FoodEd - Encouraging sustainable food waste practices through an informative app

LISA LAMA
Abstract

Every year 1.6 billion tons of food is thrown away corresponding to one third of all the food that is produced. It accounts for 8% of the global greenhouse gas emission, meaning that it has a huge negative impact on the environment. In Sweden, households account for the largest amount of food waste. Therefore, this study focuses on reducing food waste on a household level in Swedish households.

There is a growing interest in HCI for how design can be used for reducing food waste by changing unsustainable behaviour. In this work a working mobile prototype, FoodEd, was designed, implemented and studied. FoodEd contains information of how to handle and store different food items in an optimal way. The aim was to raise awareness of good food handling practices and edibility beyond expiry dates in order to prevent unnecessary food waste in households. In this study, FoodEd was used by 10 participants during a week’s time. Two qualitative interviews were held with each participant during the study.

The findings of the study indicate that an informative design can be effective in providing relevant information for its users leading to more sustainable food waste behaviours.
**Abstrakt**

Varje år kastas 1,6 miljarder ton mat, motsvarande en tredjedel av all mat som produceras. Det står för 8% av det globala utsläppet av växthusgaser, vilket innebär att det har en enorm negativ påverkan på miljön. I Sverige står hushållen för den största mängden matavfall. Därför fokuserar denna studie på att minska matavfall på hushållsnivå i svenska hushåll.


Resultaten av studien indikerar på att en informativ design kan vara effektiv när det gäller att tillhandahålla relevant information till dess användare vilket leder till ett mer hållbart matsvinn beteende.
FoodEd - Encouraging sustainable food waste practices through an informative app

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ABSTRACT
Every year 1.6 billion tons of food is thrown away corresponding to one third of all the food that is produced. It accounts for 8% of the global greenhouse gas emission, meaning that it has a huge negative impact on the environment. In Sweden, households account for the largest amount of food waste. Therefore, this study focuses on reducing food waste on a household level in Swedish households.

There is a growing interest in HCI for how design can be used for reducing food waste by changing unsustainable behaviour. In this work a working mobile prototype, FoodEd, was designed, implemented and studied. FoodEd contains information of how to handle and store different food items in an optimal way. The aim was to raise awareness of good food handling practices and edibility beyond expiry dates in order to prevent unnecessary food waste in households. In this study, FoodEd was used by 10 participants during a week’s time. Two qualitative interviews were held with each participant during the study.

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Author Keywords
Sustainability; food waste; research through design; HCI

INTRODUCTION
The climate on our planet is changing and one reason is increasing carbon dioxide gases in our atmosphere [9]. The released carbon dioxide is thus a threat for our environment and the future of our planet. There is a need for behavioural changes in the society today in the way we consume our planet's resources. Food waste is one prominent source of greenhouse gas emission, affecting the environment negatively [6]. During the year of 2016 1.3 million tons of food was wasted in Sweden where 75% of the total amount of food waste occurred in households [1]. The total food waste accounts for approximately 3% of the total greenhouse gas emission in Sweden [3]. This corresponds to the greenhouse gas emission from 200 000 cars release in one year [3].

In September 2015, the United Nations member states agreed on a new set of sustainability development goals [5]. In goal 12.3 it was stated that by 2030, the aim is to reduce half of the global food waste at the retail and consumer levels per person and reduce food losses along production and supply chains [5]. To contribute to achieving goal 12.3, the Swedish government decided on February 2017, to continue their collaboration with the National Food Agency, the Swedish Environmental Protection Agency and the Swedish Board of Agriculture for reducing the food waste in Sweden [7]. An action plan was set, within nine different areas connected to one another.

One of the areas focuses on raising knowledge, behavioural change and attitude regarding the issue with food waste. Several Swedish actors are actively working towards reducing the food waste and new services have been developed to address the problem [7]. Such as Karma, an app where users can purchase unsold food from restaurants, cafes and grocery stores.
for half of the regular price\(^1\). Nevertheless, more actions are needed to reach these goals to an adequate extent [7]. For instance, according to the National Food Agency [7], the awareness and motivation of the consumers’ needs to increase along with other efforts to facilitate different consumer groups to make waste minimizing choices in different situations linked to the purchase, handling and recovery of leftovers. This study aims to contribute to achieving the sustainability development goal.

