘Dot Voting’

4.4.2 Sketching ideas

Before starting designing a digital prototype, the ideas generated at the gamestorming session that received the highest scores were sketched on paper and were used as an inspiration/aid when generating new concepts (Appendix F).

4.4.3 Prototyping interventions

The prototype design was an attempt to influence the target behaviors: 1) Leftover food, 2) turned bad and 3) expiring date. The prototype can be seen in Appendix G or [26]. The prototype included a navigation where users could navigate to different subpages and the home page had the focus on letting users enter what leftover food they would have and then search for recipes based on this. In addition, a slogan, telling people that by using this website, they could both save money and spare the environment by wasting less food, since the economy was found to be a reason in the interviews for people not wasting food.

Next, to influence and possibly change the behavior of leftover food, the prototype included a subpage, named ‘leftover recipes’, where users could browse leftover recipes. Users could enter what type of food they had leftover or filter it by food categories. The reason for choosing these six categories was based on what food people often threw away during baseline week (Appendix C).

Further, the next subpage included six tips on how to minimize food waste, which was targeted at the behaviors of 2) turned bad and 3) expiring date. By trying to educate people on what to look out for and how to use their sense of smell and taste before throwing food away.

The last subpage included a personalized page, where users could save favorite recipes and track their achievements when using this website. This page was designed with the intent of giving users an incentivization of wasting less food and introduce the social aspect of wasting less.

4.4.4 Guerilla testing

Three random people were approached. Their tasks were split in two, where the first task was to tell what they thought this website was about, based on their first impression when looking at the home page. Secondly, what information and functionality they would believe was included on the different subpages of the website.

Results from guerilla testing:

- All said that their first impression was that the website was about food and leftover food recipes.
- All said nearly correctly what was behind the different subpages (navigation links gave the right meaning to them).
- What they could do on ‘Leftover recipes’ page was understandable.
- ‘Tips’ page made sense to them.
- What content that was located on ‘My profile’ page was not that easy for them to know, but they said that it had something to do with their personal profile on this page.
- One person would have liked more information on the main page about what kind of website this is and that the most popular recipes would have an own section on the front page.
- One person was missing the option of sharing on Instagram and the use of hashtags.

Based on the results gathered from guerilla testing, there was performed one adjustment to the prototype. The adjustment was to include more information on the main page, explaining to potential users what type of website this is.

4.4.5 Expert testing

The expert testing revealed several issues with regards to responsiveness, search functionality, content editing, use of colors and adding/removing functionality to the website.

During the iterative development of the website, the personalized page was exchanged with a page that let people learn more about different food items. This was done in an attempt to target the identified behaviors, 2) turned bad and 3) expiring date. From this page, users could search and learn more about food that may still be edible, dangerous to eat or food that could be used in different recipes rather than wasting the food.

In addition, the page that included tips related to helping minimize food waste were adjusted based on findings in this research study. Further, the blue color that was used in the prototype were discovered to not be an appetizing color. Therefore, the green main color used in the final design was extracted from the background image on the front page and used instead.

4.4.6 Usability testing

Before the participants of the final baseline week were given access to the developed intervention design, the website went through one round of usability testing. The usability test was done together with four participants. By usability testing the website, there were three major usability issues that were needed to be fixed:

1. Leftover recipe page (resteoppskrifter): When users have chosen a recipe that they would like to read more about, the image and link should both be clickable. Now, it is only the link that is clickable. **The whole individual recipe element was made clickable.**
2. Check food (sjekk maten): Out of the four that tested the website, three participants hit the enter button on the keyboard and not the search button, when searching for more information about different food, which returned them with no information. **Both search options were made available to the users.**
3. Check food (sjekk maten): When testing on a laptop, all participants entered the search query with lowercase letters. This returned them with no results since they would have to capitalize their search in order to retrieve information about the different food items. When using this website on mobile and entering information into an input field, the standard is that the mobile device automatically capitalizes the first letter to be inputted in a search field. **The search should return results both with lowercase and capitalized search queries.**

4.5 Phase 5: Testing intervention effect against identified baseline

To be able to measure the intervention effect, a second run with diaries were performed using the final intervention design. The intervention design can be seen in Appendix K or [27]. The participant's tasks were similar to the baseline week, asking them to keep a diary and note down what food that was wasted, reasons for this and how many garbage bags were thrown away over one week. In addition, the participants were tasked with freely using the intervention and answering the following three questions each day related to the intervention use:

1. Have you used the website today?
2. Describe what you used the website for.
3. Have you made a leftover meal today?

Data from the baseline week were used in order to measure the effect of the designed intervention. Figure 6 illustrates what participants said to be the reasons for food waste during the first baseline week. Next, Figure 7 show reasons for food waste during the final week. Results show there is a decrease in reasons related to leftover food not being desirable to eat and a slight increase in people throwing away food due to food that has turned bad. There are no reported reasons related to expiring date of food products during the final week.

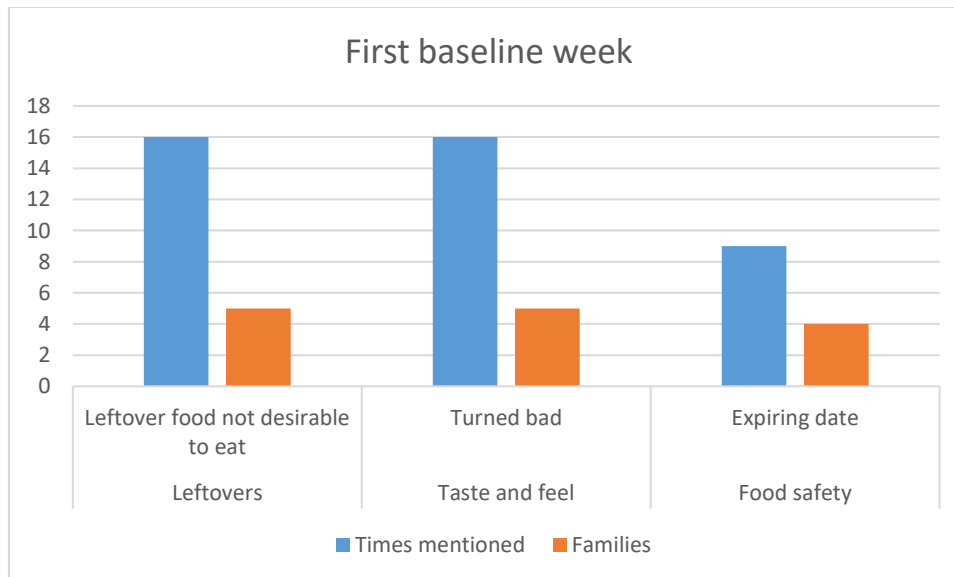


Figure 6 – Reasons given for food waste during first baseline week

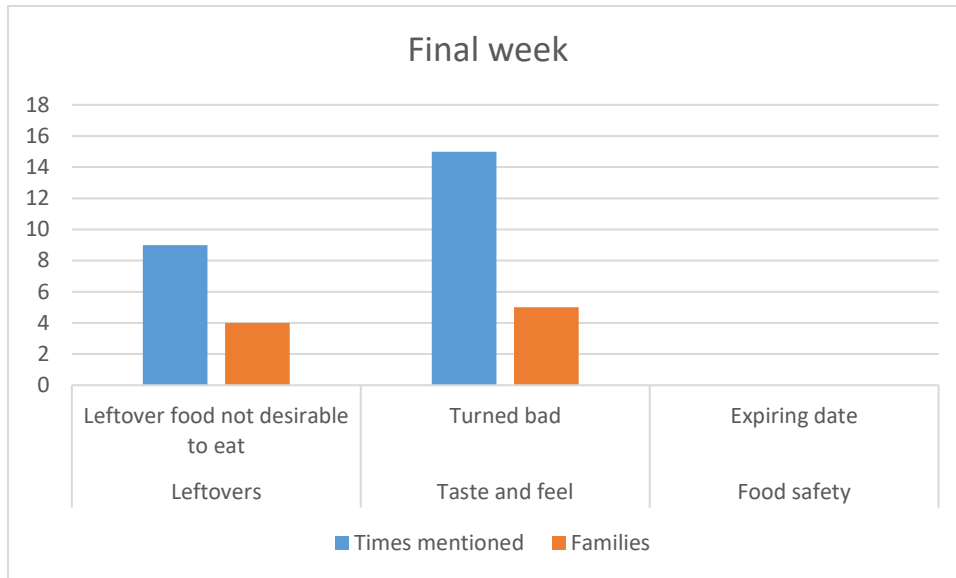


Figure 7 - Reasons given for food waste during intervention test week

Figure 8 and 9 show the comparison of total garbage bags from the first baseline week and the final week when utilizing the designed intervention.

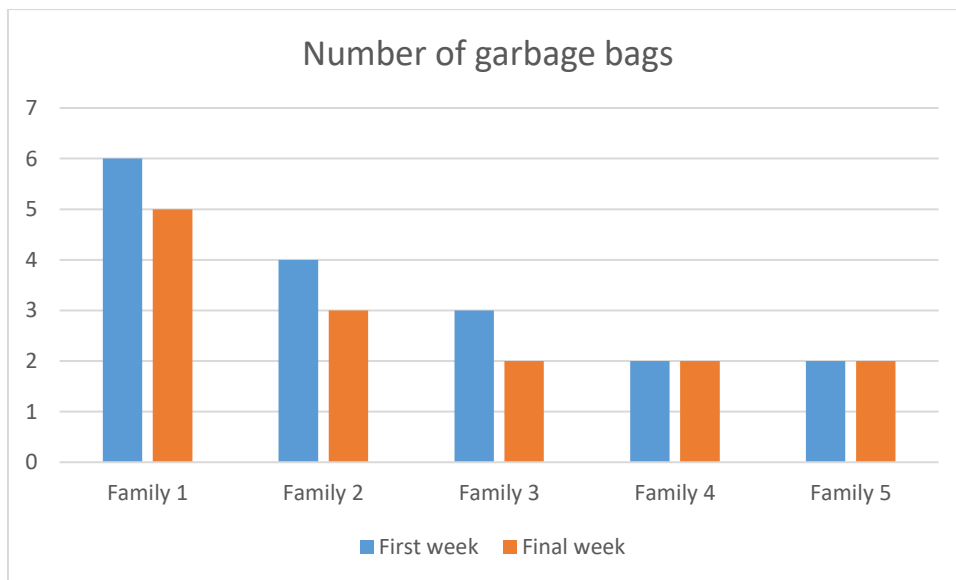


Figure 8 - Comparison of total garbage bags each family throw away



Figure 9 - Comparison of total garbage bags thrown

Finally, information about how the participants were using the designed intervention is illustrated in Figure 10. Family 1 visited the website three times and making two leftover meals based on recipes that they found on the website. Family 2 used the website once, using the website to learn more about different food products and usage. Family 3 visited the website twice when obtaining more information about food products. Family 4 visited the website two times, resulting in making one leftover meal based on the recipes on the website. Finally, Family 5 used the website one time and was using the website to obtain inspiration for new recipes.

