

Why and what did we throw out? Probing on Reflection through the Food Waste Diary

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ABSTRACT

Issues of consumer food waste in industrialised countries are becoming an increasing concern and this is paralleled by a growing interest in HCI to support more sustainable consumption practices. In this paper we report on a mobile food waste diary application that was made available on app stores, with the aim of enabling motivated people to reflect on their moments of food waste and to explore rationales. Through analysis of the entries submitted by users of the diary application, we identify instances of reflection located on different levels. The intention of supporting reflection was visible in instances of submitted diary entries where deeper insights about the relationships between food waste, previous experiences, habits, knowledge, occurrences and intentions to change were offered.

Author Keywords

Food and interaction design; Food waste; Personal informatics; Reflection; Sustainability;

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

Issues of food and wasted food are becoming an increasing concern worldwide and this is paralleled by a growing interest in HCI to support more sustainable practices [17]. To date this has largely played out in relation to energy consumption [8, 25]. However, food waste is another area of growing concern for ecological sustainability, especially considering the over-production together with the waste of food. It is estimated that around half of the food worldwide is discarded, with consumers contributing around 30% to food waste in industrialised countries [14]. The amount of food produced and finally thrown away in production and consumption greatly affect greenhouse gas emissions [6]. However, for individuals, food waste is also a personal matter and often connected

with uncomfortable feelings [9, 11]. Due to a worldwide growing population we have an increased demand in food consumption, and a reasonable alternative is a more frugal handling of food. Hence food waste, for example, through overbuying or letting food spoil, unnecessarily contributes to greenhouse gas emissions, which could be avoided if the amount we produce and the amount we consume were more balanced. However, people are aware of that they throw away but often not able to report on why they discard food, nor which types, amounts or the frequency of food waste [11].

To this end this paper presents the design and use of the food waste diary as a technology intervention probing into the potential of enabling reflection on issues around food waste. The mobile food waste diary application is intended for participants to capture and reflect back on 'reasons', experiences, and occurrences connected with food waste. This paper will first describe the motivation of this case study and the intervention in more detail, and why the mobile food waste diary application was intended to support reflection. Second, the concept of reflection in personal informatics is introduced along with a framework that describes our definition of reflection and different levels of reflection. The third section presents the design of the food waste diary application, which enables people to capture various data about food waste. It will describe how the application works and what type of contents it invites.

The diary application was put online to Google Play (Android) and App Store (iOS) for free to attract interested people in downloading, installing and using the application. Through distributing the app online we were able to capture real-world authentic data from a very specific user group, genuinely interested in food waste. Fourth, the data forms the basis of a study of use of the diary. The 843 entries submitted over 18 months were analysed qualitatively and quantitatively to understand what people throw away and why; free form comments were also thematically coded, specifically looking for indications of reflection.

Finally, the findings provide deeper insights about the relationships between food waste, previous experiences, habits, knowledge, occurrences and intentions to change for people already aware of this issue and prepared to do something about it. The order of effort that people put into using the application further points to the potential value of such a tool to support those concerned about such issues.

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MOTIVATION FOR FOOD WASTE DIARY CASE STUDY

Food waste in households is a complex issue. To date, there has been good research on how much food is thrown out by households, e.g., Schneider and Lebersorger [22] who have weighed domestic food waste. It is only more recently though that in-depth studies were conducted to explore the everyday practices around how such waste comes about in homes [9, 11]. A key insight was that the moment of throwing food away is just a final moment embedded in a number of other everyday practices that span space and time, practices such as shopping, storing, cooking, socializing and so on, where food waste becomes deeply entangled with the circumstances of everyday life [11]. For example, participants described stories of how food was wasted, determined by circumstances such as family members who would not eat as expected or how over-buying was routinely taking place in households.

Thus food waste is often described as an unintended outcome. More critically, people often feel inherently ‘guilty’ about wasting food [9, 11], but cannot often say why or from where these feelings emanate. As food waste is not simply the result of one occasion, person, or behaviour, it can be hard for people to understand the issues leading to waste and therefore identify issues they can influence or not. This points to an opportunity to think about how to support people reflecting on and understanding their own routines around food waste.