There are many ways to reduce food waste [24]. For instance, by 1) informing or educating consumers and nudge them to alter their habits, 2) extending shelf life of products and 3) change food packaging to improve the durability of food products by storing them optimally. This paper focuses on providing relevant information for consumers. The aim of this study is to examine how an informative design can influence food waste and household practices.

In this study, a “Research through Design” (RtD) [4] approach was used to design, implement and study a working prototype that promotes sustainable behaviour in real household settings. The aim of the design was to raise awareness on food handling and edibility and thus increasing food literacy [28]. Studies show there is a lack knowledge among people in this matter. The main purpose of the app was to present users with easily accessible information on storing and handling food.

The participants were tasked to use the prototype during a week and their usage, learnings and reflections was captured using semi-structured interviews pre and post the test week.

The research question follows:

- How can an informative design encourage more sustainable food waste behaviour in households?

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\(^1\)www.karma.life

**BACKGROUND**

**Food waste definitions**

The term “food waste” describes food that could have been consumed by humans, but that is instead thrown away [2]. There are three different types of food waste, that occur in households, avoidable, partially avoidable and unavoidable food waste. Avoidable food waste refers to food that was edible at the time it was discarded or that could have been edible if it was stored differently [10]. Partially avoidable food waste is generated as a result of consumers habits, examples are bread crusts, apple skins, potato peels [10]. While unavoidable food waste refers to food waste that occur during cooking that is normally not edible, examples include eggshells, vegetable peel, meat or fish bones [10]. The focus in this study lays on preventing the avoidable food waste in Swedish households.

**Domestic food waste**

In 2009, the Consumer Association Stockholm conducted online surveys consisting of questions about food waste, best-before dates etc. The results of the study show that vegetables and fruits are wasted the most in Swedish households, secondly comes bread and bakery goods, thereafter dairy products [21].

There are several causes of domestic food waste, some of them are incorrect storage, durability dates are misinterpreted, lack of confidence in one's own senses, inadequate knowledge of the foods environmental impact and lack of motivation to prevent food waste [23]. The main drivers of food waste are seen to be a person's lack of motivation and knowledge to avoid food waste [22].

Saving money can be a potential motivator for people to reduce their food waste. According to the Swedish Environmental Protection Agency, families in Sweden can save up to 6000 Swedish crowns per year if they reduce their household food waste [16]. The money could be used for something more exciting instead of ending up in the trash bin. Making people aware of this fact could result in a change in their habits.

**Best-before and use-by date**

The best-before date is a recommendation from the manufacturer and informs how long the manufacturer guarantees that the food item will keep its qualities,
such as taste, colour and consistency [13]. The food often last longer without becoming spoiled, sometimes up to several months, if stored in a correct way [17]. When a food item passes its use-by date it is considered a health risk and should be discarded [13]. The use-by date is used for sensitive food items such as raw meat, poultry, minced meat, seafood etc. [17].

In January 2011, the Consumer Association in Stockholm asked the Swedish people if they are aware of the difference between the best-before and use-by date [12]. A survey was answered by 1005 women and men in the ages of 18-74 years. The findings show that 62 % are not aware of the difference between the two terms [12]. According to the Consumer Association the confusion between the two terms may lead to unnecessary food waste [12]. The lack of understanding of the terms is also an important factor that households throw away fully edible food [19].

Target group
A study made by WRAP (Waste & Resources Action Programme) in 2014, reveals that a higher amount of food was wasted in households containing young people. People between the ages of 18-34 years are determined to waste the most food in households [11]. Farr-Wharton et al. reveals, that younger people in particular are less concerned about consuming their food before it expires, leading to unnecessary food waste [15].

HCl & food waste
A similar study, that had its focus on changing food waste and recycling habits in households among young adults was conducted by Thieme et al. Bincam, a social persuasive system was used as a replacement of existing kitchen trash bins. The systems automatically record discarded items captured by a smartphone connected to the underside of the bin lid [18]. The images are transferred to the Bincam application on Facebook shared among all of the Bincam users.

The findings of the study that the strongest effect of Bincam was related to raising the participants awareness and simulation of reflection on food waste and recycling [18]. The participants started to recycle more and better. Two weeks into the study it was determined that the participants either forgot about BinCam App or simply lost interest [18]. The participants were induced to reflect between the relationship between their food waste and money savings [18].

