Designing A Persuasive Mobile Application for Sharing Food Between Students and Restaurants

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Submitted for the completion of the KTH program; Media Technology, Master of Science in Computer Science and Engineering

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ABSTRACT
Food waste is a monumental problem as food production accounts for nearly a third of greenhouse gas emissions globally and nearly a third of it ends up as waste. By changing people’s behaviors and attitudes, this surplus food could be eaten instead. Persuasive technologies can be an effective way of changing people’s behaviors; however, they may narrow down the view of sustainability if applied in a manner that focuses too much on individuals (among other things). In this thesis project the focus has been on how to best design a persuasive application that reduces food waste by considering the needs of both restaurants and consumers.

Two versions of an application were created based on interviews with students and restaurants, where one of the applications included features based on Persuasive Systems Design (PSD). A user study was then conducted, where the users received a number of tasks to complete and answered a questionnaire on the PSD features afterwards. The results showed that both of the applications had a similar number of errors from the users during the tasks. Besides this, all of the four features based on PSD were rated positively by users, with all features having a mean rating of 0.83 or higher on a 7-point Likert scale.

SAMMANFATTNING

Två versioner av en mobilapplikation skapades med utgångspunkt i intervjuer med studenter och restauranger, där en av applikationerna innehöll funktioner baserade på PSD-principer. En användarstudie genomfördes sedan, där användarna fick ett antal uppgifter för att genomföra. Användarna besvarade sedan ett frågeformulär om PSD-funktionerna. Resultaten visade att användarna gjorde ungefär lika många antal fel i båda applikationer under uppgifterna. Utöver detta bedömdes alla fyra funktioner baserade på PSD positivt av användarna, då alla funktioner bedömdes som 0,83 eller högre i genomsnitt på en 7-punkts Likert-skala.
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Food waste is a monumental problem as food production accounts for nearly a third of greenhouse gas emissions globally and nearly a third of it ends up as waste. By changing people’s behaviors and attitudes, this surplus food could be eaten instead. Persuasive technologies can be an effective way of changing people’s behaviors; however, they may narrow down the view of sustainability if applied in a manner that focuses too much on individuals (among other things). In this thesis project the focus has been on how to best design a persuasive application that reduces food waste by considering the needs of both restaurants and consumers.

Two versions of an application were created based on interviews with students and restaurants, where one of the applications included features based on Persuasive Systems Design (PSD). A user study was then conducted, where the users received a number of tasks to complete and answered a questionnaire on the PSD features afterwards. The results showed that both of the applications had a similar number of errors from the users during the tasks. Besides this, all of the four features based on PSD were rated positively by users, with all features having a mean rating of 0.83 or higher on a 7-point Likert scale.

Author Keywords
UX; Persuasive Design; Food Waste; Sustainability

ACM Classification Keywords
H.5.m. Information interfaces and presentation: Miscellaneous

INTRODUCTION
Food production is a big contributor to climate change. In total it is estimated to account for nearly one third of greenhouse gas emissions globally [1]. In fact, just the meat and dairy production alone accounts for 18% of the global greenhouse emissions and meat production is set to double by 2050 [17].

This means an ever-increasing impact on the climate. As a matter of fact, avoidable food and drink waste, i.e. food that was edible at some point, was estimated to contribute the equivalent of 17 million tons of CO₂ in greenhouse gas emissions per year in the UK alone in 2011 [14]. However, with better management, a big part of the food that is thrown away today could be consumed instead, lessening the need for production and thus reducing the impact on the climate.

Today nearly a third of the food produced ends up as waste according to a report by the Food and Agriculture Organization of the United Nations (FAO) [1]. This means 1.3 million tons of edible food wasted annually in total. According to the same report by the FAO, per capita food waste by consumers in Europe and North-America is 95-115 kg/year, which is over ten times that of sub-Saharan Africa. The food waste in high-income countries is mainly caused by consumer behavior as well as a lack of communication between different parts of the supply chain [6]. This means that by simply changing consumer behaviors and attitudes toward the consumption of food, a big part of food waste could be avoided.