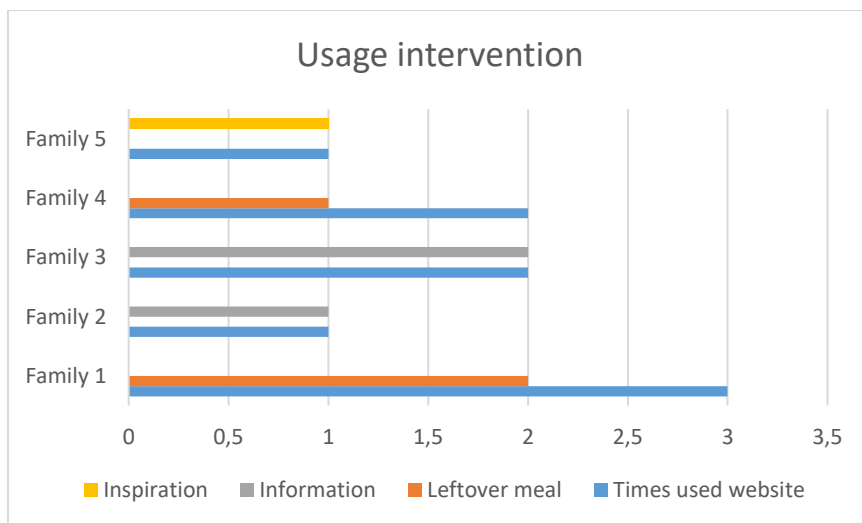


Figure 10 - Participants usage of designed intervention during final week

After analyzing data gathered from the final week, calculations were done in order to estimate the measured effect of the designed intervention over time:

Calculations done based on first baseline week:

Average family diary (first baseline week) =

$$0.62 \text{ CO}_2 / 160\text{kg} = 0.003875 \text{ CO}_2/\text{kg}$$

$$182\text{kg} * 0.003875 \text{ CO}_2 =$$

182kg of food waste cause 0.7 tons of CO₂ emissions per year

Calculations done based on final week:

Average family diary (final week) =

$$145\text{kg} * 0.003875 \text{ CO}_2 =$$

145kg of food waste cause 0.5 tons of CO₂ emissions per year

These calculations estimate that the average family would have wasted almost 40kg **less** food per year, if each week for a year were the same as final intervention test week instead of the baseline week. The environmental benefit of such a change is a decrease in CO₂ emissions with 0.2 tons per year per family. To compare this to something more tangible, the estimated environmental reductions equal the energy use of an average household for 5.5 days [28].

5 Discussion

The objectives of this research study were to investigate if one could change food waste behavior through user-centered design. This chapter reflects on the methods used and findings presented in the previous chapters and relate this to the initially established research questions. First, to what degree insights into food waste behavior gathered through user-centered design can be used to reduce food waste. Secondly, discussing how behavior change theory can be merged with user-centered design when designing an intervention. Finally, how a user-centered design approach can be utilized to influence inexpedient and unsustainable behavior.

5.1 Insights into food waste behavior gathered through user-centered design

By using a qualitative and user-centered approach, this study has contributed into understanding and gaining new knowledge into target food waste behavior from the user's perspective. By performing user research in Phase 1 and 2, and through the iterative design process in Phase 4, it has been found that users do not have enough knowledge of the different food items and how to make use of different food ingredients. Because of this lack of knowledge, it has been discovered that it is more convenient to throw the food in the garbage bin and then go to the store to buy new food ingredients. To illustrate this, most families said in the conducted interviews that they would have leftovers after each dinner, but because of it not being enough for next day's dinner, they would throw this away and make a new type of dinner. This behavior was particularly prominent when the economy of a family was seen as good, and especially when the parents in the family had just received their salary.

Further, this study has identified which of the detected behaviors are the most negative for food waste and that seem key to change in order to reduce food waste. The identified behaviors 1) Leftover food, 2) Turned bad and 3) Expiring date are believed to be the main behaviors for why people waste food. Of the one interviewed, the participant was saying: "There is always leftovers after dinner, which usually ends up in the garbage bin. Even when we save leftovers planned to be used the next day, we end up wasting it." A different participant expressed: "It usually happens that we find food that we have forgot about, and because it has turned bad, we have to discard it". Lastly, a common answer regarding expiring date sounded like this: "If the expiring date has expired, we would most likely discard this food because of health reasons".

During this research study, user-involving methods such as gamestorming, guerilla testing and usability testing were not viewed as methods giving new insights into which food waste behaviors to target. However, these methods were supporting aids for designing an intervention that people would want to use and would be able to make the use of. Interviews and diaries were found to be the user-involved methods that gave the most valuable insights.

The use of diaries was the most successful method used to gather data in this research study. By having two weeks of diary keeping, it gave valuable information in understanding waste behavior and finally being able to evaluate if the proposed intervention influenced the targeted behaviors. The duration of one week per diary was seen as sufficient and it should not be much longer than that based on feedback from the participants. Overall, feedback from participants regarding participating using diaries, were positive.

Some drawbacks with using diaries are that one does not have full control of the experiment, since participants are trusted to keep the diary. It is therefore viewed as essential that participants are well briefed before starting the experiment. For future research, it is recommended to check in regularly with the participants and hear how the experiment is going, either by contacting them directly or address that if they are unsure about something, they should contact you.

5.2 Merging behavior change theory with user-centered intervention design

Behavior change theory was combined together with a user-centered design approach in order to identify target behaviors interventions. Based on findings through interviews and diaries, target behaviors were established. Since Zachrissons proposed process model is based on the behavior change wheel, this model was a good aid to steer this process in the right direction when designing for a behavior change.

The combination of Zachrissons process model together with a user-centered approach was also discovered to be a combination that worked well. In a user-centered approach one tries to understand your users better and base the design on findings, decide on an approach to solve the problem and finally measure the effect of the design, and these steps were overlapping with Zachrissons prototyped process for industrial design. However, it also seemed necessary to make some adjustments in this research study in order to combine the prototyped process with a user-centered approach. This led to the development of “Process Model for Informing User-centered

Design for Sustainable Behavior”, see Figure 11. This model gave the possibility to iterate back and forth between the different steps until a full understanding of the topic were reached.

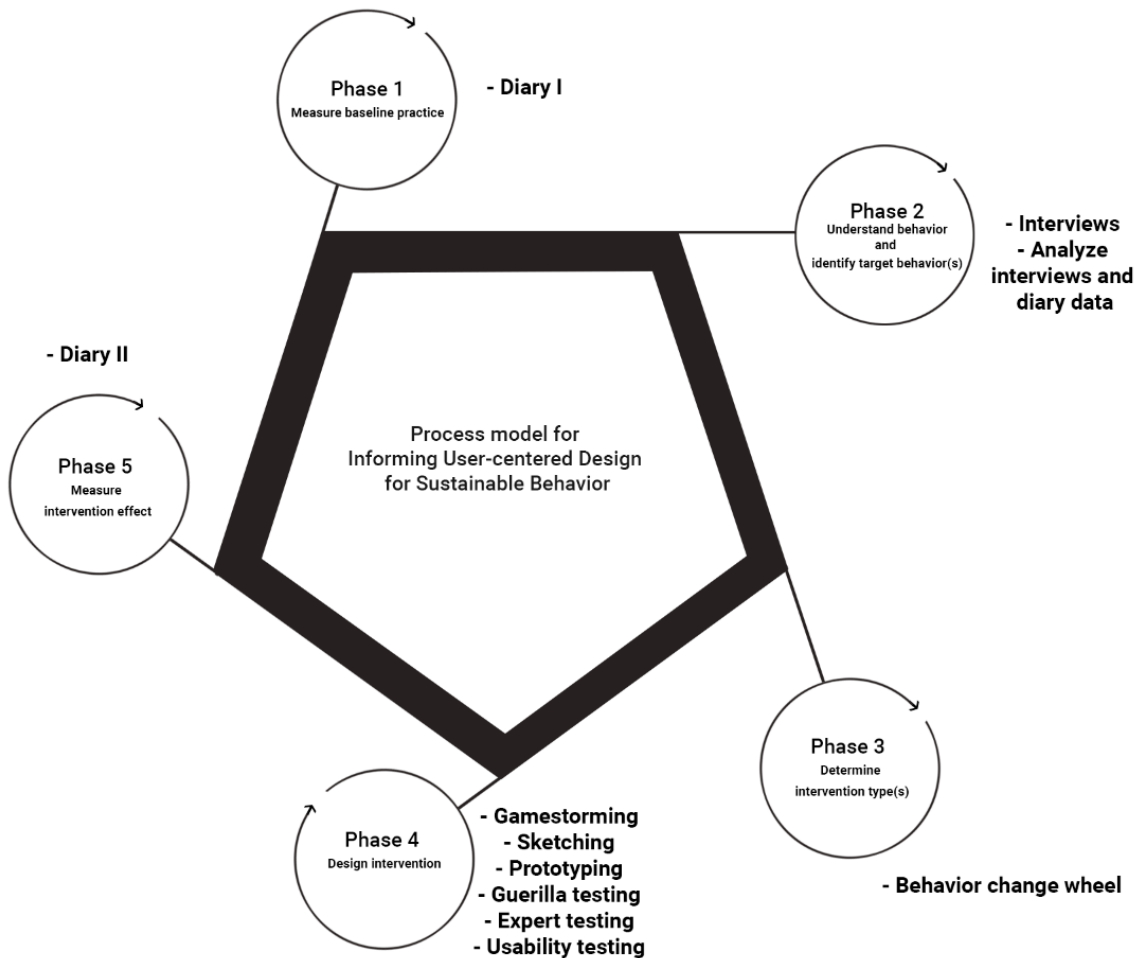


Figure 11 - Process Model for Informing User-centered Design for Sustainable Behavior

Further, to be able to determine intervention types, the behavior change wheel was used. The behavior change wheel proved to quickly offer an easy-to-understand overview of intervention type possibilities based on research into changing user behavior. However, it was not clear how the selected intervention types would work, and what criteria should be used for selecting the intervention type. Still, the behavior change wheel was found to be a good aid to consider interventions, such as education, persuasion and incentivization.

From an interaction designer view, the literature research within the psychology field helped generate ideas and concept strategies when trying to change behavior. From a retrospective perspective, the behavior change design cards discovered when performing initial background research were not used. The design cards were discovered quite late in the process, but could

have been a better fit for an interaction designer to make the use of instead of selecting intervention types from the behavior change wheel.

