

# Share or Waste?

## Using an ICT-platform to share food on a university campus

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**Abstract—** Considering that food production for human consumption has a large environmental impact, food waste is major challenge for sustainable development. Although food waste occur at all phases in the food supply chain, private consumption has been identified as a major phase of food waste generation. Intervening at this phase provides an opportunity of change. The article reports the testing of a digital prototype designed to facilitate for employees and students at a university campus to share food. A representative group tested the prototype and associated food sharing activities for two weeks. At the closing of the test period they filled in a questionnaire evaluating their experience. Twenty-three responses were obtained showing that twelve people used the prototype for collecting food, whereas nine used it for sharing their food. Six people did both. Main reasons for not collecting food included lack of time, unavailability of shared food in their proximity and inaccessibility of spaces where food was located. Main reasons for not sharing food were that they lack of food to share, lack of time, and that sharing was possible without the prototype. General conclusions from the study are that people will use a digital service for sharing food in the workplace if there is a critical mass of users and if an effective organization of sharing and collecting food is provided.

**Index Terms—**Food waste, digital prototype, sharing, workplace, user study.

### I. INTRODUCTION

Food that is being produced but not consumed, so called food loss and food waste, is a major issue at international and national levels as up to one third of all food is spoiled or squandered before it is consumed by people [1], [2].

This loss and waste also represent a waste of labour, water, energy, land and other inputs that went into producing that food. Kummu et al. [3] shows that the production of all lost food corresponds to 24% of those total freshwater resources used in food cultivation, 23% of total global land use for crops, and 23% off the total global use of fertilizers. Food losses and food waste also contributes with emissions of greenhouse gases in a time when mitigation efforts need to be enhanced quickly [4]. According to the European Commission food waste alone generates about 8% of Global Greenhouse Gas Emissions [5]. For an overview of the current literature of how food waste occurs and can be understood see [6].

Food waste has been defined as food losses occurring at the end of the food chain (retail and final consumption) and relates to retailers' and consumers' behaviour [7]. For reducing food waste several strategies have been suggested such as awareness raising among consumers and retailers exemplified by Quedsted et al. [8]. Others have suggested to decrease the plate size at buffets with significant reductions in food waste e.g. [9] and efforts have also included to mark up the shelves of fridges with colour codes to keep track of current stocks and thus stopping foods from being wasted by buying unnecessary groceries [10].

In an overview of different interventions to prevent food waste at the consumption stage, Carlsson Kanyama et al. concluded that many initiatives and strategies formed to decrease food waste are not evaluated at all [11]. The authors suggest that effects of ongoing initiatives, such as selling not-consumed food from restaurants at a lower price should be evaluated in the short span as well as in longitudinal studies. Reynolds et al. [12] came to similar conclusions. In their literature review, the authors found 13 interventions quantifying food waste reductions. The most effective interventions were those that changed the size or type of plates, showing up to 57% food waste reduction in hospitality environments.

### A. Digital interventions towards more sustainable food practices

The sharing of consumer products and other resources is not new. It is something people have done throughout history. Habits, structures and organization of sharing vary with types of resources, cultures and how well established the particular type of sharing is. For instance, the sharing of books is a well-established habit in most countries - privately as well as through library services. Sharing of cars and spaces is also something that people are used to, through for example, car rentals and hotels. During the last decade, sharing of cars and spaces has also been facilitated through digital platforms and services such as Uber (cars) and Airbnb (accommodation). According to a national enquiry, the most common sharing transaction in Sweden was accommodation [13]. Digitalization is a driver for the increase of sharing services through its possibility of upscaling and diffusion. Through digital platforms sharing services may be spread to groups of people beyond the closest circle around the resources being shared.

Food is not usually in focus when the sharing of resources is discussed. It differs in substantial ways from the most shared resources because it is not really shared in the sense that cars, apartments, books or tools are. When these physical objects are shared they are used by other people through their respective function, entailing wear and tear. However, they are not consumed in the sense that their use means that they cease to exist. Sharing food, on the other hand, involves giving away and receiving food to own. The sharing occurs in the sense of sharing something that you have too much of, because you might not be able to consume it before it perishes.