Food waste can naturally be used as compost, which may have some benefits as it can be used in agriculture as a fertilizer among other things. This means that composting your food waste is not without its benefits. However, preventing the food from becoming waste in the first place is eight times more beneficial in terms of reducing greenhouse gases, rather than composting [15]. This means that rather than trying to find ways to make food waste useful, we should focus our efforts on trying to minimize it instead.

Research has shown that there are multiple behaviors and attitudes that lead to food waste in households, such as a lack of planning, knowledge of partitioning and storage [13]. Yet, it is important to note that surplus food does not automatically lead to waste. Gifting food for example is one way of making use of surplus food that would have otherwise gone to waste.

Gifting food is not without its problems though. Discarded food may be risky material as it may have gone bad, be
undercooked, or just be otherwise inappropriate. It may also demonstrate poor culinary competence to the people who receive it. These are just some of the reasons why gifting food is not very commonplace, as gifting is shaped by contextual factors, such as the extent to which households are socially embedded within a locality [5].

THEORY AND RELATED RESEARCH

Sharing Leftover Food
As a study done at a university campus shows that sharing leftover food through social media tools is a challenge [8]. The relationship between the person donating and the person eating was key in establishing trust in whether or not the food was edible. Another factor that hindered sharing foods was that it was not deemed as socially acceptable to eat foods once they had been deemed as waste by someone. In order to make gifting leftovers a viable way of reducing waste, these problems of trust and social acceptance need to be addressed.

Persuasive Technology
Some information technology systems and services can be very persuasive and therefore an effective way to change people’s behavior, such as making them behave in a healthier manner. These are called persuasive systems and they are characterized by reinforcement, change or shaping of attitudes and behaviors [12]. In fact, persuasive technologies have been a popular method of addressing sustainability related issues within HCI, as they comprised about 45% of the literature within the field according to a meta-analysis [3].

Despite being a popular method, the persuasive approach to sustainability is not without its faults. According to an analysis by Brynjarsdottir et al. [2], the persuasive approach can narrow the view of sustainability. The persuasive approach tends to focus too much on individuals and behaviors and neglect the need at other scales beyond that, as well as socio-cultural particularities and the dynamics of change over time.

Brynjarsdottir et al. provide three suggestions on how to adapt persuasive sustainability to cover its aforementioned weaknesses. The first suggestion is broadening our understanding of persuasion, which implies that persuasion should be more of a process where the user is presented with different perspectives which in turn shape their beliefs and actions, rather than almost being coerced into them [2]. The second suggestion in the paper encourages the inclusion of users in the design process. This brings systems closer to the definition of sustainability that users enact in their daily lives. Their third suggestion is to move beyond the individual and focus more on community, political, and infrastructural engagement.

Another research paper by Knowles et al. [7] mentions how persuasive technology might increase an internally motivated drive to make a real difference for sustainability by; “...consciously attending to the values that promote pro-environmental behavior...”. The research paper goes into detail on five different patterns of persuasion and how they may promote this pro-environmental behavior in practice.

The first pattern is promoting self-transcendent values instead of self-enhancement values. This could mean for example using means to activate values related to peace, equality and justice.

The second pattern that Knowles et al. mention is being consistent in which values to promote and avoid undermining this message by introducing conflicting reasons for users to change their behaviors.

The third pattern is designing to the value. In practice this means, that since research has shown that behavior is strongly influenced by values, the goal should be to facilitate a shift in values, rather than a shift in behavior.

The fourth pattern in the paper is to facilitate reflection in order to make people think why they would adopt more pro-environmental behaviors. This could mean asking the users about what is important to them.

The fifth and final pattern suggested by Knowles et al. is measuring impact ripples. This would mean that instead of measuring more direct impacts of persuasive technology, one should focus more on the indirect impacts of it. An example provided in the paper is measuring the users overall concern for the environment.