5.3 Utilizing user-centered design to change unsustainable user behavior

This research study aims at contributing with more knowledge on how to utilize qualitative, user-centered and user-involved approaches to influence inexpedient and unsustainable behavior. In 1983, Schön presented his theory on how to think reflectively [29]. Schön divided his theory into two different types of reflection; reflection in action, which is done during an activity, and reflection on action, which is done after an activity. In this section, his theory on reflection on action has been used as a guide in order to reflect back on process of this research study. As this research study was structured with going through five different steps, reflection will be made on which of these parts gave most value for the user centered designer aiming to change user behavior, and value to the overall field of interaction design.

In relation to sustainable design and designing for behavioral change, this study has investigated unsustainable behaviors using a user-centered design approach. Within the sustainable design field there is a need to both do quantitative research, but also qualitative research when addressing an unsustainable behavior. The part that gave most value during this research study may be the initial data gathering, collecting, measuring and analyzing user data through diaries and interviews. This gave a clearer understanding of **why** food waste behavior is occurring and was valuable to be able to design an appropriate intervention.

The data gathered from Phase 1 and 2, making use of user-centered methods such as diaries and interviews, could be used for further research within the sustainable design field. As such, research performed in this study could be of value for the sustainable design field, exploring and measuring how designed interventions can be utilized to change user behavior and create positive environmental impact reductions.

Secondly, interacting with users in Phase 4, generating concepts and testing the intervention design, gave inspiration on how to design the final intervention. After debriefing the participants that participated in the evaluation of the intervention, they expressed that even though they did not use many leftover recipes, they had gained inspiration on making use of food leftovers. In addition, related benefits by participating were that the participants expressed that the feeling of wasting food was not a good feeling and that they were now thinking twice, because of

participating in the experiment. Thus, regardless of intervention type, just having an intervention may in itself contribute to behavior awareness and change. It seems this intervention effect is already starting to influence through the user involvement in the design process.

A part of the five-step process that could be improved upon, is aiding the designer more on what criteria should be the basis for intervention selection; how the target behaviors should relate to potential intervention types. When you have defined a problem and you have an in-depth understanding of the problem, based on which knowledge and which contexts of use should you choose one intervention over another?

The effect of the proposed intervention was not seen as an intervention that would change food waste behavior entirely on its own. To be able to fully change behavior, users would have to be motivated of changing their behavior, and would probably take more than one week to change. It could have been interesting to see if the new and improved behavior would be sustained if the intervention had been evaluated over a longer time span.

Even though the effect of the proposed intervention in this research study did not dramatically change waste behavior, the identified behaviors seem key to be able to change food waste behavior. This research study has proposed one iterative and user-involved intervention design process. If performing a similar research study in the future, different user-involved methods for user research and user involvement could also be explored, such as observation or ethnography studies.

5.4 Limitations of this study

In this study, semi-structured interviews and diaries were used to get an overview of why food waste is occurring in the sample. When performing interviews, a participant's response can be unspesific and sometimes not reflect the whole truth. To improve the internal validity of this study, observations could have been conducted to confirm or disconfirm the credibility of the participant's response in the interviews and to verify the use of diaries corresponds to the researcher's assumption. For example, observations could have conducted in situations when data is given – such as observing the informants cleaning up after dinner and filling out the diary – or in situations that involves related interview data – such as participating in grocery shopping

activities. Due to time limitations, observation was not selected in this research study, and instead the researcher relies on the reflections made in publications using the methods in related studies.

The process, phases and methods used in the study have been attempted thoroughly explained. This has been done in an attempt to increase the external validity and reliability of the research. Further, each diary participant has been instructed on the use of the diary forms and data gathering process, and the assumption is thus made that they have used the forms in the same way and as intended by the author. Further, when performing interviews all participants have been introduced the subject topic the same way before starting. All interviews have followed the structure of the semi-structured interview guide, with the exception of emerging open topics changing from participant to participant since they were encouraged to talk freely.

Since the findings in this research study are based on qualitative methods and therefore involves a small sample size, it is rather difficult to generalize it to other populations. However, since this study aims at being an exploratory study, the primary aim is on in-depth knowledge of food waste behavior and increased experience related to the topic of by changing food waste behavior through user-centered design methodology – and not on generalizability. Nonetheless, the small N and also the short time period for data gathering and user testing should be noted as study weaknesses.

5.5 Future research

The way economy play as a role in relation to food waste has be found to be an unexpected and interesting factor. It seems that the better a family's economy is – not only between families but also within the fluctuations in each family economy, the more food is likely to be wasted. From a retrospect, economy could have received more attention when selecting behaviors to target when designing the final intervention. For example, it would have been interesting to see if food waste could be minimized by using an intervention type that would give participants with a preferred behavior an economic incentivization and give participants with a non-preferred behavior a coercion. Thus, relationships between economical perspectives and food waste behavior are considered highly relevant for more investigation in future research.

To confirm the response gathered from interviews and verify the use of diaries, observation should be used as a method in future research. This could be done by conducting home visits and

observing how a family would clean up after dinner. It would also be interesting to observe how participants would procure their food and if observations would reveal other key behaviors. The key behaviors identified are believed to be the main reasons for food waste. However, the small N and the short period used for data gathering, could be improved by extending this research study and involving more participants – ultimately increasing the generalizability.

By merging user-centered design and behavior change theory in this research study, it was discovered that the identified behavior change theory sources did not support the decision-making process of selecting a specific intervention type for the case at hand or assisted in designing the intervention. The view is practical issues related to selecting and applying behavior change theory should be developed more in order to successfully merge it with a user-centered design approach. For example, designers could benefit from clearer guidelines on selecting intervention type based on the intervention target group, the type of behavior one aims to change and where (context) the targeted behaviors are taking place. In addition, the design process would have benefitted from a stronger design link to behavior change theories. Design cards for implementing behavior change theory into the design was discovered somewhat late in the design process, and thus the usefulness of these were not fully explored in this study. The usefulness of these cards could be further explored in future studies continuing the merge between the methodologies.

6 Conclusion

Current food waste behaviors are not sustainable in the long run. Minimizing the amount of food that is not being consumed by a human being is important in order to minimize carbon dioxide emissions and ultimately reduce global warming. This study has investigated how a user-centered approach can be utilized to design interventions that influence user behavior on food waste. To set a reference point and measure the intervention effect, five families used diaries to track their food waste. The interview study performed in IMT4882 Specialization II were extended with additional three interviews in order to understand food waste user behavior and what inexpedient user behaviors that should be targeted.

The study has three main contributions. First, the study answers the call from the field of waste research on adding more in-depth qualitative and user-centered research to further the understanding of underlying reasons for waste behavior. The study analyzes which negative behavior(s) related to food waste could be targeted through design interventions, identifying key negative behaviors. Through this first contribution, the thesis contributes to added in-depth knowledge in the field. Based on the qualitative data from interviews and diaries, negative behaviors were mapped out, linked to A) Leftovers, B) Taste and feel and C) Food safety. In addition, it is hypothesized that a family's economy is linked to food waste.

Key behavior to target is identified as: (1) **Leftover food.**, (2) **food turned bad** and (3) **expiring date**. Findings related to (3) expiring date showed that young participants did not have sufficient knowledge of what food products would be safe to eat, and would throw away food indiscriminately if it had expired. Further, buying too much food is a common behavior resulting in food waste, for example through an accumulation of dried goods, which would (2) turn bad. Too much food also creates unnecessary leftovers. The main influences on key behavior (1) leftover food were found to be: a) the **time of day** when people eat, b) the **type of meal** and c) the **day of the week**. The assumption related to people wasting more in their spare time was confirmed in the diary results. The types of meals generating the most food waste in the sample were dinner and breakfast. During dinner, participants would often waste leftover vegetables. During breakfast, bread crusts were wasted. Finally, on Saturday, Sunday and Monday more food is wasted compared to the other days of the week.

Second, the study investigates how to influence and change identified negative food waste behaviors through design interventions in order to make them more sustainable. The study iterative explores and tests how a designed intervention can be utilized for the aim of reducing food waste. Based on gathered insights on negative behaviors and from behavior change theory, it was deemed likely that the intervention type **education** should be efficient for influencing this target behavior. By measuring the effect of the designed intervention in Phase 5 against baseline practices identified in Phase 1, the effect of the intervention could be tentatively measured. The effects were positive, and it seems the education intervention raised awareness and contributed to a minor reduction of food waste. The results indicate that such a designed intervention has the potential to change food waste user behavior through user-centered design.

A third contribution is the experiences related to merging design disciplines and behavior change theory; exploring the use of user-centered design processes for changing user behavior. Within the design process, methods from behavioral theory were utilized in order to understand human behavior and possible intervention types. The merge between behavior change theory and user-centered design was found to work well together when defining a problem behavior and understanding reasons for these behaviors to occur. However, behavior change theory and user-centered methods should be developed more to guide the interaction designer when selecting intervention types. The study prototypes a user-centered behavior change design approach, drawing on traditional user-centered design process and user-involved practices within the field of sustainable design. A process model for informing user-centered design for sustainable behavior (Figure 10) is proposed.

Further research is suggested on increasing the sample size and incorporating observation when gathering data about food waste behaviors. This could help confirm the credibility of the participant's response and help selecting the more appropriate intervention type. Since economy was found to be an unexpected and interesting factor contributing to food waste, it would be interesting to investigate how economy impacts food waste.

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Appendix A – Diary forms

	Breakfast	Lunch	Dinner	Evening snack
Day				

Appendix B – Consent form diaries (translated version)

Request for participation in research project

(Master’s study: food waste reduction using user-centered design)

Background and purpose

The purpose of the study is to measure and identify the customer's perception, experience and behavior when it comes to food waste and food waste being discarded. The study is part of the subject IMT4904 Master thesis, which is part of the master's degree in interaction design at NTNU in Gjøvik.

What does participation in the study involve?

Participation in this study means that you will write down all food that is thrown in a week. The food to be discarded must be noted on the form given and the number of food waste bags to be discarded must also be noted down.

When the forms are retrieved, I will ask questions regarding the week that has gone and questions about food waste. The interview is estimated to take an estimated 20-30 minutes. In the interview, I will ask you questions that include your experience and behavior regarding waste management, your shopping habits, and your habits within the use of technology.

Participation is anonymous, and identifying information such as name or the like will therefore not be registered. There will be no information about you from other sources that can reveal your identity at any stage of the study. Data from the interview will be recorded in the form of notes. The notes will be digitized and the paper notes will be shredded when this is done.

What will happen with the retrieved information

All personal information will be treated confidentially. You as a participant in the interview will not be able to be recognized by publication of the study. By end of studies, June 1, 2017, all non-anonymized data from the interview will be deleted. Anonymized data will be deleted after 1 year. This is in order to use obtained data in any further research.