Another study focusing on raising awareness of food waste among young adults was done by Caleca [22]. With the help of a peripheral interaction device that visualizes expiry dates of available food [22]. Major improvements were seen in the participants in raising their awareness, similar to the study done by Thieme et al. The presence of the device was seen to be affecting the behaviours of the participants, resulting in major improvements in remembering what food they have available at home [22]. The study confirmed that most of the participants were unaware of how to store different food items in an optimal way as well as how long different food items last [22]. In both studies, the feeling of guilt or being ashamed when disposing food or recycling incorrectly was highly present [18][22].

Another study focusing on reducing food waste on a household level was conducted by Farr-Wharton et al. [27]. EatChaFood, an app to help consumers keep track of food they have in the fridge with the help of a camera that captures photos regularly. However, users manually have to register every food item in the app in order to use it. The authors highlight the fact that this requires a lot of work from the users. EatChaFood was evaluated in households during three weeks’ time. The users reported that their food waste decreased due to understanding when the food had to be consumed before turning bad. Another similar app, FrigdePal was evaluated by Farr-Wharton et al. [27], which is an app to help users to keep track of what they have in the fridge by scanning food items. The app was used by four households for three weeks and findings show that the use of the app lead to a decrease in food waste due to increased awareness of available food at home.

METHOD
In order to study the learnings, reflections and the potential to reduce food waste using an informative app in households a RtD approach was used. The RtD method is applied to research that focuses on improving the world by changing its current state to a preferred state [4]. In this study, the current state refers to the high levels of food waste in Swedish households. The preferred state is hence to obtaining a reduction of the food waste. Therefore, the purpose of the prototype
was to make consumers aware of optimal ways to store and handle their food items in their home.

In the study an informative app FoodEd was designed and studied in real household (N=10) settings during a week. The householders were tasked to use the app to reduce their food waste and reflect on their practices. To capture their improvement, practices, reflections and learnings pre and post semi-structured interviews were held with each participant. The participants were also tasked to 1) take notes about wasted food and the reasons for it, and 2) document missing food items or information in the design.

All the interviews were held individually in a calm environment. The pre-interview focused on understanding the participant’s current food waste behaviour and practices. FoodEd was introduced at the end of the pre-interview and handed over to the participants to use over a week’s time. The user had the freedom of choice to use the app whenever they preferred. The purpose of the post-interview was to understand how FoodEd had affected the participants. All of the interviews were audio recorded and transcribed. More detailed descriptions concerning the pre and post interviews are presented in the following sections.

Pre-interview
The session started with a brief presentation of the study and the structure of the interview. The focus laid on understanding the participants current situation concerning 1) food waste habits, 2) knowledge on handling and storing food, 3) leftovers reuse, 4) motivations for reducing food waste, and 5) understanding of best-before date and use-by date.

Post-interview
The post-interview was held one week after the pre-interview. Participants were asked about their experience with FoodEd and how it had affected their food waste habits. The interview where held using the same script as the pre-interview.

Thematic analysis
The pre and post interviews and participant notes from the study week was analysed using thematic analysis. The aim of a thematic analysis is to recognize themes that are valuable and use the themes to address the research [14].

First, this process began with a preliminary walkthrough of the data to familiarize with the data and form potential preliminary codes. Secondly, the data was formally coded through a thorough walkthrough of the entire dataset. Thirdly, codes were collated and sorted into merging themes. Fourthly, the themes were reviewed, refined, and merged. In this step eight themes were determined to be stronger and informative in relation to the research question.

Prototype
The mobile prototype FoodEd, was developed in Marvel². The focus of the prototype was to raise awareness and inform its users on good ways to store and handle different food items, such as vegetables (tomato, aubergine, peppers, cucumber, potatoes, carrot, broccoli, beetroot, zucchini, salad, onion, asparagus), fruits (apple, banana, avocado, lemon grapes, pear, orange, berries, melons), meat (chicken, lamb, pork, beef), bread, fish (salmon, cod), dairy and egg (cheese, milk, yogurt, egg, butter). For each food

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2 www.marvelapp.com
item there was information about optimal storage such as best storage temperature, if it can be frozen, and how long it could potentially be edible beyond expiration if stored correctly. The foods that were included and prioritized in FoodEd were the ones that was seen to be wasted the most in Swedish households according to the study by the Consumer Association Stockholm [21].