Practice Theory
Southerton and Yates [16] explore the food waste problem through the lens of practice theory instead. They conclude that there are a number of cultural demands that can be linked to food consumption, such as food safety, economy and convenience, which may discourage people from buying leftover food if not considered. This means that the food needs to be safe to eat, affordable and easy to access. These perspectives may be incorporated into persuasive systems in order to shed more light on problems with food consumption and to gain a more holistic perspective of the problem.

Designing and Evaluating Persuasive Systems
Oinas-Kukkonen and Harjumaa [11] present a framework for designing and evaluating persuasive systems that includes 28 different design principles/strategies. The key benefits of each principle were laid out by the authors to help designers choose the most beneficial ones for their context.

Several different persuasive strategies were compared with each other in a recent study by Wunsch et al. [18]. The study focused on persuasive technologies that tried to encourage biking as a low-energy mode of transportation. They conclude that different principles of persuasion are effective under different circumstances, while encouraging more research into the principles within different contexts. In their case the first strategy which used the principles of
recognition, competition, cooperation and comparison resulted in a significant rise in bike usage, while another strategy using the principles of authority, reduction, tunnelling and tailoring did not lead to a sufficient behaviour change [18].

**Research Question and Purpose**

*How to best design a persuasive application that reduces food waste by considering the needs of the restaurants and students?* This involves creating and testing an application with a number of persuasive systems design (PSD) features, as well measuring the error rates of these features by comparing it to a similar application without PSD features (See Fig. 1).

**INTERVIEW STUDY**

Brynjarsdottir et al. [2] suggestions of involving the users in the design process, meant that interviews of the restaurants and students were conducted in order to gain a better understanding of the users’ and restaurants’ needs around food and sustainability.

**Method**

Semi-structured interviews were conducted with a total of eight restaurant managers at KTH Campus. The interviews were done in collaboration with researchers from the “Rädda Maten på KTH” initiative at SEED, KTH. The initiative aims to reduce food waste at KTH Campus. Two of the interviews were conducted by me personally, the rest was done by the research group. The aim of these interviews was to establish how much and why food was wasted but also to find out what their interest in such an application would be and what requirements it would need to fulfill. The interviews consisted of questions regarding their levels of food waste, how it is handled currently and what their needs are (See Appendix A). The interviews were done in person at KTH Campus with the exception of one interview, which was done via email due to availability and time constraints. The answers from the interviews were written down directly on paper. No audio recordings of these interviews were made.

In addition to this, semi-structured interviews with the target user group of KTH students were also conducted by me. A total of 4 male and 4 female students were interviewed in person at KTH Stories Café. The mean age of the people interviewed was 24. The interviews consisted of questions regarding the students eating habits, their social practices of eating and their experience with using applications to buy food (See Appendix B). The answers from the people interviewed were written down directly during the interview and no audio recordings were made.

The answers from both interviews were then analyzed and different themes were found by searching for patterns within the answers. The answers would then be sorted into the themes to try to form a more cohesive picture of the user sentiment.
Results: Interviews with Restaurant Managers

A thematic analysis of the interviews with restaurant managers divided the answers into three themes.

Levels of Food Waste

The interviews with restaurant managers revealed that levels of food waste at the restaurants could vary greatly from day to day, but many of the managers stated that the number of leftovers were fairly minimal. Several managers stated that most days there was no waste, but on occasion the amount of food left over would go up to a few dozen portions. When asked what they attributed this to, most of the managers stated that they have a good estimation of the number of guests at the restaurants and can therefore control how much food they need to buy for each given day. Several of the food items that were left over each day could also be used in other meals and/or simply sold later on.

Requirements for an Application

The restaurant managers mentioned a number of requirements that an application that would sell leftover food needed to have. These were that it should be quick and easy to use for both customers and restaurant employees, but that it should also contain the essential information for customers, such as allergens. Also, as the restaurant employees are fairly busy, the use of the application should not take up more than a couple minutes of their time each day or it won’t be worth it, one manager explained.