Voluntary participation

It is voluntary to participate in the study and you can at any time withdraw your consent without giving any reason. If you withdraw, all information about you within this study will be deleted immediately, except information that is already published and anonymized.

If you have questions about the study, please contact Project Manager Thomas Mork Nordsven on telephone 994 17 344 or by e-mail to thomamno@stud.ntnu.no. You can also contact supervisor Miriam Begnum by e-mail to miriam.begnum@ntnu.no for any uncertainties or questions for this study.

Consent for participating in the study

I have received information about the study and I am willing to participate

(Signed by project participants, place and date)

Appendix C – Baseline data

Family 1

	Breakfast	Lunch	Dinner	Evening snack
Mon	1 crust of bread	1 slice of bread with brown cheese		
Tue	Almost full bag of chips 1 crust of bread		2 chicken thighs	
Wed			3 chicken thighs	1/3 of a package of crispbread
Thu	1 crust of bread	½ slice of bread with white cheese 1 slice of bread with ham	1 package soft potato bread	
Fri		2 slices of bread	5 tomatoes	
Sat			2 baked potatoes 1 bowl of cut salad	
Sun			4 carrots 6 small potatoes	

Food waste reported from Family 1, during Baseline week

	Breakfast	Lunch	Dinner	Evening snack
Mon	Throwaway: not desirable to eat	Throwaway: Leftover food “leftover from lunch at school”		
Tue	Food Safety: expiring date/forgotten Taste and feel: Decreased quality due to age “old/lost its flavor”		Food Safety: poor preparation “poor cooked, afraid to eat it”	
Wed			Food Safety: poor preparation “poor cooked, afraid to eat it”	Taste and feel: crunched
Thu	Throwaway: not desirable to eat	2x Throwaway: Leftover food “leftover from lunch at school”	Food Safety: expiring date	
Fri		Throwaway: Leftover food “leftover from lunch at school”	Taste and feel: decreased quality due to age	
Sat			Throwaway: Leftover food not desirable to eat Taste and feel: turned bad	
Sun			Taste and feel: turned bad Taste and feel: turned bad	

Reasons for throwing away food, Family 1 during Baseline week

Family 2

	Breakfast	Lunch	Dinner	Evening snack
Mon	2 peaches 3 clementines		Noodles Vegetables	
Tue			2 potatoes	
Wed			5 small sausages	
Thu	1 crust of bread ½ salat			
Fri	1 crust of bread			
Sat	300g salat		150g vegetables	
Sun				1 orange 1 clementine

Food waste reported from Family 2, during Baseline week

	Breakfast	Lunch	Dinner	Evening snack
Mon	Taste and feel: Old/not safe to eat Taste and feel: Old/not safe to eat		Throwaway: Leftover food from dinner Throwaway: Leftover food from dinner	
Tue				
Wed			Throwaway: Leftover food from dinner	
Thu	Throwaway: not desirable to eat (dry) Taste and feel: old/not safe to eat		Taste and feel: Old/not safe to eat	
Fri	Throwaway: not desirable to eat (dry)			
Sat	Throwaway: leftover food from dinner		Throwaway: Leftover food from dinner	
Sun				Taste and feel: Old/not safe to eat Taste and feel: Old/not safe to eat

Reasons for throwing away food, Family 2 during Baseline week

Family 3

	Breakfast	Lunch	Dinner	Evening snack
Mon	1 crust of bread		1 wiener sausage	
Tue	1 ½ rotten apple		2 tbsp. avocado dip 1 sausage bread	3 raspberries
Wed				
Thu				
Fri		1 rotten kiwi		
Sat	1 rotten apple 20gr fried salmon	1 rotten orange 2 chocolates 2 salty crackers		1 500gr microwave popcorn
Sun	120 gr bacon 50 gr fish pudding	1 fish cake	1 lemon 2 dl cream 1 hamburger bread	3dl yoghurt

Food waste reported from Family 3, during Baseline week

	Breakfast	Lunch	Dinner	Evening snack
Mon	Throwaway: not desirable to eat		Food safety: expiring date/not desirable to eat	
Tue	Throwaway: forgotten/turned old		Throwaway: leftover food not desirable to eat Throwaway: accumulated quantities	Taste and feel: turned bad/old
Wed				
Thu				
Fri		Throwaway: forgotten/turned old		
Sat	Throwaway: forgotten/turned old Throwaway: not desirable to eat	Throwaway: forgotten/turned old Throwaway: leftover from some weekends ago Throwaway: accumulated quantities		Throwaway: accumulated quantities
Sun	Taste and feel: turned bad Throwaway: not desirable to eat	Food safety: expiring date	Taste and feel: turned bad Food safety: expiring date Taste and feel: turned bad/dry	Food safety: expiring date/forgotten in the fridge

Reasons for throwing away food, Family 3 during Baseline week

Family 4

	Breakfast	Lunch	Dinner	Evening snack
Mon		½ box of sour cream	Half salad head	Creamed potatoes
Tue				
Wed	1 crust of bread	1 crust of bread		remnants of salad Half package of ham
Thu				
Fri				
Sat				Remnants of salad
Sun				

Food waste reported from Family 4, during Baseline week

	Breakfast	Lunch	Dinner	Evening snack
Mon		Food safety: expiring date	Taste and feel: turned bad/not desirable to eat	Throwaway: not desirable to eat
Tue				
Wed	Throwaway: not desirable to eat	Throwaway: not desirable to eat		Taste and feel: turned bad/not desirable to eat Food safety: expiring date
Thu				
Fri				
Sat				Taste and feel: turned bad
Sun				

Reasons for throwing away food, Family 4 during Baseline week

Family 5

	Breakfast	Lunch	Dinner	Evening snack
Mon	1 crust of bread			
Tue				1 crust of cheese
Wed				
Thu		1 yoghurt		Grapes
Fri				Remnants of cheese
Sat				
Sun	Remnants of chips			

Food waste reported from Family 5, during Baseline week

	Breakfast	Lunch	Dinner	Evening snack
Mon	Throwaway: not desirable to eat			
Tue				Throwaway: not desirable to eat
Wed				
Thu		Food safety: expiring date/forgotten		Taste and feel: turned bad
Fri				Throwaway: not desirable to eat
Sat				
Sun	Throwaway: not desirable to eat			

Reasons for throwing away food, Family 5 during Baseline week

Appendix D – Interview guide (translated version)

General information

Age:

Gender:

Job/study situation:

No. members family:

Ask WHY every time they describe something.

Procurement

- Can you tell me when you decide to go to the store to buy food?
- How is the planning of purchasing? Can you give an example of a day when you make a purchase?
- Do you write a shopping list? Why?
- The last time you bought food, how long was it scheduled for the food to last?
- Where do you buy your food?
- What thoughts do you make about expiration of products?
- What thoughts do you make regarding price on food products?
- In what way do you think the shops help you to get what you need?
- How do you follow the shopping list when you are in the store?

Usage

- How do you store the goods when you get home from the store?
- What is done with leftovers after dinner? (are leftovers used the next day?)
 - o What about other types of meals?
- Of what is being bought, how much do you end up using?
- What is done with leftovers of other types of food? (Throw it? Freeze? Eaten the following day?)

Situations

- Describe your family's relation to food.
- When and in what types of situation do you throw away food? (expiring date/not tempting/mood?)
- What is the difference between shopping weekdays and contra weekends?
- What motivate you to waste less food?
- In what way do you mean your finances influence how much you throw away?
- What are the kids in the family's task when it comes to cooking?
- What are your opinions about eating the same dinner two days in a row?
- In what kind of situation do you throw the most garbage/food?
- In what kind of situation do you throw less garbage/food?

- Give an example of when you think you have been good at minimizing food waste.
- Give an example when you have not been as good at minimizing food you throw

Assumptions

- Why do you think most people waste food?
- Can you give some examples of how we can avoid wasting food?
- What can the stores do to avoid food waste?
- What can consumers do to avoid food waste?
- Is there anything else you have at heart?

Appendix E – Consent form interviews (translated version)

Request for participation in research project

(Master’s study: food waste reduction using user-centered design)

Background and purpose

The purpose of the study is to measure and identify the customer's perception, experience and behavior when it comes to food waste and food waste being discarded. The study is part of the subject IMT4904 Master thesis, which is part of the master's degree in interaction design at NTNU in Gjøvik.

What does participation in the study involve?

Participation in this study means that you will be asked questions regarding procurement, usage, situations and assumptions related to food waste. The interview is estimated to take an estimated 20-30 minutes.

Participation is anonymous, and identifying information such as name or the like will therefore not be registered. There will be no information about you from other sources that can reveal your identity at any stage of the study. Data from the interview will be recorded in the form of notes. The notes will be digitized and the paper notes will be shredded when this is done.

What will happen with the retrieved information

All personal information will be treated confidentially. You as a participant in the interview will not be able to be recognized by publication of the study. By end of studies, June 1, 2017, all non-anonymized data from the interview will be deleted. Anonymized data will be deleted after 1 year. This in order for data obtained can be used in any further research.

Voluntary participation

It is voluntary to participate in the study and you can at any time withdraw your consent without giving any reason. If you withdraw, all information about you within this study will be deleted immediately, except information that is already published and anonymized.

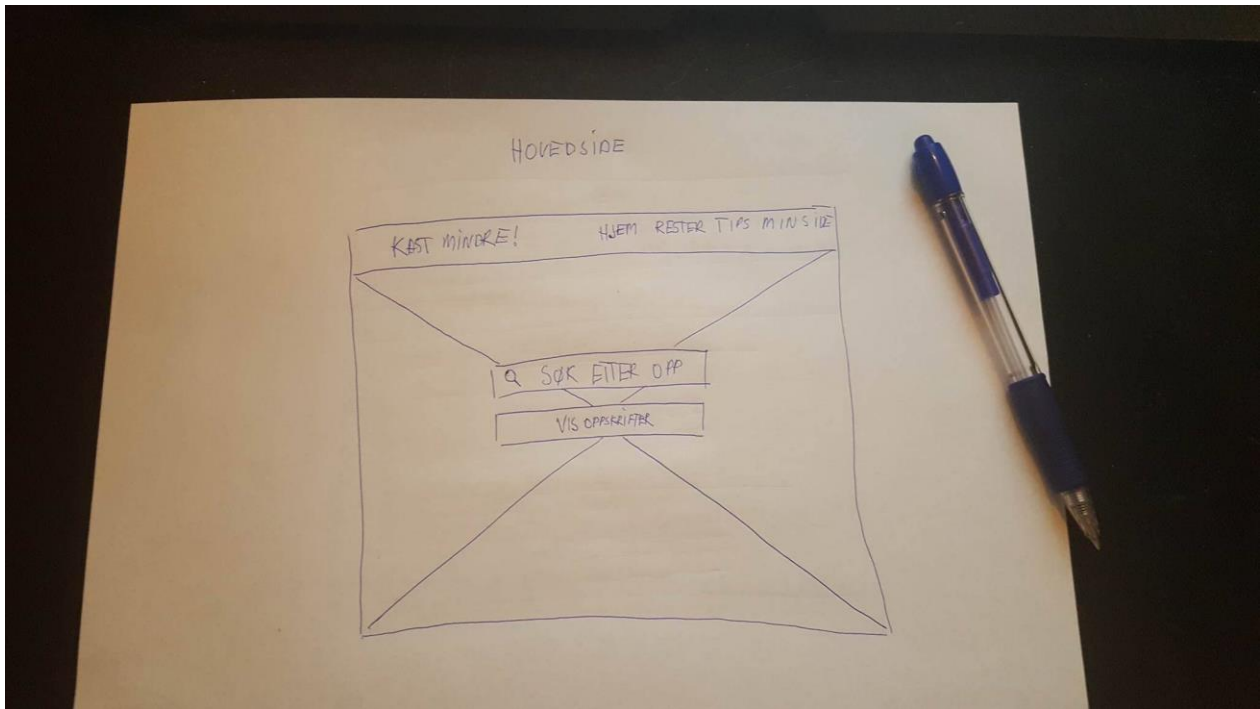
If you have questions about the study, please contact Project Manager Thomas Mork Nordsven on telephone 994 17 344 or by e-mail to thomamno@stud.ntnu.no. You can also contact supervisor Miriam Begnum by e-mail to miriam.begnum@ntnu.no for any uncertainties or questions for this study.