In the case study presented here we explore the role of digital technology and its potential in recording data to reflect on previous experiences, habits and patterns [1, 10]. A paper diary from the *Waste and Resource Action Programme* led to thinking about the potential for a digital diary. To this end we developed¹ a mobile food waste diary application for iOS and Android smart phones. This case study is intended to mainly look for reflection supported by technology, though at the same time stays open for different interpretations such as social and material circumstances. The mobile food waste diary application was intended for participants to record instances of food waste enabling later reflections, as well as explore the rationales and experiences people would provide when throwing out food. We aimed to bridge the gap between the moment of throwing away food and the connection to previous experiences before that led to the food turning into waste. We intended to support reflection both during the recording what food was wasted, as well as when revisiting the recorded data.

REFLECTION IN PERSONAL INFORMATICS

The food waste diary can be seen as related to personal informatics, where different areas of everyday life can be recorded for reflection. Personal informatics systems are interactive applications that support users in understanding various aspects of their life, such as experiences, behaviours, patterns, habits and emotions. Advances in new sensing technologies made personal informatics a popular topic for HCI research

¹The interaction design was elaborated in group meetings where concepts and suggestions were discussed iteratively towards user experience as well as feasibility for programming. We had several meetings discussing interaction design until the programming started.

[16] as it incorporates vast amounts of collected data for providing the user insights on their daily life. Li, Dey, and Forlizzi [16] summarized four primary life domains and information sources for personal informatics systems, namely *exercise, general health, finance and journaling*.

Food waste is quite different to those areas and might concern only a certain set of interested people. While many of such applications automatically gather user data, for instance, by activity trackers [7], other systems strongly rely on manual user input. Pirzadeh et al. [18] researched journaling tools as a means to improve self-knowledge and proposed a diary application as a “*support tool to help individuals record and reflect on their experiences*”. These authors stressed that the process of gaining self-knowledge include the clarification of one’s own feelings. The food waste diary connects to this research by two shared assumptions. First, our proposed application takes advantage of manual data input for an in-depth *engagement* of the users with their own experiences, occurrences and feelings as opposed to more convenient but maybe unreflected automatic tracking. Second, we hypothesized that this deeper commitment would be helpful in uncovering sensible and personal reasons people provide for food waste.

Khovanskaya et. al [15] critically drew attention to the role of data mining algorithms behind the scenes of personal informatics systems and provoked their participants to critically *reflect* about the influence of these computational mechanisms. Baumer et al. [1, p.98], on the other hand, highlighted and critically remarked that the effects of reflection in most research projects were described as “*universally beneficially*” and “*wholly good*”. As the food waste diary encourages its users to reflect on a rather ‘uncomfortable’ issue, namely own experiences and patterns that lead to wasting precious resources like food, our proposed system adds an interesting instance to the literature that potentially can evoke negative feelings or emotions such as felt guilt, as was evident in our material.

On reflection

Reflection is a core element to many interactions being studied in HCI, from providing increasing self-knowledge through personal informatics, or changing behaviour through persuasive technologies. Digital technologies for reflection can record data automatically or require manual capture as in case of the food waste diary. In this paper, the term ‘reflection’ can refer to an individual mental cognitive activity in examining previous occurrences that lead to food waste. But reflection can also be thought of as social activity, e.g. examining a household’s collective data about food waste together in a group [1]. Both, individual and collective approaches to reflection, are included in the definition of reflection in our paper. What both approaches of individual and collective reflection have in common, is the purpose that reflection could possibly provoke critical thoughts or alternative actions through data examination or discussion. As Baumer et al. [1] discuss,

“sometimes the goal of reflection is not only to increase self knowledge but to take action based on this increased



Figure 1. First screen on application start (1) to insert reason, category, optionally picture, comment and price of food product. Users can also enter the reasons why food was thrown away (2) and choose from a predefined list or generate personalised and customised reasons. Collected food waste entries can be viewed as list (3), as collected pictures of food waste (4) and as chart graph with most popular reasons (5).

awareness. Systems of reflection vary as to the extent that they support taking such action.” [1, p.96]

This level of reflection is also described as “transformative reflection” in Fleck’s and Fitzpatrick’s [10] research, specifically reflection revealing an intent to change. They note that different definitions of reflection serve different purposes and present a framework for levels of reflections. These levels (R0 - R4) are presented as a means to identify reflection occurring and also to evaluate reflection later on in the findings [10, p.217 ff.]:

- *Description (R0)*: Reportive account or statement about experiences and things without further explanation or reflection.
- *Reflective description (R1)*: Reportive in nature with explanation or justification of reasons and experiences, without further reflection.
- *Dialogic reflection (R2)*: Exploring different relationships between experiences and knowledge and considering different explanations or other viewpoints.
- *Transformative reflection (R3)*: Revisiting experiences with the intention to change, re-organise or do something differently. Challenging personal assumptions and practices.
- *Critical reflection (R4)*: Reported experiences are related to wider social and ethical implications. Considering the bigger picture and implications.