Risks and Concerns

Several managers also expressed concern with issues pricing the leftover food. If the prices of the food are too low, their already low profit margins make it not worth for the restaurants to even use the application. One manager especially expressed concerns with selling the food at a lower cost, as they said that customers may come to expect the lower prices and therefore be more reluctant to pay full price for food.

Results: Interviews with Users

A thematic analysis of the user interviews showed a number of emerging themes.

Eating at Home or at a Restaurant

It was common for the students interviewed to cook their own food at home. As for the reasons given for this, most students said it was done to save money, as the restaurant meals would not fit their budget. As one user put it:

“I make lunch at home and bring it with me. I usually have a pretty strict budget so I can’t really afford to eat here [at restaurants], even with the student discount.”

The majority of the respondents had similar answers, meaning they would most often cook at home. However, if the students were stressed over time, they would tend to choose to eat at their preferred restaurant over cooking at home. A user mentioned:

“Usually I try to make food at home and bring it with me, but sometimes I don’t really have time or I’m too stressed to make anything. Then I usually eat at Nymble or KTH Stories, but I try to avoid unhealthy alternatives.”

This was a clear theme with most of the users, however some users preferred eating at restaurants since they didn’t like cooking. In conclusion those who chose to eat at restaurants did it because of the ease of it and because they preferred restaurant foods. As one user put it;

“I usually to buy food at the restaurants most often as I’m not really interested in cooking. It is easier for me than making food at home and it tastes better.”

Influence of Friends and Peers

When asked about how their friends and peers influence their eating habits, it was clear that most students were influenced in one way or another by them. The most common influence for students was to sit together and eat within their friends’ group as one user put it;

“Yeah, I will almost always eat with my friends. I think [eating together] is really important in my friends’ group.”

The users were also influenced by what their friends ate. A user mentioned how their friends influenced them to go vegan.

“My friends were definitely an influence on me becoming vegan. I think your social circle influences the type of food you eat a lot.”

Another mentioned how a friend had inspired them to eat healthier. It was a clear theme throughout the interviews; friends and peers definitely had a clear influence in what food choices they made.

Use of Applications to Buy Food

When asked about their usage of applications to buy food, most of the users had not used such applications before. One user mentioned how it would just complicate things

“I haven’t really even thought about using them since I think it’s so easy to buy food the regular way. I think it would just complicate things.”
Two users had experience with applications to buy food. One user liked how it was quick and easy to use;

“I do use the Starbucks app to pay for things sometimes because I think it’s easy if you’re in a hurry. Also, you only need your phone which is great.”

However, one of them did not use the application anymore. The user mentioned how they had forgotten about the app as they did not use it much. They also stated that maybe they would use it more if more of their friends were also using it with them.

**IMPLICATIONS FOR DESIGN**

Based on the interview themes from the restaurants and users, four principles out of the 28 principles suggested by Oinas-Kukkonen and Harjumaa [11], were chosen for the PSD version of the application. The principles were chosen by trying to match common themes from interviews to a design principle that would address the issue. These principles were then subsequently implemented in the application by introducing four core features. These principles chosen were the following;

*Personalization*

The principle of personalization was chosen based on the fact that users tended to eat at their preferred restaurants e.g. to avoid unhealthy alternatives as was mentioned in the interviews. A system that offers personalized content or services has a greater capability for persuasion [11]. This means presenting content relevant to the user first, rather than in random order, such as being able to mark restaurants as favourites so that they appear at the top if the page.

In practice this meant that users were able to mark their favourite restaurants by pressing the heart shaped favourite button. This would then move the restaurant to the Favourites category, so that they were easily found and identified by the user (see the first frame in Fig. 3).

*Suggestion*

The suggestion principle was chosen based on the fact that users don’t have a lot of time when deciding what to eat, meaning saving time when choosing foods could be beneficial. Also, users that had used apps to buy food before liked the fact that they were good if you were in a hurry. Systems offering fitting suggestions will have greater persuasive powers according to Oinas-Kukkonen and Harjumaa [11]. This means suggesting or recommending foods to users in order to alleviate the process of choosing foods could be more persuasive for the users.