Consent for participating in the study

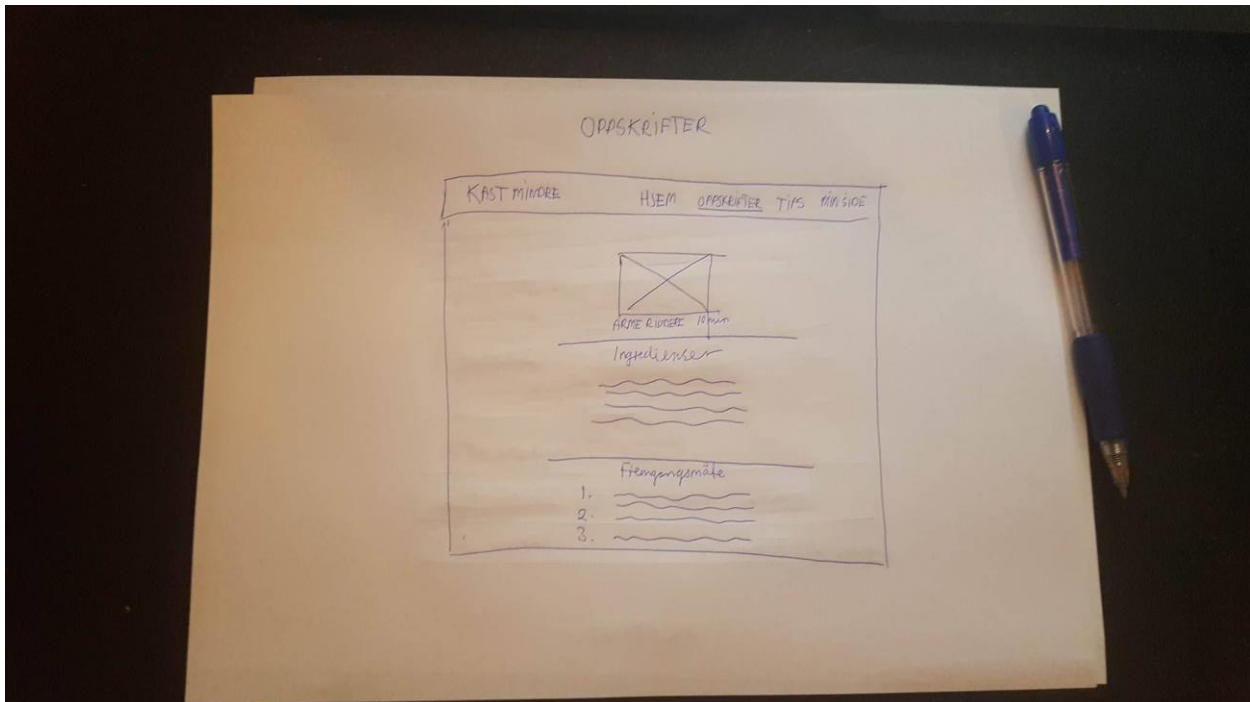
I have received information about the study and I am willing to participate

(Signed by project participants, place and date)