Different levels of reflection play out in different domains, and reflection is by far not only a core element to increasing self-knowledge or changing behaviour. Within HCI, reflective design practice described by Schön [23] is unfolding differently: From Schön’s perspective, reflection on materials and design processes incorporates the processes of “reflection-in-action” and “reflection-on-action”.

Reflection-in-action supports people while they are completing a task, finding out what is different and how it can change thinking and doing. Reflection-on-action entails a process that takes place after something has been done, e.g., a final reflection on an artifact where the own processes are evaluated and reflected upon.

The data submitted via the food waste diary was coded openly as well as according to the presented levels of reflection (R0 - R4) to understand if the diary was used towards reflection. This framework [10] aided in finding indicators of how different levels of reflection unfold for the subset of people who are interested in keeping a diary about their food waste.

Before moving on to the findings and elements of reflection in the data, the components and the interaction design of the food waste diary are described to provide an understanding what kind of information the food waste diary application invited to record.

FOOD WASTE DIARY APPLICATION

Food waste diary is a mobile application that allows people to capture occasions of waste. It encourages them to reflect on moments of waste and to connect to earlier experiences of discarding valuable food. The application has been developed to a stable prototype and has been freely available at Google Play (Android) and the App Store (iOS) since 7 Dec 2012. People who are genuinely interested in their food waste can download this application. Indeed, the food waste diary was installed on 1065 devices and 843 entries have been submitted in the 18 months up to 5 June 2014.

Consumers who are aware of the issue of food waste and want to collect information about how much food they actually waste and why, can do so by entering this information into the diary. We used the most common platforms Android and iOS to offer a technology that can scale and is accessible to most people living in industrialised countries, where

consumer food waste is prevalent [14]. The application was made available in English and German.

The food waste diary application offers the possibility to record information and to review a history of information. To record information, the obligatory fields for an entry are the reason why food ended up in the bin and the ‘type’ of food. Figure 1 (2) depicts how users can choose between five predefined reasons to record why a specific item was wasted:

- “*Visibility of food stock is missing*”
- “*Over-buying*”
- “*No shopping list*”
- “*Change of cooking plans*”
- “*Special offer*”

These categories are motivated by a questionnaire study that identified the most common reasons of disposed food in households [13]. As we assumed during the design process that the mentioned reasons are not exhaustive for most users, the interface also offers the possibility for a user to specify their own explanation to capture the multifaceted nature of waste (see Figure 1 (1)). This provides a compromise between ease of use (through the pick list) and openness for interpretation (by enabling their own comments if they wish). The other obligatory field to be entered is the type of food, e.g. “*Dairy*”, “*Bakery*”, “*Fruits and vegetables*”, etc., drawn from standard food categories.

Then there are a number of non-mandatory fields for ‘costs’ and a ‘comment form’ for free notes and the possibility to add a ‘picture’ (see Figure 1 (1)). Allowing the declaration of costs to be entered is motivated by studies [11, 20] as an incentive for consumers to waste less. The comment form for free notes was motivated simply to enable people to add more content or stories to a food waste entry. Supporting photo capture was motivated because, once included, it could be used for open engagement with the topic and further elaboration. The location of the user is automatically detected with the in-built GPS sensor, if users allow the application to do so.

After a user has submitted an entry, the screen changes to the history of submitted food waste entries, with the option of filtering for personal entries or the entries of all people using and submitting to the food waste diary. Figure 1 (3-5) presents an overview of three different views for history of food waste entries as:

- Consecutive list of entries ordered by time, Figure 1 (3).
- Pictures that have been taken from food being wasted, Figure 1 (4).
- Chart with most common reasons why food has been wasted, Figure 1 (5).

People can toggle between the individual or collective data by tapping the corresponding icon on the top left of the History screens (see upper left of screens in Figure 1 (3-5)). To consider privacy aspects, the location of submitted entries is not visible in the collective History view. The identity of

the person who submitted the entry is not visible, as data is anonymised in terms of the personal details.

The trigger for people to submit entries is the incident of food being thrown away [2]. The event-triggered nature of the application implies that users have to invest additional time and energy for the mobile food waste diary in case they want to capture their waste. The aspiration at the start of the project was to provide people with a tool to support the reflective process with the mobile food waste diary application.