Although sharing food differs in important ways from sharing other types of consumer products, it may also be facilitated by digital platforms. As for other sharing activities a digital platform may facilitate the exchange of products and reaching a large group of users. Sharing food may also play a significant role for the reduction of food waste as giving away food that is left over from a cooked meal may prevent edible food from being thrown away. Similarly, giving away fruits and vegetables from the garden may lead to them being eaten instead of turning to soil. This paper explore the question of how a digital platform may support the activity of sharing food involving a larger group of people beyond the closest community. That is, the point of the digital platform would be that it could draw the attention of food being given away by people that usually don't give and receive food from each other. It would make matches with groups that usually don't meet in this type of sharing activity. In this way it would also be instrumental in creating a social network around food sharing.

### *B. Digital interventions reducing food waste*

Quite a few efforts have also been made to develop and test digital applications for reducing food waste and some examples are given below. Farr-Wharton et al. [14] developed a mobile app called EatChaFood that kept track of what is at home in the refrigerator cabinet, among other things because a camera regularly takes photos inside the fridge, categorizes all food items and color codes them. The same author also developed an app called FridgePal with the aim of reducing waste by e.g. keeping track of the best-before dates [15]. Yalvaç et al. reports about a digital app to be launched called EUPHORIA that will help people keep track of their food and to cook with others with the ingredients they already have at home [16]. In short, efforts have been made to improve storage at home to avoid food waste.

Another strand of digital applications have focused on facilitating sharing left-over foods with others as a way to avoid food waste. An app called Leftover Swap, allowing the user to find food that other people want to give away or you can give away food yourself was evaluated in [14]. Results show that lack of trust formed an obstacle for receiving food. This could be overcome if the food were packaged, if the people who give away the food were known to the receiver or if anyone else recommended those who give away the food [14]. There is currently an application available in appstore called Olio with 714 000 users where private citizens can give away or receive food and other items [17]. Olio seems to be an easy app to use, but to our knowledge, it has not been scientifically evaluated. Olio also

depends on volunteer work to manage food safety within the sharing system. Our own study aimed for simplicity, reducing management functions to a minimum.

The idea of digital platforms facilitating food sharing through the creation of social networks has been explored by Ganglbauer et al. [18]. They studied a specific community formed around the website Foodsharing.de in Germany. The platform allows consumers, farmers, organizations and retailers to offer and collect food. It is also linked to a food-sharing Facebook group, where broader community discussions take place. Through studying discussions in the Facebook group, the authors observe a vibrant community engaging in practical ways at local levels to exchange food mediated by Foodsharing.de. They were also engaged on a global level in discussing values and motivations for the Foodsharing.de community to evolve. Just like the Olio service mentioned previously, Foodsharing.de seems to be an initiative enabling the reduction of food waste. Nevertheless, there is not enough evidence to provide us with data to show that this is the case.

Although there clearly are a few apps and research prototypes aiming for facilitating for people to share their food, there was none suiting our specific purposes: to be used at university campus with a minimum of management. In this type of workplace a lot of food is handled (lunch, snacks, catering etc). Also, in this type of workplace we assumed that people could trust the food being shared, as they have a collegial relationship . University campuses are workplaces for both students and professionals, they host restaurants and cafés, the inflow of food is considerable, as generally also is true for food waste. Thus, university campuses present an interesting arena for lowering food waste through sharing of leftover foods. This has not gone unnoticed, but an example of an effort to lower food waste in a campus comes from Pittsburgh University where an app called PittGrub was developed. PittGrub includes a notification system to select users to invite to events that have leftover food [19]. The study, however, focuses on the computational aspect of the app and the results don't reveal anything about how useful it was. The setting in a campus provides several interesting features for sharing leftover foods: lots of students who may be willing to collect free leftover foods due to their own scarcity of resources, lots of employees that are often ordering catering where there might be leftovers and lots of employees who may be willing to share and receive leftover foods with each other or with students because of environmental concerns and interest in innovation and development. In the long run the food sharing platform is intended to facilitate for people to give food away as well as collect food given by others in a workplace environment, consisting of 12 000 students and 5 700 employees. Thus, a successful the platform could have a great impact.