This meant that recommendations were implemented in a way that showed a “Recommended” icon on a food item visible next to its title (see the second frame in Fig. 1). The recommended food items would also show up first when
opening a restaurant’s page, in order to be more visible to the user.

Social comparison
The principle of social comparison was chosen based on the fact that the users mentioned how their eating habits are largely influenced by what their friends eat. System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others according to Oinas-Kukkonen and Harjumaa [11]. This means for example being able to see how much food you have saved/bought.

The social comparison principle was implemented with personal and global statistics. These were implemented in the app with graphs that showed how many portions the user had bought, how much money they had saved and the carbon dioxide equivalent effect of the food that was rescued. The graphs also showed how many portions the user had bought compared to the average user so that they would be able to compare themselves to them (see the third frame in Fig. 1). The users could also see what they had bought previously and at what time in their history timeline.

Social facilitation
The social facilitation principle was also chosen based on the fact that users eating habits are influenced by their friends [12]. According to Oinas-Kukkonen and Harjumaa [11], system users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them. This means being able to see e.g. how many other users are using the application in their area.

In practice this was implemented by simply showing the user count of the application in the top right corner of the statistics page (see the third frame in Fig. 1).

In summary; four different principles were chosen based on the interview themes. These principles then in turn influenced what features would be added to the PSD version of the application.

Design of Applications
After choosing the design principles two different versions of an application were created, one of which was designed according to the Persuasive Systems Design (PSD) model [12]. The applications were made with web technologies such as HTML, CSS and TypeScript using the Ionic mobile app framework, which is built on the Angular web application platform.

The basic layout and features were designed in collaboration with Cecilia Katzeff (associate professor in Human-Computer Interaction) and her colleagues at the Dept. of Sustainable development who were part of the “Rädda Maten på KTH” initiative at KTH. The layout was based on requirements for the initiative and suggestions from the restaurants that were interviewed. A basic requirement of the application was to be able to buy leftovers from restaurants, as well as share your own food with other users by gifting it to people who want it.

Both of the applications had a layout with one tab dedicated to restaurants and their leftover food. This included a list of restaurants with a number of purchasable food items. The food items included basic information about price, allergens and the number of portions left. The second tab in the application consisted of leftover food shared by other users of the application, along with an option for the users to share food themselves (See Fig. 1 for the layout of the restaurant page of the applications).

In addition to this, the version built on the PSD model implemented a number of design principles chosen based on the user interviews that were conducted. The second
application that was made was similar in other aspects, but lacked the features inspired by PSD design principles.

USER TESTS
A number of user tests were conducted where the users would receive a number of tasks to complete within both of the applications. The tests were then followed up by a questionnaire where the users rated the persuasive design features.

Method
The two applications were tested by the target group of students. Six users in total, three women and men, participated in the in the user tests. According to a study by Nielsen and Landauer [10], approximately 89% of usability problems can be found with just 6 users, which is why the number of users were deemed sufficient.

Users were given a list of tasks to complete in the applications, which was printed on paper and handed to them. The tasks consisted of simple actions within the app such as buying a food item from a restaurant, but were different for both versions of the application (See Appendix C for the full list of tasks). Because the application without PSD features did not include as many features, the tasks were inevitably fewer for that particular application. The users were encouraged to verbalize their thoughts during the tasks, in accordance with the think-aloud method [4]. The task completion was video recorded anonymously (see Fig. 2). All of the users performed the tasks in both of the applications. The tasks where counterbalanced to ensure the order in which they were tested did not affect the results.

After completing the tasks in both of the applications the users then filled in a questionnaire on the PSD features, where they could rate each feature on a Likert scale [9] from -3 (very negative experience) to 3 (very positive experience). Along with this the users could also briefly comment on each PSD feature in the questionnaire in order to get more qualitative data. The questionnaire focused exclusively on the PSD version of the application and did therefore not include questions on the other application (See Appendix D for full questionnaire).