The prototype also had a "Lessons" page that contained information regarding the best-before and use-by dates on food packaging and steps to take before discarding food that has expired.

The aim was to make the prototype straightforward and easy to use. The information in the prototype, as well as the picture featured in the lessons section was taken from Swedish National Food Agency [13].

![Figure 2: Lessons page in FoodEd. Showing an illustration of steps to take before discarding food where the durability date passed.](image)

### Participants
The participants were recruited through social media. A total amount of 10 participants took part of the study, 5 females and 5 males. The participants were a mix of students and workers between the ages of 22 to 28.

An overview of the participants is presented below (table 1).

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Occupation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P1) Male</td>
<td>26</td>
<td>Student</td>
<td>Living with mother and sister</td>
</tr>
<tr>
<td>(P2) Male</td>
<td>26</td>
<td>Working</td>
<td>Living with roommate</td>
</tr>
<tr>
<td>(P3) Male</td>
<td>26</td>
<td>Internship</td>
<td>Living with roommate</td>
</tr>
<tr>
<td>(P4) Male</td>
<td>27</td>
<td>Working</td>
<td>Living with partner</td>
</tr>
<tr>
<td>(P5) Male</td>
<td>28</td>
<td>Working</td>
<td>Living with partner</td>
</tr>
<tr>
<td>(P6) Female</td>
<td>26</td>
<td>Student</td>
<td>Living with roommate</td>
</tr>
<tr>
<td>(P7) Female</td>
<td>22</td>
<td>Student</td>
<td>Living alone</td>
</tr>
<tr>
<td>(P8) Female</td>
<td>27</td>
<td>Working</td>
<td>Living with partner</td>
</tr>
<tr>
<td>(P9) Female</td>
<td>22</td>
<td>Student</td>
<td>Living with partner</td>
</tr>
<tr>
<td>(P10) Female</td>
<td>26</td>
<td>Student</td>
<td>Living with partner</td>
</tr>
</tbody>
</table>

### RESULTS
First, I will begin by presenting themes related to current practices, knowledge, problems and motivators among the participants drawn from the pre-interview. Secondly, the themes concerning the learnings and impact of using FoodEd drawn from the post-interview will be presented.

### Expiration dates
Seven participants (P1, P2, P4, P5, P8, P9, P10) said that they did not know the difference between the terms use-by and the best-before date. P10 mentioned
that they had not realized there was a difference between the two terms. The confusion and misunderstanding of the terms often led to unnecessary domestic food waste as in this case.

Half of the participants (P1, P2, P8, P9, P10) were not aware about how long different food items last after date of durability passed. Although seven participants (P2, P3, P4, P5, P6, P7, P8) stated that they would consume the food if it smells and tastes good, three participants reported that they will not consume food where the date of the durability passed, due to being afraid of getting sick (P1, P9, P10). Here illustrated by P9:

“Even if the food looks good, I will throw it away, I am afraid of getting sick.” (P9)

This indicates a general lack of trust in their senses among participants in which they are uncertain if food that looks good is actually edible. This in combination with the potential hazardous discomfort of actually getting sick further seals the decision that it is better to be on the safe side and throw it away. P6 further emphasised that it is the lack of knowledge about how to judge if food is good that is missing and fostering this practice of throwing away:

“I don't know if a food item turned bad or not, or how to find out therefore I just throw it away.” (P6)

**Knowledge about storing food and reasons for throwing**

Most of the participants were unaware or unsure how to store their food items correctly to optimize their shelf life (P1, P2, P5, P7, P8, P9, P10). This indicated that there is a general lack of knowledge in food management. Furthermore, one participant highlighted that this is a particular problem when purchasing new kinds of food items as this required new knowledge and practices:

“Whenver I buy something that I haven’t bought before I am unsure how to store it and how long it will last.” (P10)

Generally, several reasons where mentioned for discarding food such as:

- Food becomes bad/mouldy (P1, P2, P3, P5, P7, P8, P9, P10)
- Buying too much food (P1, P10)
- Lacking knowledge of how long different food items last (P1, P4, P6, P9, P10)
- Lacking knowledge on how to check if food is good/bad (P1, P6, P9, P10)
- Best-before day passed (P1, P2, P4, P6)
- Food is forgotten (P2, P4, P5, P8, P10)
- Leftovers are not reused or thrown away (P1, P4, P6, P7, P9, P10)

This shows that the most common reason for food waste is when the food becomes mouldy. Possible reasons for that are: the food is forgotten, buying too much food or that people do not know how to use certain foods in their meal.