The purpose of the article is to report the design and user study of a prototype of a digital platform to facilitate for employees and student at a university campus to share food with each other. The primary research questions we explore are:

- What are the crucial design requirements for a digital food sharing platform to facilitate for food sharing in the workplace?
- What are the obstacles for sharing food in the workplace?

## II. METHOD

The research method for exploring the above questions consisted in the design and development of a prototype for a digital food sharing platform; a user study of the prototype; and an evaluation of the use through a survey to the test users. The user study allowed us to explore our research questions and the use of the resulting prototype in the university setting.

The design of the prototype followed a user-centred and participatory design methodology, where a functional digital prototype was developed and, then, tested together with the end-users in a user study. The concept of the digital food sharing platform was first tested on a smaller group of potential users - three test users from the research team and three test users external to the team. The test users were asked to perform the basic tasks of booking food and posting information on food they wanted to share. The process of how they carried out the tasks was observed. Then, questions were asked concerning ease of use, attractiveness, potential impact, etc. Based on results from interviews made with the test group around the concept, a functional prototype of a digital food sharing platform was designed. The prototype was developed in an iterative process by the research team with help of developers. The prototype was developed as a mobile website using PHP Hypertext preprocessor (an open source general-purpose scripting language), Bootcamp and a MySQL database. The prototype had the following functionality:

- **Sharing food:** The users could post information about food that they wanted to share. This included:
  - Name and description of the food
  - Picture (uploaded or taken with the mobile phone directly from the page)
  - Location: as the prototype is developed for use in a university, the users selected a university department from a dropdown, then they could write a more specific location in a text field
  - Date of availability
  - Number of portions available
- **Booking food:** The users could see a list of all available food, sorted either by location (department) or by chronologically (latest first). When selecting a food item users could see detailed information about it, and book one portion. The food sharer got a notification that the food had been booked, and if there were not more portions left, the food item would be removed from the available list
- **Administration:** The users had also access to an administration page where they could edit their personal information, see and edit the food they shared, and see a list of the food items they had booked
- **Registration and login:** The prototype functionality was only open for registered users. Registration for the

test was sent as an invitation and only available for users with an email address from the university domain



Fig. 1. The start screen of the food sharing prototype

The prototype is at the moment only a research tool and it was taken down and the data removed after the test and data analysis. The source code was made available as open source for possible further development. The start screen is shown in Fig. 1 and the interface for the booking page is shown in Fig. 2.

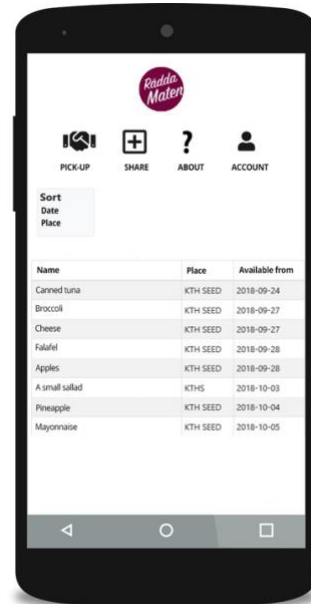


Fig. 2. Interface for the booking page of the food sharing prototype

### A. User study

We recruited 34 participants from university staff and students by sending a mail to colleagues in two different buildings on the campus and to student representatives .

Participants were, then, asked to access the prototype through the weblink, which was included in a mail. All participants were informed that the user testing would last for two weeks and that it was OK to just pick up food even if they did not have anything to share. At the end of the first week of the test period the participants got a reminder to start the testing. A second reminder was sent at the end of the second week.

### 1) Procedure of testing

To facilitate the sharing of food, students were allowed access to a fridge in a place they usually could not enter. During the two weeks of the testing period, 31 persons created an account for the app. Out of these, 19 were active users and 12 did not use the app. A total of 42 portions were shared and 28 of these were booked (ordered). The kind of food shared was for example, leftover lunch food from catering, home baked bread, fruit from private gardens, and packaged food.