METHODS IN FOOD WASTE DIARY CASE STUDY

To understand real world use by people who are genuinely interested in an application that facilitates reflection on food waste, we chose to distribute food waste diary online at the Google Play and App Store on iTunes where the app could be downloaded, installed and used for free.

In the study that we describe next, we were curious whether people would download and use such a tool, and if they did, how participants would describe their waste and whether this would prompt further reflections on everyday food practices. The data presented here is a result from users who might already be aware of food waste, hence motivated enough to install the app, and possibly want to know more about the whys and hows of their waste.

The choice of app store distribution as the basis for study and data collection is becoming increasingly common [3]. It was particularly appropriate for the food waste diary as it was important for us to target people who would be genuinely self-motivated by a concern for this issue; the app store route was also informed by the experiences reported in [11] around the guilt associated with this issue, and where some recruited participants for a fridge intervention, the FridgeCam, in the end did not use it because they were not genuinely interested, despite agreeing to participate in the study. In the case of our data in the diary study, we can be more confident that all instances of use are authentic. The trade-off however is that we cannot make any claims that the findings will generalize as we have a very special self-selected subset of people genuinely interested in food waste and prepared to submit their authentic data.

As also noted by [5], there are methodological adaptations and trade-offs, as we do not have direct access to the participants. This means that we necessarily will lack some information about the participants such as demographic profiles. We cannot complement the data collected via the application with qualitative interviews to understand if and how use of the diary impacted actual practice. Hence there are limits to what we can claim about the actual reflection and/or changes enabled by the diary, rather we focus instead on indicators that might suggest possible reflection. However, we suggest that the access to authentic data from people genuinely interested in the topic provides a useful perspective on the potential of technology to support such people.

Thus, to study the use of the food waste diary we focus on analysis of the 843 submitted entries using a quantitative as well as qualitative approach. The data submitted via the food

Country	Reason	Type	Comment	cost	curre	ID
it_IT	Over-buying	vegetables	no waste	0	EUR	8d15f817d04a3b19c4e95e3b3dddd964
en_GB	was unwell	Fruits and vegetables	orange juice opened before ill. when well again had gone off. guessed cost	1	GBP	00a828affd838f66f62b84dd39716354
en_GB	Over-buying	Dairy products and eggs	bought box of 6 as 4s not available option. Cooked a quiche and a cake but unable to use last two.	0.56	GBP	00a828affd838f66f62b84dd39716354
en_GB	Visibility of food stock is missing	Drinks	last of bottle of lemon cordial open long time rediscovered in fridge	0.3	GBP	00a828affd838f66f62b84dd39716354

Figure 2. Excerpt of data entries submitted via food waste diary.

waste diary was exported to a .csv file and processed using SPSS.

As the application requires users to provide a 'rationale' and 'type' related to a food item, the most popular rationales and types of food thrown away, along with other quantitative data, is collated and presented. This quantitative analysis enabled us to get a broader picture about the most prominent reasons for and types of food thrown away, or how many entries were submitted with free comments.

Of the 843 entries, half (49,8%) have been submitted with a comment, a field that was optional and not required. Even though most of the comments were brief, they offered interesting insights and were qualitatively analysed using thematic coding [4]. A representative excerpt of entries is provided as data evidence (see Figure 2).

Concerning the data it is also important to note that users of the food waste diary were not required to enter personal information for registration; instead they were identified with a unique ID that is submitted along with an entry. The analysis is therefore based on public and anonymous data where links to individuals were removed. Due to technical reasons 182 entries were submitted without a unique ID, hence they could not be mapped to a specific user (ID). This only impacted the analysis of how many entries were submitted by the same user and how many entries were submitted from different countries. Otherwise this data is included in all other analysis.

The next section focuses on the distribution of prominent reasons for food waste, the qualitative thematic coding of these entries as well as the counted occurrences of specific instances. The codes for the qualitative coding are based on the framework for reflection [10], where the data was assigned to different levels of reflection, namely "R0: description", "R1: reflective description", "R2: dialogical reflection", "R3: transformative reflection", and "R4: critical reflection". During the process of analysis an additional level of reflection emerged from the material that we named:

- "R5: Emotional reflection". Emotional reflection reports on and connects specifically feelings with experiences, such as feeling guilty for throwing food away.

Besides the codes for reflection, we also identified instances of social and material circumstances in users comments about wasted food.

FINDINGS

The findings obtained by quantitative data exploration are presented first, followed by the results of the qualitative thematic analysis [4] with a focus on the levels of reflection.