Secondly, comes the reuse of leftovers. This indicates that they do not want to put extra effort in storing their leftovers. Signifying that they do not care if some food will get thrown away.

There seems to be a lack of knowledge regarding to how long different food items last. This was observed among 50 % of participants. Evidently this group is not big enough to show a proper statistic about the population, nevertheless it shows some kind of trend in the society. The society lacks information in how long different food items last. This could partly be related to misunderstanding of the difference best before and use by date.

Four participants stated that they did not know how to check if food is good or bad. Checking edibility of food by senses is problematic for some people, as they might not be able to tell if something is still good or bad due to not trusting their senses or not havening enough knowledge when it comes to certain foods.

**Participant motivations for reducing food waste**

Overall, several motivating factors were found among the participants for throwing less food such as:

- environmental concerns (P4, P5, P7, P8, P10),
- saving money (P1, P2, P3, P6) and the
- feeling guilty (P6, P9, P10)
A number of participants mentioned their economy as an important factor for reducing their food waste. P3 stated the importance of optimizing their economy to survive the month, hence leading to minimal food waste:

“I need to optimize my economy to be able to survive the month, the environment doesn’t feel like an acute problem.” (P3)

Most of the participants were concerned about the environmental aspects of unnecessary food waste and its negative impact. This shows that they are aware of the effect it has on the environment as illustrated by P4:

“I don’t take food for granted, I know there are people that can’t afford to buy food. Also, I know how much energy it takes from the environment to produce food.” (P4)

The feeling of guilt when discarding food was identified as a negative emotion and had an impact on participant’s willingness to alter their habits:

“Whenever I throw away any food, I feel like I failed.” (P6)

While asked about how much food P1 had thrown away during a week’s time, the feeling of guilt was highly present which demonstrates that throwing away food is associated with a sense of shame:

“It feels a bit like an interrogation, I know it isn’t but I can’t help to feel a bit guilty for throwing away food.” (P1)

FoodEd led to improved practices of using senses to judge food

The participants (P1, P9, P10) view on expiration dates changed during the week. Instead of solely checking the expiration dates before deciding if a food item is edible or not, they started to use their senses. In which means that they smell, taste and look at the food to decide if it still good or not before throwing it away.

This implies that these participants learned to trust and use their senses to determine if a product is edible or not. Previously these participants were showing a lack of trust in their own senses:

“I didn’t throw away that much actually, very much thanks to the FoodEd. Before I used to discard food whenever the best-before date passed, now I will use my senses to see if it’s still edible before I throw it away.” (P1)

Although participants (P1, P9, P10) earlier reported that they will not consume food where the date of the durability passed, their opinions had changed during the test week. This implies that education of people in this matter is possible and their habits can change:

“I learned that you shouldn't only look at the best-before date when deciding if a food item is edible or not.” (P9)

Further P10 explained how FoodEd impacted their behaviour towards food where the date of expiration passed, indicating on gained trust in their senses:

“Nowadays I dare to taste food where the expiration date passed, earlier I would have just thrown it away.” (P10)

Situation when FoodEd was used

In general, FoodEd was mainly used after food shopping when participants were unsure of how to store their food items (P2, P4, P6, P9, P10):

“I used FoodEd when I was unsure of how to store certain food items, as well as after I made grocery shopping” (P6)

Whereas some participants turned to FoodEd when they had doubts about if different foods where edible or not, as illustrated by P1 and P9:

“When I was going to check if the tomatoes, I had in the fridge still could be eaten after a couple of days. I looked it up in FoodEd and there read that tomatoes can last up to two weeks in the fridge. Therefore, I decided to eat them.” (P1)
"It is nice to have an app to turn to when you are unsure of a food item, or if you have food that you don't know if its edible or not." (P9)

This implies that having an app to turn to gives a sense of confidence in easily being able to clarify any doubts a user has concerning their food. If not having this possibility the food would likely end up in the trash bin due to one of the reasons in the previous section (Knowledge about storing food and reasons for throwing).

A few participants reported that they used FoodEd when they had nothing to do or just for fun (P2, P7, P9). Either these participants thought they were knowledgeable enough or they thought using FoodEd was fun.