### 2) User survey

When the test period was over, participants were asked to fill out a questionnaire evaluating their experience with the application and the food sharing activities. Questions demanded responses in different forms. These forms varied from checkboxes, multiple choice boxes or in statements, which the informants were asked to rate by numbers (1-5) corresponding to how true they were judged to be. All questions had a line for comments in free form.

Questions were grouped into the following sections:

- Role at the university
- Use of the app to share/pick up food, including reasons for non-use
- How easy/hard it was to use the app
- How easy/hard it was to pursue a sharing/pick-up of food
- Obstacles for using the app
- Improvements of the app

## III. RESULTS

A total of 23 persons responded to the survey. Out of these, 12 were employees and 11 were students. Nine respondents had used the app for sharing food (39%). Twelve respondents (52%) had used the app for picking up (i.e. booking) food that somebody else had put up for sharing. Six respondents both shared and picked up food.

### Crucial design requirements

The usability of the app in terms of ease of use and comprehensibility were given high scores. Nevertheless, improvements could be made concerning the clarity of information on where to pick up food and the notification of when food had been picked up.

Out of the nine respondents who had used the app to share food two had some problem in understanding where to put their shared food to be picked up. Seven out of the nine people who had shared their food thought they were clearly informed when somebody had booked the food that they had published.

However, only three out of the nine who shared food thought it was clear when their shared food had been picked up. This was also shown by the open response comments, e.g.:

*My own food was not collected because they couldn't find it or forgot?*

There was also some confusion around where to put food to be shared:

*It wasn't easy to find a good place for the food I wanted to share. You would probably need a well marked place for it, since it might feel strange to collect food if you're not sure whether it's the right place. Maybe the app could suggest a general marking of food so that you'll be able to recognize it.*

Twelve respondents used the app to book and collect food. Eight out of these thought it was easy to understand where to pick up the food, two were neutral and two did not know. There seems to have been a general unclarity regarding the physical location of food shared. Some comments illustrating problems in picking up food were:

*It was a bit confusing that food was left in different places. A solution could be that you only see the food that [is put in places], to which you have access or that food can only be left in one place.*

*The wrong place was marked for the food I was going to collect, that's why it turned out to be hard to collect*

*I never picked up the food I booked. How are you supposed to get into rooms which have a card reader? Maybe you could have a central place to put the food, so it would be easier to find your way*

*You were able to see who was to collect it [the food], but sometimes there happened to be a lot of food in the fridge though not in the app, which people seemed to forget to collect*

*To collect food was a bit tricky. Us students only had access to the small kitchen on floor 1 and a lot of food was put on other floors, which lead to that you could not pick it up. Then there were food, which were supposed to be put on floor 1, and which I could not find anyway. An idea would be to mark out fridges and normal cupboards where you can collect the food, to make it easier to know where to leave it and where to collect it.*

### Obstacles for sharing food not related to design

A major obstacles for not sharing food was that the participants did not have any food to share. Eight participants stated this, while four stated that they did not have the time and three that they could share their food without using the app. The major reason, which respondents stated for not picking up food was that they did not have time to. Another reason was the

misunderstanding that a participant could not pick up food unless they also shared food. Other reasons were that:

- There was no food to share in the same building at the university where the person's workplace was located
- Students did not have access to other storing places than one particular kitchen
- The booked food had already been removed when the person who had booked it came to pick it up
- No food seemed interesting enough to book/pick up

As stated above, the most common obstacle that respondents saw for sharing food according to the multiple choice question was that they never had leftover food from home. This is an interesting result considering the fact that private households in Sweden waste 45 kg edible food per person and year [20]. Reasons why respondents from our survey stated that they did not have any food to share might be that they were not representative for Swedish households or that their own left-over food did not live up to their own criteria for what kind of food could be shared or not.