Quantitative exploration

The submitted entries (N = 843) revealed trends of people's experiences and 'reasons' why food is wasted. The quantitative data exploration points to "Over-buying" (N = 178) as the most prominent rationale, followed by "Visibility of food stock missing" (N = 96) and "Change of cooking plans" (N = 66). Figure 3 provides more details on rationales behind wasted food. Interestingly, 414 entries and accordingly 49,1% of entries showed reasons self-defined by users without the existing categories being used. We will present patterns in these instances in the section of qualitative findings.

Further data exploration reveals that the most thrown away items were "Fruits and vegetables" (N = 194), followed by "Bakery" (N = 116) and "Meat, fish and tofu" (N = 111). Interestingly here again 27% of entries had self-defined food types submitted by users. These were more specific descriptions of the food types thrown away. For the existing entries with unique IDs it was technically possible to derive the country region of entries being submitted mostly from the US (N = 208), followed by Germany (N = 128), Great Britain (N = 128) and Austria (N = 128). We see a congruent pattern here as entries were submitted mainly from industrialised countries, where consumer food waste is reportedly prevalent [14].

Submitted online content usually shows a pattern from very few active users to many users who are less active. Such a pattern could be observed with the food waste diary too. The



Figure 3. Most prominent predefined ‘reasons’ that were submitted through the mobile food waste diary application. 49,1% of entries were self-defined by users and not using existing definitions.

user who submitted most entries had 133, followed by a user with 64 entries, another user with 38 entries, and further down a declining curve where 146 users submitted a single entry only.

Costs were submitted in 58,5% of all entries. Since this field was not obligatory in the food waste diary application (as opposed to ‘reason’ and ‘type’ that were obligatory), entering costs appeared to provide an added benefit to users. Costs were being mentioned as a reason why people want to waste less food [11, 20], and this is confirmed here where it seemed to be popular for users to add estimated costs of food waste to an entry.

Qualitative accounts

We will now describe patterns in self-defined food types and reasons, and the results from the thematic analysis of the comments. Submitted text in languages other from English has been translated to make it understandable for an international audience.

Given that 49,1% of the *reasons* submitted by users were self-defined we wanted to understand in more detail what users provided in their submitted entries. All were descriptive in nature. For example, there were many instances about the physical state of the food, such as “leftover”, “overcooked”, “out of date”, or “mouldy”.

Other submitted (custom) reasons mentioned emotions connected with discarding food such as “don’t feel like eating”, or bodily conditions “no appetite” and “migraine trigger”. In addition, social circumstances were mentioned as reasons and submitted as self-defined text such as “Susie didn’t like it”, or “procrastinated about cooking”. Connections between the busyness in life and discarded food were also evident, as time is needed to prepare and consume food at home, e.g., “haven’t been at home enough”. This supports findings from studies about wasted food [9, 11]. Similarly, there were comments about not remembering what was there: “forgot in the fridge”; cases similar to this in [12] were partly attributed to lack of visibility into food storage areas and forgetting generally what food is there.

Of the submitted entries, 27% of food types were self-defined. The analysis of these entries also, expectedly, points to more specific characterisations of items being discarded. Examples were “fish taco”, “rice”, “pizza”, “chinese” or “yogurt”. What is interesting here is the specificity of the food type and it is interesting to speculate on what memories and meanings are implicitly entailed in these descriptions for people, e.g., remembering the particular pizza meal, why they decided to have pizza, who was there, etc. One might speculate about the memories and meanings that are implicitly entailed in these descriptions

Reflection in comments

More detail about experiences was provided in the free comment field, which was used in 414 (49,8%) of all entries. Given that this was a voluntary field, it is a statement in itself that people were prepared to make this effort in nearly 50% of entries. The comments, submitted along with the entries, provide more in-depth understanding of what people submitted in terms of thoughts, experiences, explanations and connections. Of the 414 comments, most were *descriptive (R0)* accounts (173 instances), elaborating on the type of food thrown away, e.g. “Baked beans”, “Remains of roast chicken” or “Cheese was moulded”. This descriptive level is reportive in nature. It may be possible that users reflected on their entries while they were making the note or at a later point when revisiting them, similar to Schön’s notion of reflection-on-action, but the note itself does not provide direct access to evidence of reflection beyond awareness.

There were 58 comments that can be described as *reflective description (R1)*, a description reportive in nature but with an explanation. Illustrative excerpts were

“Didn’t agree with me”
 “Salad that wasn’t eaten for lunch - not hungry”
 “Tried gluten free pop tarts - too dry and not sweet”

In these instances explanations about why something was thrown away were provided, from not liking something, to not being hungry, to some experienced quality of the food item itself (“too dry and not sweet”).