Results: Task Performance
The user tests revealed that the navigation within both of the applications was fairly smooth during the user tests as all of the users managed to complete every task in both applications. However, the users did have trouble with some of the features. The user tests revealed some of these usability flaws where users had issues navigating the application or difficulties finding which button to click on in order to execute a certain task. It is worth noting that the PSD application had a list of 5 tasks while the reference non-PSD application only had a list of 3 tasks (see Fig. 5).

The number of erroneous actions during the user tests were fairly similar in both the PSD and non-PSD applications (3.167 and 3.833 per tester respectively). As the user tests were counter-balanced, the number of errors varied based on which application the user started with.

The feature that the most users had difficulties with was buying the food items, as it was not clear which element to click on in order to be able to purchase something (task 2 in PSD and task 1 in non-PSD version). Most users clicked on different elements other than the purchase button within the page, such as the title or picture of the food.

During the tests several users mentioned how the button to purchase a food item should be more prominent on the page and include the word “buy” instead of just the price (see Fig. 4). Another issue compounding this was the fact that because the elements on the page were so large users would have to scroll down to even see the button when they first navigated to the page.

Users also had some difficulties differentiating between food from restaurants and food that was shared by other users as the elements were visually very similar. In other words, users had difficulty realizing if they were looking at food items from restaurants or from other users, as the only noticeable differences between them were that instead of the price showing, the user shared food items had a “request” button and that it was under the share tab.

Another common usability problem was in regards to finding out how to share food items (task 3 in PSD and 3 in non-PSD). This was related to the aforementioned problem as many users did not realize this function was within the
“share” tab in the application and therefore could not find the button to share foods. The button for sharing was also fairly hard to spot as it was fairly small.

**Results: Questionnaire for PSD features**

The questionnaire that the users took after completing the tasks revealed how each of the Persuasive Systems Design principles were rated by the users. On the Likert scale of -3 (very negative) to 3 (very positive), the favouriting feature was rated as 2.0 on average with a SD of 0.6 (see Fig. 6). Among the reasons for this, users mentioned in the questionnaire that it was “easily found and saves time” as well as “making it easier to find the restaurants that you prefer”. One user also mentioned how it was convenient to have all the favourites on the same page as the rest of the restaurants, because you “…do not have to navigate somewhere to see my favorites when I added something to the list”.

However, as one user mentioned it was considered: “A good feature but not needed because there were only a few restaurants available [in the App]”. As there were only four different restaurants within the app, they all stayed within the same view whether they were marked as favourites or not.

When it comes to recommendations, the feature was rated as 1.5 on average (SD = 1.0). In the questionnaire users also mentioned the positives of the feature being “If you have trouble deciding what you want to eat, this gives you an option”. Users also mentioned how the feature was lacking as it was: “A bit unclear what this means… needs more explanation” and that “…it would be nice to have filtering to select all recommendations”. Some users also pointed out how it does “…not rate the food”, but merely recommends it based on something that is hidden to the user. So, in essence, the recommendation feature was simply a binary indicator on screen and did not provide the users with sufficient tools to understand what the selection of recommended items was based on. Besides this, it did not provide the users with options to customize or filter their recommendations.

Personal statistics were rated 2.167 on average (SD = 1.16), the highest of all the PSD features. Among the comments in the questionnaire for this feature were: “I like the fact that you can see how much CO₂ you can reduce by using this app and how much money you actually save” as well as “It is nice to see how much money you have used, eaten and [it helps] to follow the budget”. All of the users were either positive or neutral when rating this feature.

However, some usability issues on the graphs were also pointed out. One user mentioned labelling was an issue as there were no descriptions of the labels anywhere within the application. The user said: “…the labels were not so clear describing the graph, e.g. it was difficult to interpret the graph when it just says "My Portions" and "Average". It would be great to have description on them as well somewhere in the graph.