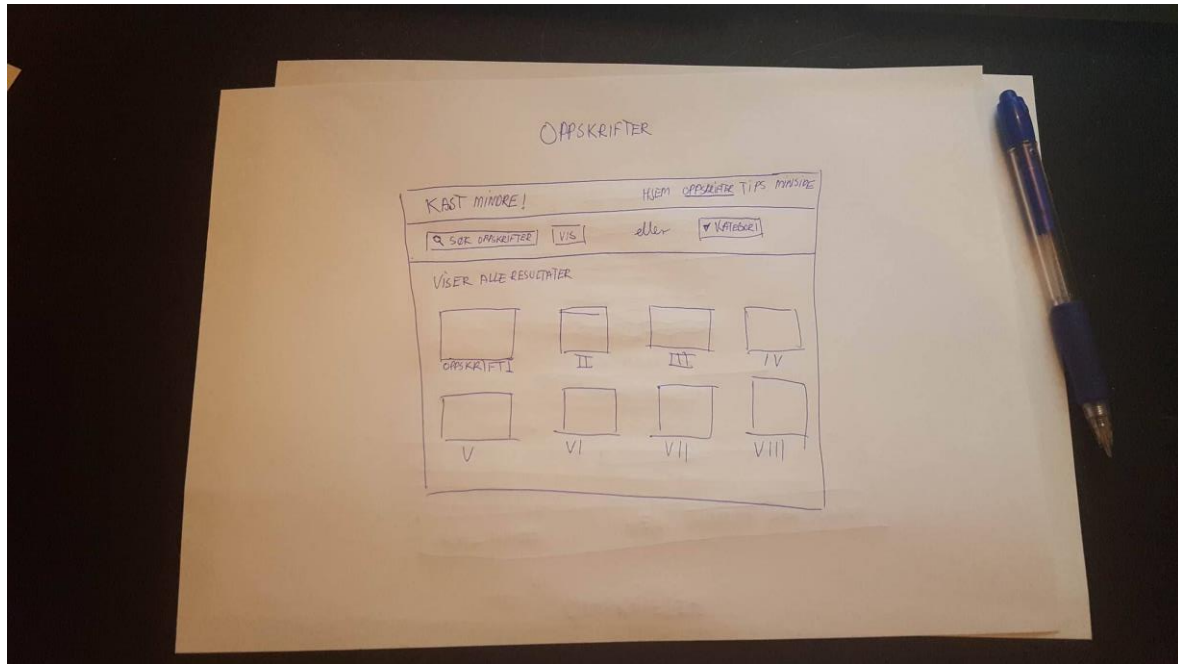
Appendix F – Sketches



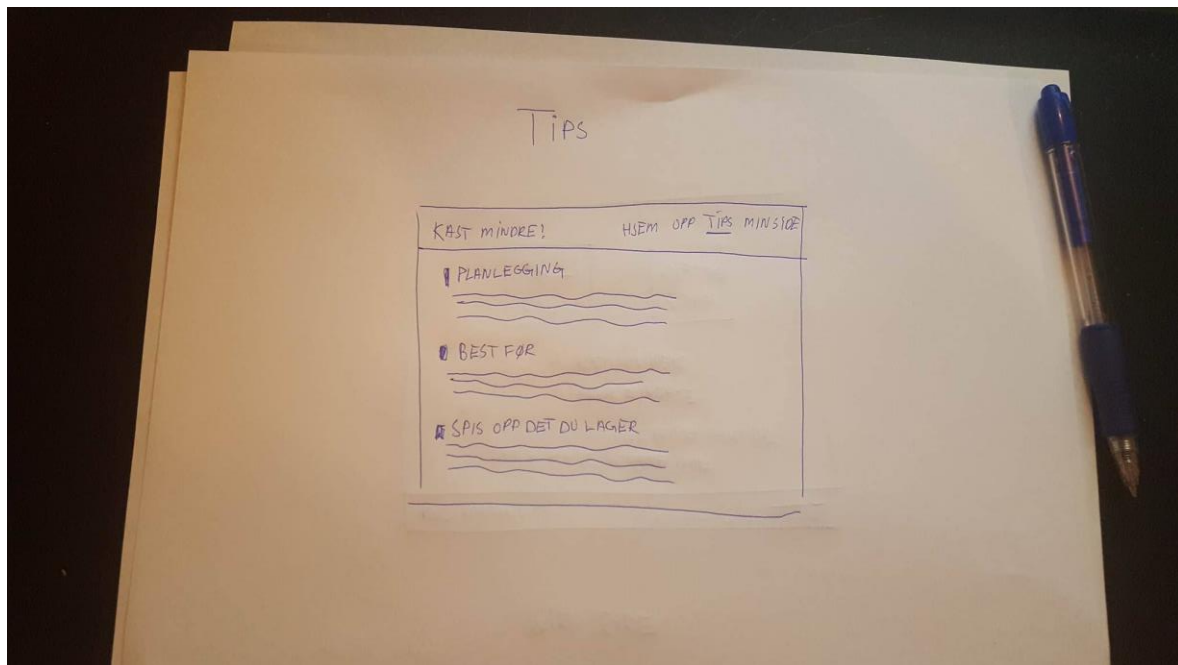
Sketching: Front page



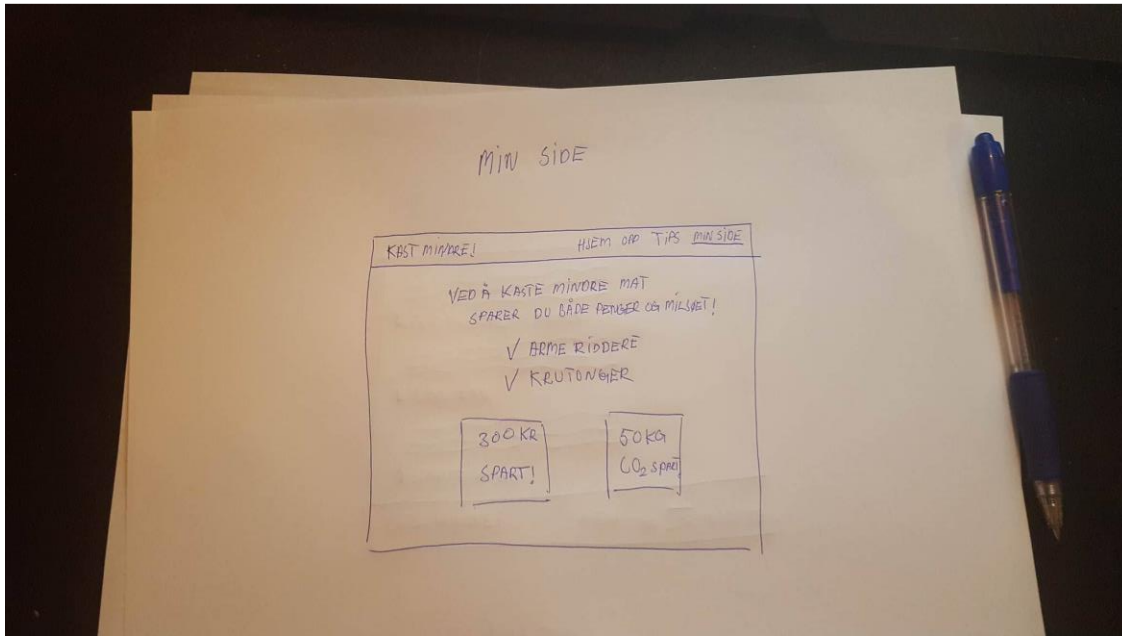
Sketching: Recipe page



Sketching: Recipes page

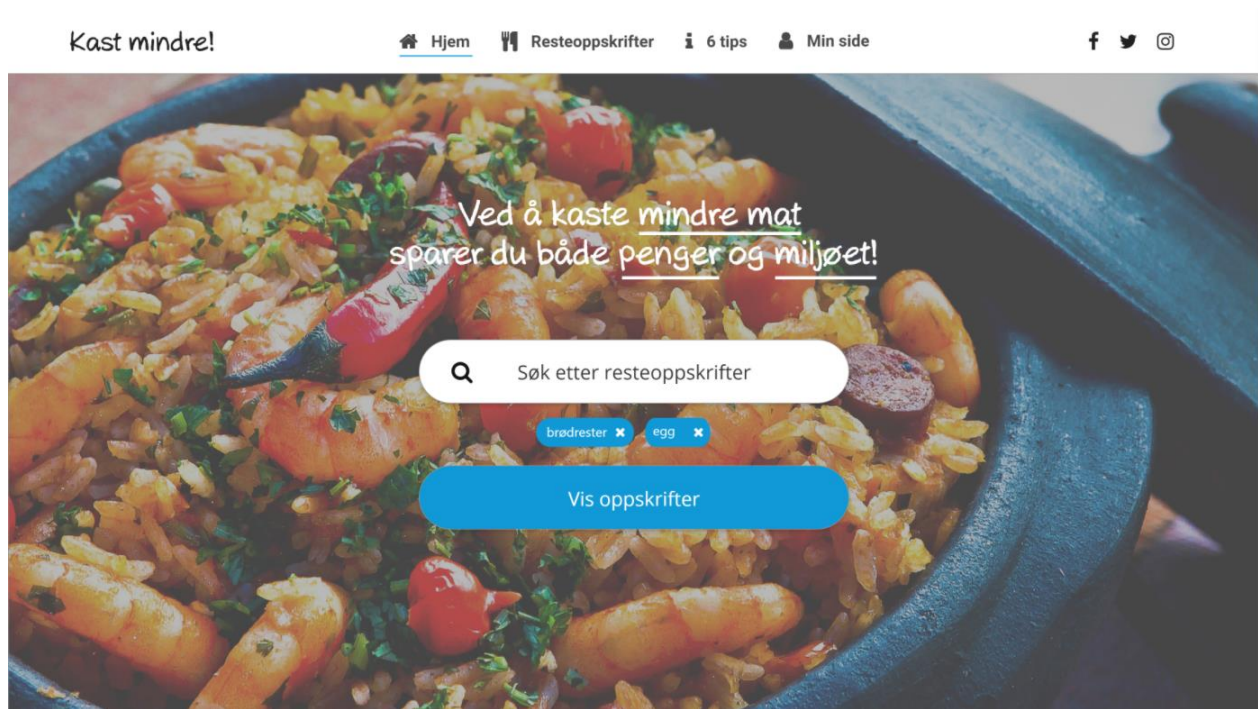


Sketching: Tips page

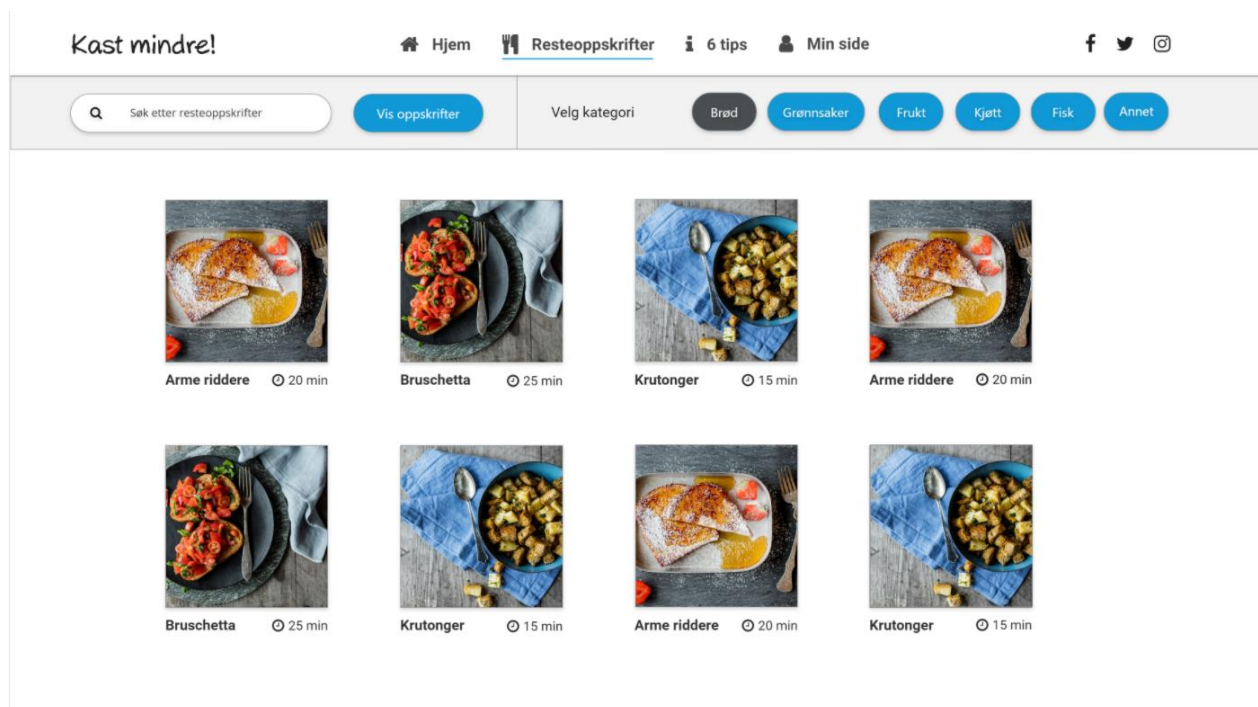


Sketching: My page

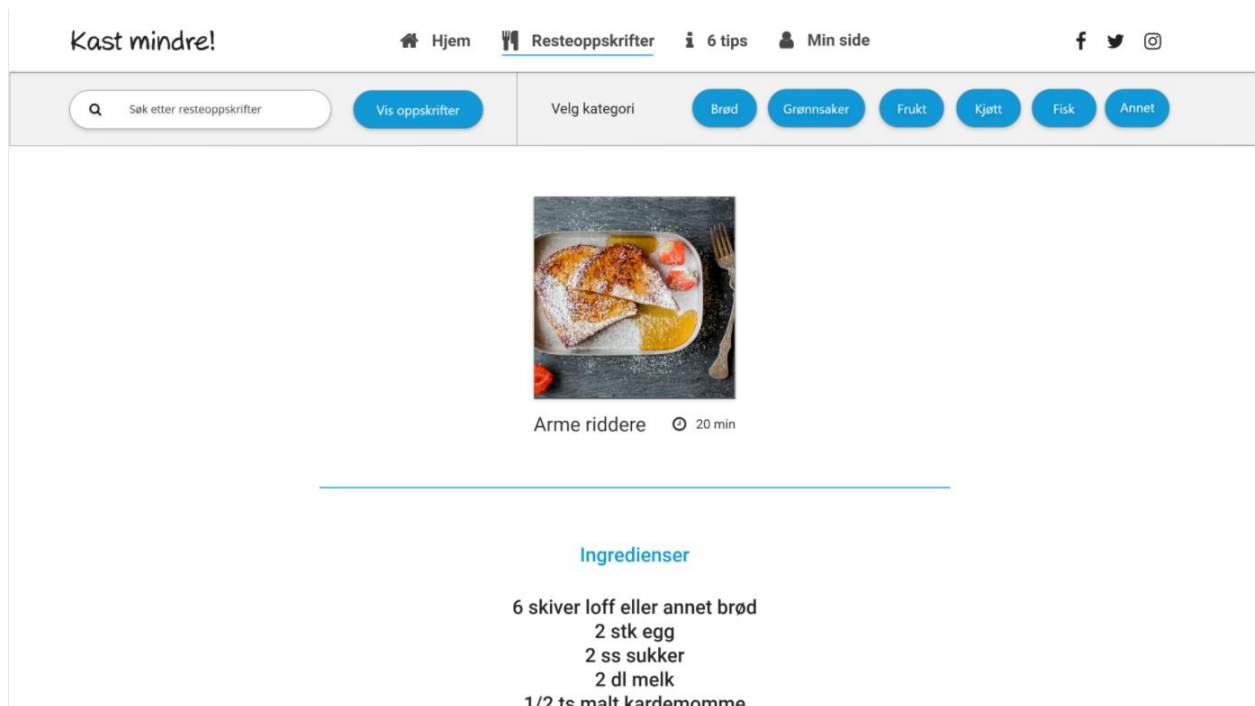
Appendix G – Digital prototype



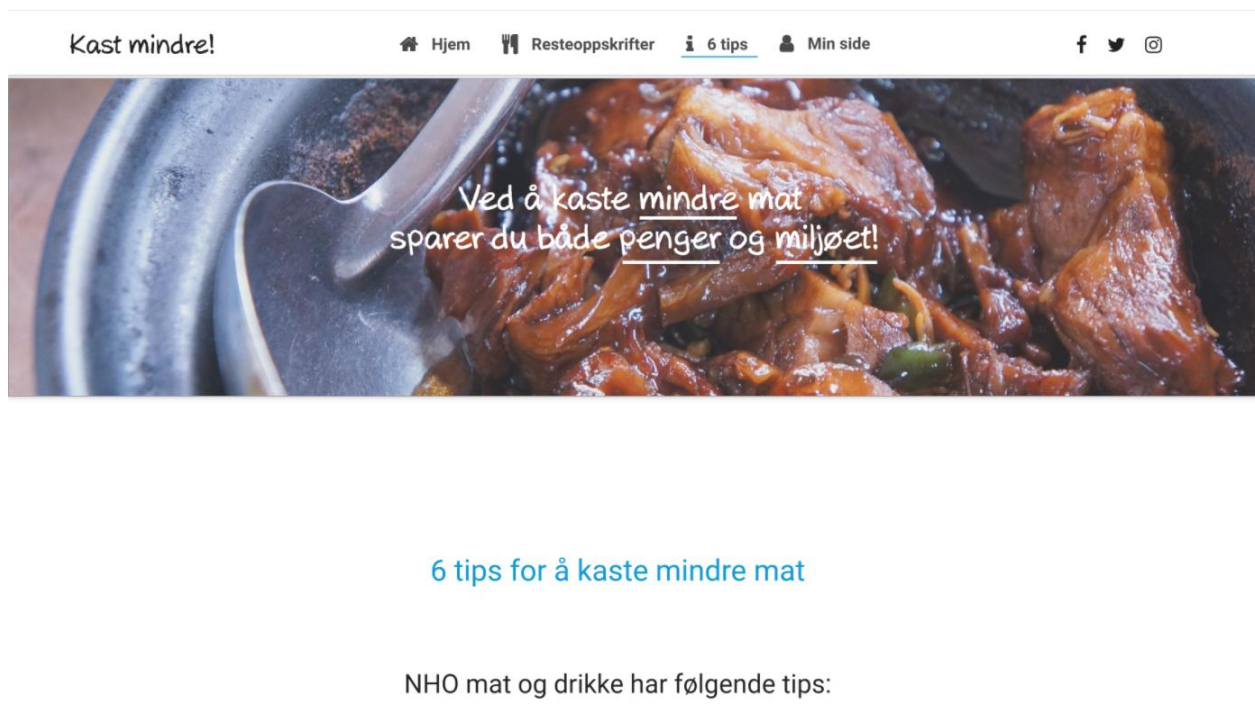
Prototype design: Front page



Prototype design: Leftover recipes.



Prototype design: Recipe page



Prototype design: Tips that would improve food waste.



Favorittoppskrifter



Arme riddere



Ovnsbakte grønnsaker



Prestasjoner

Prototype design: My page – Favorite recipes and accomplishments

Appendix H – Usability testing script (translated version)

Steven Krug usability testing script intro:

Before we begin, I have some information for you, and I'm going to read it to make sure that I cover everything.

You probably already have a good idea of why we asked you here, but let me go over it again briefly. We're asking people to try using a Web site that we're working on so we can see whether it works as intended. The session should take about an hour.

The first thing I want to make clear right away is that we're testing the site, not you. You can't do anything wrong here. In fact, this is probably the one place today where you don't have to worry about making mistakes.

As you use the site, I'm going to ask you as much as possible to try to think out loud: to say what you're looking at, what you're trying to do, and what you're thinking. This will be a big help to us.

Also, please don't worry that you're going to hurt our feelings. We're doing this to improve the site, so we need to hear your honest reactions.

Hand out consent form

Tasks

1. Leftover: Think back at the last dinner when you had leftovers. Check on KastMindre if you could have spared and used these remnants for something.

1.1 You have now figured out what you could use these residues for. What food products are needed in this dish?

1.2 Imagine you have vegetables that were leftover in the fridge. Use KastMindre to check if you could have used the vegetables.

2. Expiring date: You will have a visit and will serve egg dose and waffles. You have a cardboard of egg that has expired 2 weeks ago in the refrigerator. If you crush them, the whole house will smell bad. Are they edible in waffles? Can they be used raw in egg dose? You go to KastMindre to check.

3. Turned bad: You have a packet of meat dough that has been in the freezer for a long time, and you are unsure whether it is still edible. You go to KastMindre to check if it can be thawed and eaten today.

4. You have lately thought you want to minimize food that you throw. You go to KastMindre to learn more about how to get better.

Appendix I – Usability consent form (translated version)

Request for participation in research project

(Master’s study: food waste reduction using user-centered design)

Background and purpose

The purpose of the study is to measure and identify behavior when it comes to food waste and food waste being discarded. The study is part of the subject IMT4904 Master thesis, which is part of the master's degree in interaction design at NTNU in Gjøvik.

What does participation in the study involve?

Participation in this study means that you will be tasked to look at a working prototype. During this session, you will be asked to perform five different tasks by using the digital prototype. We are not testing you, so do not be afraid to make “mistakes”. The purpose of this session is to find flaws and improve the functionality of the proposed design.

This usability test is estimated to take an estimated 20-30 minutes. Afterwards I will ask you a few questions related to the design. In the interview, I will ask you questions that include your experience and behavior regarding waste management, your shopping habits, and your habits within the use of technology.

Participation is anonymous, and identifying information such as name or the like will therefore not be registered. There will be no information about you from other sources that can reveal your identity at any stage of the study. Data from the usability test will be recorded in the form of notes. The notes will be digitized and the paper notes will be shredded when this is done.

What will happen with the retrieved information

All personal information will be treated confidentially. You as a participant in this usability test will not be able to be recognized by publication of the study. By end of studies, June 1, 2017, all non-anonymized data from the interview will be deleted. Anonymized data will be deleted after 1 year. This in order for data obtained can be used in any further research.

Voluntary participation

It is voluntary to participate in the study and you can at any time withdraw your consent without giving any reason. If you withdraw, all information about you within this study will be deleted immediately, except information that is already published and anonymized.