In responding to the multiple choice question regarding reasons for not collecting food shared by others, five respondents picked that they don't trust the quality of other people's food and five that they did not want to receive food from people they did not know. Trust and transparency of food cooked by unknown people was a recurring theme as it also was mentioned in the freely formulated comments from respondents. Examples are given below:

*To pick up fresh groceries, packaged food, or food left over from catering feel unproblematic. But it would be more difficult for me to pick up somebody's personal leftover food if I don't know that person.*

*It became clear to me that if I can't be sure that ingredients which I don't tolerate (e.g. pepper, banana, oats and coconut milk), it would not be tempting to receive somebody else's food. It's too much hassle to need to ask. On the other hand, it's very easy if the rescued food would be whole foods, i.e. apples or other unprocessed food.*

*It's hard to share cooked food. Maybe it would be most efficient to share food from catering and restaurants. The most wasted personal food would probably be cooked food. This might not be very attractive to share.*

Another significant obstacle in sharing food was that the activity was not part of a recurring everyday routine and, thus, sometimes hard to remember. Respondents commented this aspect as:

*Sometimes it's hard to remember to bring food to share. I usually give away food (or groceries) that I will not eat to family or friends.*

*It's not part of my habits*

An obstacle for the food sharing app to spread to other groups to create a critical mass of users could be that sometimes it might be easier to share food without using the app. As one user put it:

*Some types of leftover food (e.g. pastries and biscuits) are also easy to just put on the table in the kitchen and, then, you know that everybody are free to have some.*

From the perspective of reducing food waste, this is of course fine because food is shared. But the food in this case would only be available for a limited group of people. For instance, it might not be available to students who might be those needing it the most.

Some informal observations were finally made, which had to do with social aspects of sharing of food. One such norm was a reciprocity in sharing food. That is, some participants assumed that if a person shares food they are also allowed to collect food but a person is not allowed to pick up food if they have nothing to share. Since this was not a requirement at all mentioned by the app, users' assumptions might originate from a social norm indicating that to receive we also need to give.

#### IV. DISCUSSION AND CONCLUSIONS

The overall conclusion from the results of the survey is that the design of the digital prototype for sharing food in the university workplace worked well. This is based on that the 12 people who used the prototype for collecting food, the 9 who used it for sharing their food, and those who did both could fulfil their activities without problems regarding the interaction with the prototype. Since half of the respondents were students and half were employees, we could see a pattern in that employees shared food to a greater extent while the students mostly collected food. Another conclusion is that the prototype has to be improved before a full-scale intervention. Yet another conclusion is that for realizing the potential of the app a critical mass of users is needed. In combination of a critical mass an efficient organization of sharing and collecting food is needed. It is important that shared food is actually picked up. Otherwise it might go bad and needs to be thrown out, which stands in conflict with the purpose of saving food. This might also cause problems in trusting that sharing food actually leads to a reduction in food waste and consequently also might prevent people from sharing. Thus, some kind of information regarding when food is picked up given to the person who shares their food will be needed.

Logistics and flow is necessary in order for people to trust that the sharing activity is working. This includes information regarding when food is picked up and pick-up places to be situated close to and accessible to all people sharing and collecting food. During the user testing we discovered that students don't have access to the same areas as employees and were therefore shut out of picking up food that was announced on the prototype. Moreover, designated storage places would facilitate the sharing food as well as labelling the shared food.

A second significant aspect for the sharing of food in the workplace to succeed is to provide conditions for the formation of the habit of sharing. A habit is an routine-like behaviour, described as an automatic response to cues in the environment; as proceeding with little awareness; and as goal-directed [21]. In order to facilitate shaping habits around sharing and collecting food in the workplace, the implementation and marketing stages of the food-sharing app are crucial. These stages hold the opportunity of drawing the users' attention to the existence of the app, starting narratives and communities around it and, thus, facilitating for its users to support each other making a routine out of sharing food in the workplace. Users may remind each other to bring food from home, to announce leftover catering food in the app, and to spread the message of the food sharing activity on the university campus. Patience in seeing habits form will be needed as the formation of new habits take time. In the case of food sharing it may even involve deactivating old habits, such as packaging food at home and bring it to work instead of saving it in the fridge with the risk of it going bad. One possible backside of these habits is the possibility of rebound effects, as users can use the sharing as a way of reducing food waste guilt, avoiding other efforts such as adjusting purchases. These effects needs to be explored in longitudinal studies.