![Mean Rating of Persuasive Design Features with Standard Deviation](image)

Figure 6. The mean rating of the Persuasive Design Features from the questionnaire where the features were rated from -3 (very negative) to 3 (very positive). The error bars for the average values are based on the standard deviations for each feature.
Global statistics were rated 0.833 on average (SD = 1.83), the lowest of the four PSD features. Users commented in the questionnaire on how the feature was an “Interesting feature but not necessary” and “I am not that interested to know how much other users save money or how many portions they have saved.”

More detailed information about other users was also requested. One user mentioned how: “…I would like to see more about what my friends have bought and so on”, as the statistics only provided a global average of all the users, without the ability to filter them in any way, so as to e.g. only see your friends’ statistics.

**DISCUSSION**

This study looked at how to design a persuasive mobile application in order to share food between restaurants, staff and students. A problem with persuasive design is that it may narrow down the view of sustainability by focusing too much on individuals and their behaviors instead of looking at communities as a whole and socio-cultural particularities [2].

Opinions and insights about food practices were gathered through interviews with both restaurants and users. These insights were then incorporated into an application by matching them with appropriate Persuasive Systems Design (PSD) principles which dictated some of the features in the application. An application without these PSD features was also developed for reference. The applications were then tested by a group of six users, where the users were given a number of tasks to execute in both versions of the application, followed up by a questionnaire on the PSD features.

Looking at the amount of errors in the user tasks, they seemed to vary based on what application the user started the tasks with. Given that the non-PSD version of the application had fewer features and the tasks were not as many, one could have expected that version to have fewer errors in the tasks. But the fact that it had a fairly similar number of errors indicated that these usability flaws existed in both applications and were not related to PSD features.

As for the usability flaws that were discovered during the think-aloud user tests, many of them were due to similarities in the interface between pages. In order to address this, the user should have clearer indicators as to what page they are on and what the purpose of the page is to avoid confusion. This could be done by highlighting key words and elements within the page as well as adding a short explanation when launching the application for the first time to explain the purpose and main features.

When it comes to the Persuasive Design Features from the questionnaire; favourites were positively received by the users with a mean rating of 2.0, with a fairly small variance within the user group (SD = 0.6). The users expressed that is was an all-around good feature which saves time when looking for restaurants as it allows the users to easily identify which ones are relevant to them. It was also fairly unobtrusive if the users chose to ignore it, meaning it did not add unwanted complexity to the application for users who did not care for the feature.

Recommendations were rated 0.5 points lower than favourites, with more varied opinions within the users (SD = 1.0). Overall the feature was appreciated, however the implementation may have been confusing to the users as it was not explained why an item was recommended to them. Some users expressed a desire to see ratings of the food, which may have provided a clearer way for the users to see why an item was recommended. A user also suggested to be able to filter recommendations based on different criteria, which would have allowed for even more personalization and perhaps more relevant recommendations.

So, possibly the biggest flaw of the recommendation feature was that it lacked any context for the user. Just seeing an item as “recommended” is not very relevant to the user as they do not know what this entails. The feature could also tie in with having categories for different types of food as it allows the users to filter item to only see what best suites their tastes.

Out of the PSD features, personal statistics proved the most popular among the test user group with a mean rating of 2.16 (SD = 1.16). However, it was interesting to see that global statistics were rated the lowest, 0.83 (SD = 1.83). These two features were heavily tied together, but their ratings were the furthest apart from each other. What people liked about the personal statistics was that they could see their reduction of CO₂ equivalents and also how much money they have saved, which would help if keeping a budget. However, as Knowles et al. [2] point out, it is important to stay consistent in which values to promote in order to not undermine the message of promoting sustainability. Because of this it might be better to only include statistics on issues that affect sustainability, such as the CO₂ equivalents. This would mean not including statistics on how much money is saved, since it is related to self-enhancement and a therefore not compatible with sustainability. It is interesting to see that most of the users mentioned things related to saving money and not the sustainability aspects when they talked about the statistics feature, which supports the aforementioned conclusion.