**Missing food products in FoodEd**

As the possibility to include all food products was not possible, participants were asked to write down any food products they were missing. One participant, P4 was missing garlic whereas P3 was missing a variation of breads such as hard bread, white bread, wholegrain bread. Another participant mentioned that they were missing information about drinks, such as juices, beers etc:

“Something I was missing in FoodEd was information about juices, beer, and other drinks”  
(P1)

This indicates that a more variety of food items could have led to a greater decrease in participants food waste.

**Changing practices based on FoodEd learnings**

All the participants said that they learned something they didn’t know beforehand through FoodEd. They also mentioned that their new knowledge led them to making better decisions when it comes to storing and handling their food. As illustrated by P4:

“I learned that grapes are best stored unwashed in a plastic bag in the fridge. Also, that bananas should not be kept in the fridge. I didn’t know that cucumbers were temperature sensitive!” (P4)

Four participants (P1, P4, P6, P10) reported that they bought less food than the previous week, due to not throwing away as much as previously. This indicates how their new knowledge and practices lead them to making better decisions.

All the participants store at least one or more food items differently than they did before. Examples of food items participants started to store differently are bananas, avocados, tomatoes, asparagus, bread, onion, lemons, apples, oranges. This shows that a change of practices could happen even in a short time. Here illustrated by P1:

“Nowadays I keep my bananas in a plastic bag, they last much longer than before.” (P8)

Both P2 and P3 expressed that they had a good knowledge on how to store different food items beforehand, however they were less knowledgeable of the durability of different foods, this shows how knowledge leads to less food waste:

“Earlier I knew how to store most of the food items, but I had no idea how long they last.” (P2)

“I’ve learned how long different foods lasts in the fridge before turning bad” (P3)

**Motivation to change behaviour**

Three participants, (P1, P9, P10) mentioned that they would like to see the effect from their behaviour as it would motivate them to waste less food. It implies that users might lose interest in changing their behaviour without seeing the impact of their actions. Implementing some kind of feedback could improve the engagement of the users in the app. Other mentioned motivators during the interviews were competing with friends and saving money (P1, P5, P8, P10). Here illustrated by P1 and P5:

“I would like to see the effect from my behaviour, how much food I saved and how it affected the environment. Also, how much money I saved, it would be nice to be able to compete with friends.” (P1)
"It would be nice to be able to collect points depending on how much food one saves and, in that way, compete with friends inside the app. Also getting rewarded with discount codes or getting money to shop for or donate through the points." (P5)

DISCUSSION

The purpose of the study was to encourage sustainable food waste practices in households targeting young adults through FoodEd. The results of the study imply that the participants’ knowledge increased leading to changed food waste habits and a decrease in unnecessary domestic food waste. In this study, the current state refers to the high levels of food waste in Swedish households. The preferred state is obtaining a reduction of these high levels. The results indicate that interesting changes in food practices occurred during the test week, implying a good potential to reduce food waste through increased food management knowledge.

Four participants in the study mentioned that saving money as one of their motivations for throwing away less food. In the study by Thieme et al., participants also reflected on their food waste and money savings, and how they can benefit from reducing their food waste [18]. One participant realized the value of the food she threw away and how she could have used the wasted money for another meal by seeing the food she had wasted [18]. However, this study and the study made by Thieme et al., were both targeting young adults. 50% of the participants in this study were student whereas in the study by Thieme et al., 73% were students and 27% were unemployed or self-employed. However, if the participants had a more stable economy, they may not have cared about the money saving aspect.

The feeling of guilt when discarding food was expressed by some of the participants. P1 stated that they felt interrogated when asked about how much food they had thrown away during a weeks’ time. This reaction leads one to think if more of the participants felt in the same way without mentioning it as well as, how honest the participants answers were when it comes to how much food they had thrown away. The feeling of guilt when discarding food has been present in previous studies within HCI and food waste and is seen to be very common [18][22].