The results from using and evaluating the digital app for sharing food at the university point to a possible success in developing it into a proper commercial app extended to the whole campus and not only to a limited test group. Some issues need, however, to be resolved first regarding responsibility and management of the app. t present, there is no business model for the app that could generate income from its users, as food is given away for free with no fees. Thus, supporting the app will require funds from a third party or from the university. Managing the app could be done by a third party given that there are funds to pay for it. Another important task if the app would be launched for the whole campus would be how to market it for achieving optimal use: both in terms of number of users but also in terms achieving a critical mass of users in separate workplaces in different buildings. Likewise, the issue of where to share food has to be resolved and an idea could be to place refrigerators used for sharing foods in premises available to both students and staff. Some resources for maintaining such fridges would, then, be necessary.

Lack of trust and transparency is an obstacle for sharing food in the workplace. This came to the surface in the testing of the app and has also been observed in other studies e.g. [15]. The quality of the food as well as its contents could be questioned. The food might contain ingredients that the participant could be allergic to. Food left over from catering showed to be most popular to collect.

To accommodate the best interest of all and to use the full potential of reducing food waste the organization of pick-up places also needs to be reflected in the design of the prototype. Moreover, information of when food has been booked and whether it has been picked up must be clear. Sometimes food shared could serve several people and specifying portions available as well as following up the availability after users had collected portions would need to be clearer. In sum, the

organization of food sharing has to be worked out on a detailed level through mapping out the target group, the activity flow of sharing and collecting in the spaces where the groups move, and through specifying the needs of the respective groups. This organization should, then, be reflected in the design of the digital food sharing platform. Finally, care should be taken to provide opportunities for habits around food sharing to be formed.

## V. FUTURE RESEARCH

For each ICT application researchers develop, they need to take a step back and reflect around what is really required, at which level of technology, and what the advantages are of an ICT based solution compared to a low-tech solution. In the case of a closed environment as a workspace or, in the case of this test, a university department, there is already a built community and certain amount of peer trust. Examples of non-technological solutions for food sharing could be for example a common fridge where everything inside is for share. In this case we could argue that there are certain advantages:

- Trust: Even in a known environment, eating food from unknown sources may be uninviting. ICT provides traceability of the food shared, which presumably adds trust.
- Extra layer of information: ICT allows to add extra information to the food share, this includes for instance:
  - An availability date so the end-users know when the food was shared.
  - Text information, this include for example information regarding ingredients which may be important for people with allergies, information about special diets such as vegetarian or vegan, or storytelling about the origin of the food such as sharing apples from the garden.
- Notification: ICT allows easy overview of the shared items without having to go to the physical place of the food, and push notifications so users can know about items without actively looking.
- Providing feedback on when food has been picked up. To avoid extra work for the people who collect the food, this may be managed through sensors or RFID-tags on the food.
- Forming a social network around food sharing by, for instance, linking to a Facebook group or similar

A main disadvantage is the need for development and maintenance of the technology, and the exclusion of users who do not have access to the needed access devices. It may be relevant to see if the advantages of the ICT solutions are enough for supporting the extra complexity, and if the same advantages could be gained by other simpler means, such using paper cards and so on. These questions are relevant not only for the case of food waste but also for other cases in the "sharing economy", and comparative studies between high-tech and low-tech solutions could be an interesting research topic.

At last, in order for research on reducing food waste through the design of technology intended to intervene with people's

behaviour the outcome of user studies needs to be carefully evaluated. The long-term goal is to reduce food waste on the consumption level and to be able to conclude that this goal has been reached we need to have a quantification of the amount of food wasted during the use of the sharing platform. We also need a baseline level to compare this result to. Such a baseline could consist of e.g. measurements of food waste prior to the use of the platform or measurements of food waste in a control group. The big challenge in this is to arrive at a clear method for measuring food waste at the consumption level. Most intervention studies of food waste prevention in households have asked respondents to estimate the quantity of their own food waste [11]. Since this method does not generate very reliable results, more precise and objective methods to measure household food waste need to be developed.

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