If you have questions about the study, please contact Project Manager Thomas Mork Nordsven on telephone 994 17 344 or by e-mail to thomamno@stud.ntnu.no. You can also contact supervisor Miriam Begnum by e-mail to miriam.begnum@ntnu.no for any uncertainties or questions for this study.

Consent for participating in the study

I have received information about the study and I am willing to participate

(Signed by project participants, place and date)

Appendix J – Usability notes (translated version)

Participant 1

Task 1

The test person had sausages as leftovers, and navigated to leftover recipes via the highlighted button on the front page. Used the filter buttons to restrict his search. Filtered for meat and chose sausage muffins. (Do users want to use the search function?)

- 1.1 The test person returned from the front page to leftover recipes. To find out more about the recipe, the test person chose to click on the name of the recipe. Since the name of the recipe was emphasized, it was natural for him to think that this was a link that would lead to a new page. (Do both link and image clickable?)
- 1.2 The test person remained on the leftover recipe page and chose to filter with the buttons for vegetables and went to read more about baked vegetables.

Task 2

Her task was to find more information about eggs. She first went to leftovers and searched for 'egg / eggedosis'. She went back to the front and scrolled down to 'minimize food waste'. Discovered the 'Check food' button on the front page and then went to 'check the food'. When this usability test was performed on a desktop PC, she searched for 'eggs' and not 'Eggs' that would yield results. This meant that the task was not performed by the test person and this must be fixed. (Capital letters by default on mobile, query must return responses based on both lowercase and uppercase).

Task 3

Not performed due.

Task 4

Navigated to food tips and read through the list of tips without problems

Participant 2

Task 1

The test person thought back to when he left the meat residue, and went back to leftovers page via the button on front page. Used the filter buttons to restrict the search. Filtered for meat and selected meat soup (Will users want to use the search function? + The search function does not work by pressing enter when they want to search. Seems like the page needs to be refreshed in order for it to work)

- 1.1 The test person returned from the front page to the recipes. To find out more about the recipe, the test person chose to click on the image. (Do both link and image clickable? See what the other test subjects do later)
- 1.2 The test participant remained on leftover recipes and chose to filter with the buttons for vegetables and then chose a recipe.

Task 2

His task was to find more information about eggs. He first went to leftovers and searched for 'egg / eggedosis'. He went back to the front and scrolled down to 'minimize food waste'. Discovered the 'Check food' button on the front page and then went to 'check the food'. When this usability test was performed on a desktop PC, he searched for 'eggs' and not 'Eggs' that would yield results. This meant that the task was not performed by the test person and this must be fixed. (Capital letters by default on mobile, query must return responses based on both lowercase and uppercase).

Task 3

Not done - would be the same task as above.

Task 4

Scrolled down 'minimize food waste'. Let he continue until he "found" food tips on the navigation menu. And read through the list of tips.

Participant 3

Task 1

Reflected on when there were carrots again. Use the highlighted button on the front (show leftovers). Entered carrots in the search box and press enter. Today, nothing happens when using enter. (Do not think people know that the search filters "live") Consider adding enter functionality.

- 1.1 Navigated to the same dish found in the 1st task. Not pressed on the link, but first pressed the image. Pressed the link (the name of the court) when he did not get the impression of the photo (with this test, all 3 pressed the picture first when they read more about the recipe.)
- 1.2 Filtered using the filtering buttons.

Task 2

To find out more about eggs, the user first navigated to food tips. Read these tips before he noticed the "Check Food Button" at the bottom of this page. Clicked the button and entered the egg (lowercase) into the search box and press enter. The search gave no results, but tried out after a while pressing 'search'. Then found more information about eggs.

Task 3

Just went to the food tips from the main navigation and read through the tips.

Participant 4

Task 1

The user had left meat and navigated using the highlighted button on the front. Filtered for meat and then got a list of suggestions for recipes. Used the filtering because the buttons caught her attention. Did not notice the search box right away.