As to why the global statistics were rated lower, the main reason for this, according to the users, were that they were not that interested in what other people were doing, unless they could see their friends’ statistics. In order words, statistics for other users of the application were not relevant unless they were the user’s friends. This is closely related to the findings from the interviews where users expressed that their eating habits were greatly influenced by their circle of friends and family. In order to better address this, users should be able to better connect to their friends via app by e.g. being able to browse their profiles and see their
statistics. Statistics of the global userbase may not be as relevant.

Instead of global statistics, the application could also showcase more data and useful information about the community that the users were in order to involve them more in community-based activities around food.

**LIMITATIONS & FUTURE WORK**

One of the biggest limitations with the study is that the users were not able to test the app within a real environment because of time limitations. As many of the features that have to do with the social facilitation and comparison principles would be best tested in an environment with other real users over a period of weeks. This way the users could get a better understanding of the features and how they work in practice. Instead they had to assess these features after just using the application in a predetermined scenario for a few minutes.

Another limitation was the fact that the questionnaire the users took afterwards only included questions on the PSD features and not on the reference application. The value of the reference application was fairly limited because of this. This meant that the results on the PSD features were not as clear as no meaningful comparison could be done.

A larger number of test subjects in the user study may also have provided more differing opinions, leading to better insights. As the study was limited to six users and eight questions in total, the insights gained were fairly limited.

Also, as the user evaluation was done in person this could have also affected the user ratings. The users may have felt some responsibility to give more positive rating than they would have otherwise, as they were rating an application made by the same person who was conducting the evaluation.

Lastly, a limitation of the application was that, despite involving the community by interviewing restaurants and users, the persuasive design principles that were incorporated were still individualistic. This means that the individualistic problem of persuasive design was still present, giving the users a fairly narrow view of the sustainability problem.

Future work should expand the concept to look at what other, more community based, persuasive features may be incorporated into the application in order to persuade users to think and act in a more environmentally friendly manner. Besides this, trying to test the application within a real environment for a longer period of time may provide more insights and design lessons.

**CONCLUSION**

This study focused on incorporating persuasive design features into an application in order to promote and persuade the user towards sustainable behaviors.

This study concluded that the PSD features did not add errors in usability as the error rate was similar in both applications. All of the features based on Persuasive Systems Design principles were also rated positively by the users. Favourites (based on the personalization principle), recommendations (based on the suggestion principle) and personal statistics (based on the social comparison principle) all performed positively in the user tests. The global statistics feature (based on the social comparison and facilitation principles) performed somewhat worse than the others, where the rating had a much stronger standard deviation between the users. Reasons for the global statistics feature performing poorer than the other features were that the information it provided was not relevant or interesting and that the users could not see their friends’ statistics, but were instead presented with an average of the entire user base.

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**REFERENCES**


APPENDIX A – QUESTIONS FOR RESTAURANTS
1. Approximately how much food is left over every day? Does the amount vary much from day to day?
2. ?
3. What do you do with leftover food? Do you have to sell the food for lower prices after a while or throw it away?
4. What do you think about the idea of selling leftover food for a reduced price through an app?
5. What functions are necessary for the customers in such an app?
6. What features are necessary for the restaurants in such an app?
7. What is the ideal form of payment in such an app? Is payment within the app or with credit cards better?
8. How much time could you allocate to using such an app daily? What is important to know about the food for customers?

APPENDIX B – INTERVIEW FOR STUDENTS
1. How do you plan your food at KTH? Do you tend to make your own food or buy it at a restaurant or store? Why?
2. Are you influenced by your peers/friends in your food choice and habits? In what way?
3. Are you currently using applications to buy food? Why/Why not?

APPENDIX C – TASK LIST
APP 1
1. Favourite a restaurant from the list.
2. Buy a food item that is recommended from one of the restaurants.
3. Share a food item with other users.
4. Check how many users are online using the app.
5. Check how many portions of food have been saved by;
   a. you.
   b. the average user.
APP 2
1. Choose a restaurant from the list, choose a food item and buy it.
2. Request a food item that someone else has shared through the app.
3. Share a food item with other users.

APPENDIX D
- UX QUESTIONNAIRE
- USER TEST VIDEOS