When it comes to long lasting effects of FoodEd it is difficult to speculate. However, it is possible that we see an effect from participating in a study that would not have happened if FoodEd was used outside of the study. Having proper motivation to reduce food waste was an important factor among the participants in order to keep them interested in proceeding in reducing their food waste and improving their practices. In the study made by Thieme et al., it was reported that the participants either lost interest or forgot about Bincam after two weeks’ time [18]. Although Bincam is not an informative app, this may also be the case for FoodEd. During stressful times people are more likely to go back to their previous behaviours since it requires less attention from the person [25]. FoodEd was used only over a week’s time, hence measuring the long-lasting effects was not possible. Using FoodEd over a longer period of time, would have given the possibility to measure the long-lasting effects of the behavioral change and make the data more reliable. However, the result show that users can improve their habits or the way they store their food by using the app just once, thus most of the information available in the app probably already reached the user within a weeks’ time.

Initially there were three participants that said they would not consume food where the expiration date passed due to not trusting their own senses to judge if the food is still edible or not and being afraid of getting sick. This was resulting in unnecessary food waste, however after using FoodEd for a week, their practices had improved. It indicates that gaining new knowledge is an effective way of changing food waste practices.

FoodEd was mostly used after food shopping to store food items properly. Some participants reported that they used FoodEd when they had nothing to do or just for fun. This fact leads one to think if they used FoodEd because they were in the study and not actually because they needed to. All the participants reported they learned at least one new thing from the app, indicating that participants using FoodEd just for fun or when they had nothing to do, also gained some new learnings leading to improved practices.

Interestingly participants mentioned missing variations of bread and information about drinks in FoodEd. According to the Swedish natural protection agency, Swedish households pour out 224 000 tons of liquid food and drinks in the sink every year [26]. This
Future studies could consider using technology to help people decide if foods are edible or not. Someone with problems with smelling might find it hard to decide if food taste or smell good in order to consume it. Multis-sensory HCI can also help people to learn to trust their senses. Even though in this study, participants started to trust their senses more, there is a possibility that their perception was wrong.

Future research on the long-lasting effects of apps like FoodEd should be considered to understand its long-term effect.

CONCLUSION
The aim of the study was to encourage more sustainable food waste practices in households through an informative design. In the study FoodEd was shown to be effective in informing its users which automatically lead them to making waste minimizing choices. Saving money, the feeling of guilt when discarding food and environmental concerns were all seen to have an impact on participants willingness to alter their habits. During the study people have, successfully changed their habits of storing food. This implies that even while exposed to a short experiment of 7 days people can change their habits, however the long-lasting effects are yet to be measured. Meaning that people can change their habits if gives easy access to information and having proper motivation. Informing consumers through design can be an efficient way to influence people's behaviour when it comes to changing their food waste practices. Some of the users mentioned that seeing an effect from their behaviour or competing with friends would increase their motivation to waste less food. Therefore, including more social and interactive functions can be a good way to motivate users to use an app like FoodEd.

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is a large number indicating that there is a need to address this as well. FoodEd was including information about dairy products such as milk, however milk products only account for 25 % of the wastage [26]. Therefore, including information about other drinks such as juices, beers, coffee or tea is important and could have resulted in a greater decrease in participants food waste.

Participants in this study mentioned different reasons for wasting food. For example, incorrect storage, misinterpreted durability dates which FoodEd tackles. Other apps in previous studies such as EatChaFood and FridgePal has its focus on making users aware of available food in their fridge. Forgotten food was also mentioned as one of the reasons for unnecessary food waste which these apps focus on. Meanwhile, BinCam has its focus on raising user’s awareness and in this way changing their behaviour. Since lack of motivation is another reason for domestic food waste, making people aware of their habits can lead to a change.

Using semi-structured interviews to get an insight in participants food practices and knowledge during the study was very effective. However, the problem with interviews is that the participant may feel pressured to say the right thing instead of telling the truth. As in this study, where some participants expressed feeling guilty when asked about certain things, meaning that they might have been ashamed to speak the truth. If this was the case, it would mean that some of the data from the interviews would be invalid. Nevertheless, the outcome of the interviews was sufficient to answers the research question and draw conclusions.

Future work
Findings from the study reveal functionalities that can be considered in future apps. Firstly, a way for users to see the effect of their behaviour. For example, to see how much money they saved by not throwing away food that they normally would have thrown away or seeing how their food waste behaviour affects the environment. Another way is to earn reward points and getting discount or vouchers at local food store or restaurants to reward sustainable behaviours. Including social interaction and competition among users is another way to make the app more fun and engaging for its users. Another idea would be to integrate an informative app in an already existing app, that is frequently used by most people, such as Facebook. That is a way to make it more accessible for its users.
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