1.1 To read more about what she would need in the recipe, she pressed the picture.

(Everyone has pressed the image to read more about the recipe. Do all pictures clickable)

1.2 Filtered after vegetables using buttons. No issues.

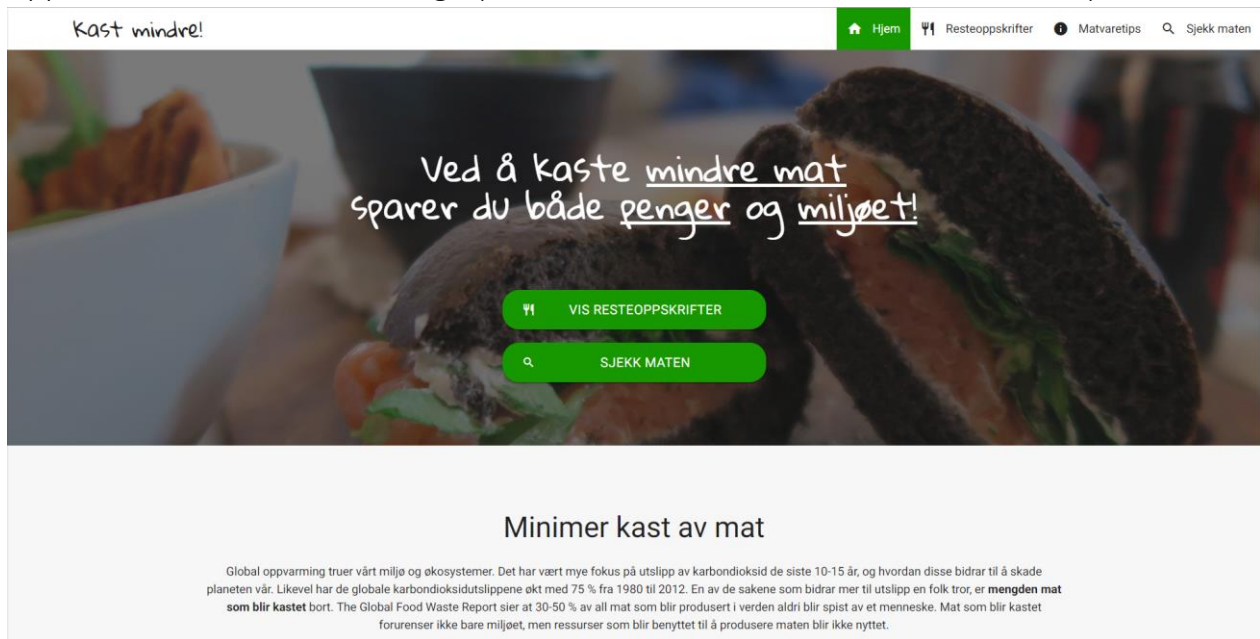
Task 2

Did not use the main navigation but remembered that she had seen a button to check the food. Went to the front and then went to 'check the food' by pressing the highlighted button. Small letter in the search box and press search.

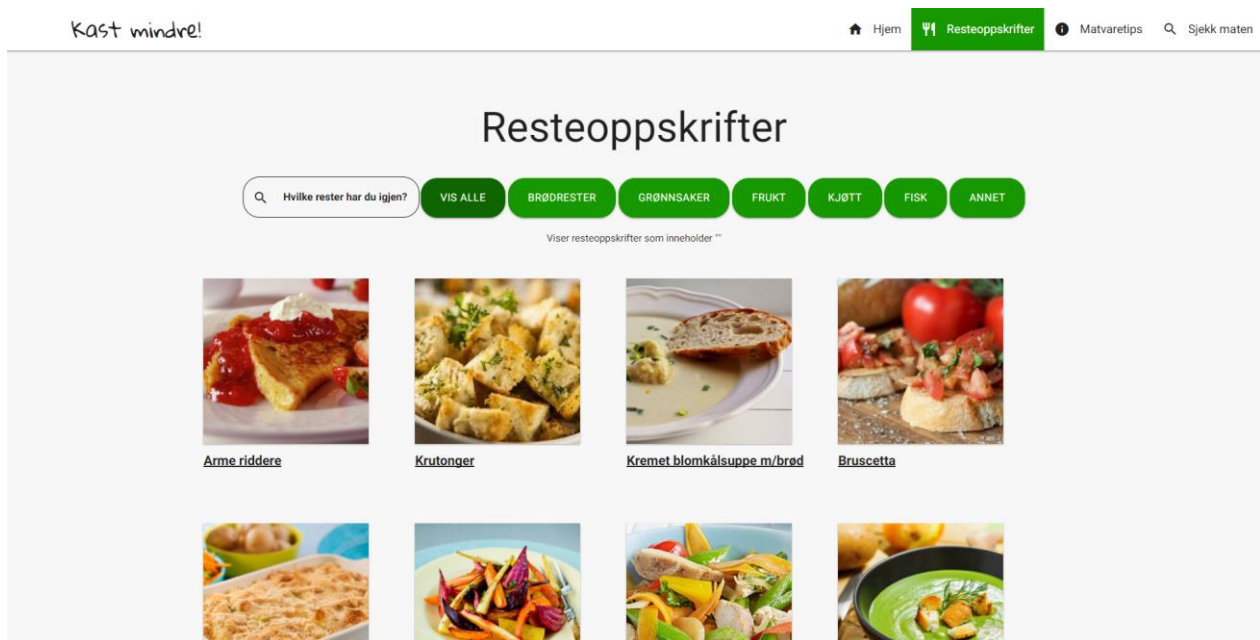
Task 3

Did not go into food tips, stopped the task when she felt she had found the answer by finding recipes, check the food and the text at the bottom of the main page.

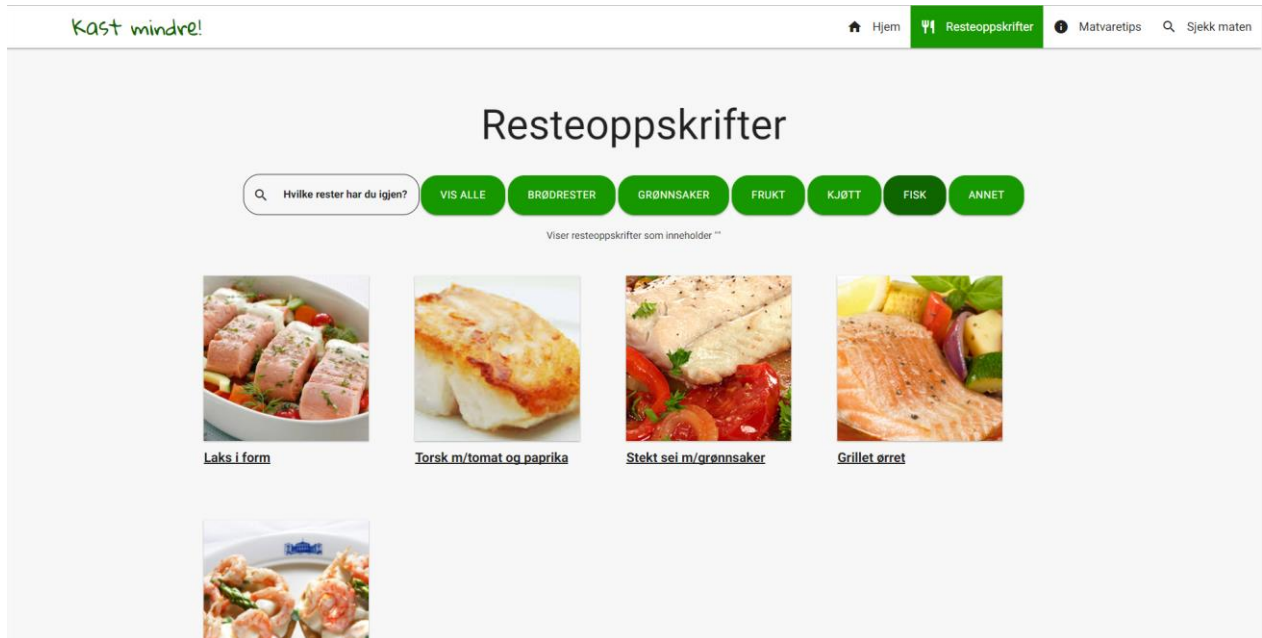
Appendix K – Intervention design (www.thomasmorknordsven.no/kastmindre)



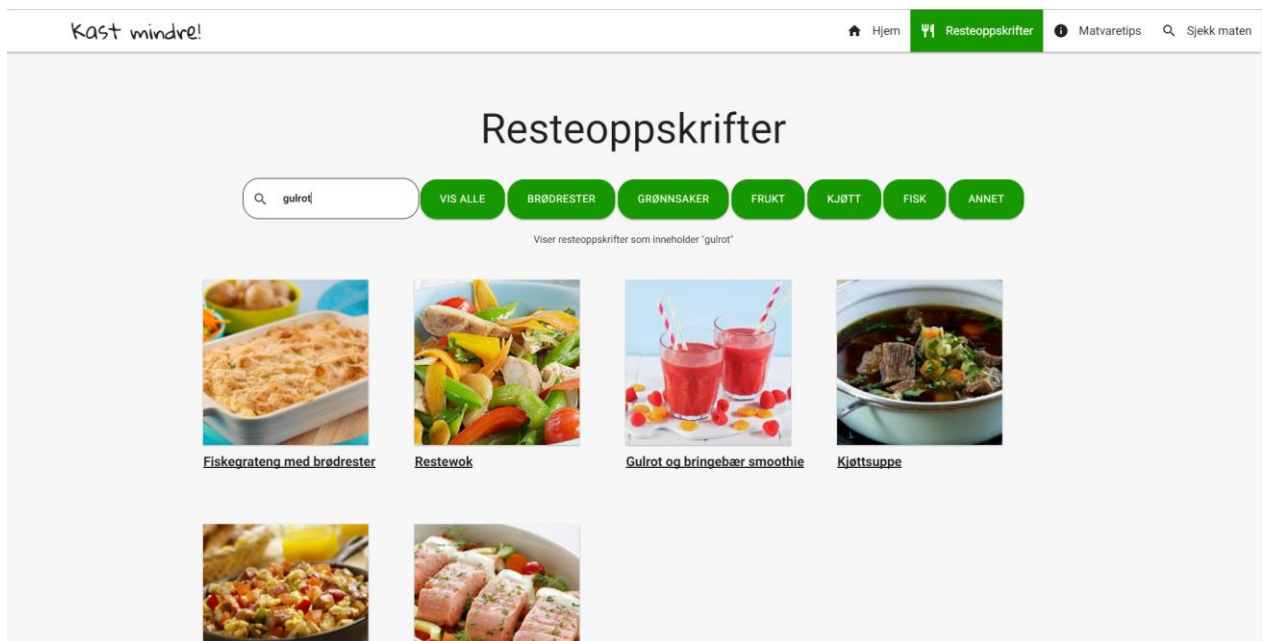
Intervention design: Front page



Intervention design: Leftover recipes



Intervention design: Filtering leftover recipes.



Intervention design: Searching leftover recipes.

Ved å kaste mindre mat
sparer du både penger og miljøet!

NHO mat og drikke/Kast mindre har følgende 6 tips

1. Planlegg innkjøp og handle etter behov.
2. Planlegg slik at eventuelle rester fra i går kan brukes i dagens middag.
3. Selv om matvaren har gått ut på dato, er det fortsatt mange matvarer som fortsatt kan brukes eller som kan brukes på andre måter (feks utgått rømme i vaffelrøre).
4. Ta vare på restemat i gryter og fat, og lag gode restemåltider.

Intervention design: Tips page

Kan matvaren fortsatt spises?

SØK

FJERN RESULTAT

Det finnes faktisk ikke råtne egg i salg i norske butikker - for det er ikke bakterier inne i eggene. Norske egg kan derfor fint spises etter de har gått ut på dato. Oppbevart i kjøleskap holder egg seg gode i flere måneder.

Intervention design: Check your food (Can the food still be eaten?).