Dialogic reflection (R2) was found in 30 instances of the data and suggests deeper reflection involving the exploration of relationships between food waste, previous experiences and other circumstances. One submitted entry for example provided a comment:

“Over estimated fruit consumption and ripening times.
 Did not get to mango or avocado before off.”

The exploration of different relationships here is evident: There is a relationship between buying a product, the estimation of how long it will last and at another point of reflection, the experience that the assessment was not as estimated. Another instance where different relationships were explored reads as follows:

“I like buying new products. I tend to buy them without shopping list. I didn’t like this taste.”

This user reflects on several experiences, habits and food waste. The user reportedly likes to try new products (a salad dressing in that case) and indicates it was impulsive buy (without a shopping list), reflecting on the connections that this might result in throwing food out and why (“*didn’t like this taste*”).

A step on from dialogical reflection is *transformative reflection (R3)*, a level of reflection where the intention to change is articulated. Six instances of transformative reflection were coded in the material, such as

“I don’t want to buy so much any more”

This entry alone is very general but was submitted along with the food type “*Candies and Snacks*”, the reason “*Special offer*” and costs of “8 Euro”. These fields connected together provide a broader picture on the intention not to buy snacks and candies any more.

The instances of *transformative reflection (R3)* share an intention to change or re-organise a habit or trying to reflect on experiences, patterns or habits that should not be repeated, such as “*Stop putting more on the plate than you can eat*”.

There is a specific instance of transformative reflection that is very interesting in terms of the various levels of reflection that come together:

“Wasted 1.5 bunches of kale because heard it’s toxic to juice every day. Could have eaten sooner though but bought silverbeet instead and hurt back so stopped cooking etc. Don’t buy 3 bunches at once.”

The comment expresses various relationships, between description and knowledge (“*heard it’s toxic*”), alternative actions (“*bought silver beet instead*”), unexpected occurrences (“*hurt back*”) towards a transformative reflection (“*Don’t buy 3 bunches at once*”). This comment is more like a little story in character, where the person who submitted the comment seems to not only reflect on the circumstances leading to the kale being thrown away, but already provides an alternative future action. This also reflects the complex negotiations people make in their everyday life and that food is not discarded carelessly.

Critical reflection (R4), where social and ethical circumstances are considered, were not traceable in the comments. Such deep reflection could probably be observed if we had been able to interview users of the food waste diary, asking the question if and how reflection was an issue in the use of the diary.

As described in the methods section we added another code to the levels of reflection that we described as *emotional reflection (R5)*, a code emerging out of the material. Studies on food waste have pointed to feelings of remorse and guilt when people talked about discarding food [9, 12], which resonates with the findings from this study. Comments that reflected emotions and feelings were found in 18 instances:

“I’m too full to finish all up. Pathetic”

This comment was submitted along with the reason of “*Mixed food*” and “*Over-buying*”. The user submitting this entry frowns upon the discarded food; other instances even talk about being sorry for having to throw away food. One example is “*I’m very sorry but it was very disgusting and overcooked*”. Emotional reflection itself can be descriptive (R0), reflective descriptive (R1) and in some instances dialogical (R2), where an experience is related to an emotion such as being sorry but it is just not tasty. The emotion in many cases reminds of remorse or an utterance of dislike or tiredness. It suggests that the reflection on food waste triggers uncomfortable feelings when having to discard food. Hence reflection can cause “*inner discomfort*” [18].

Social and material circumstances

The data from the food waste diary also pointed to the social and material organisation of everyday life implicated in food being thrown out. Social circumstances describe broader contextual elements in the organisation of everyday life that are influenced and shaped by the people we share our lives with. The social context mattered and practices around planning, shopping, cooking, and eating are highly influenced by who else lives in the home. The food waste diary pointed to 13 instances of specific social circumstances such as “*Bad communication/no cooking combination found*”. Social circumstances point to communication or throwing out food because of over-provisioning (“*packed too much for Susan’s lunch*”) or having bought more than wanted “*My partner bought too much*”.

Additionally there were also material circumstances as evident from a user who noted about their egg purchase:

“bought box of 6 as 4s not available option. Cooked a quiche and a cake but unable to use last two.”

This quote can be interpreted in terms of the materiality of food packaging and in which quantities eggs are sold in the super-market, as eggs are only available in a pack of six but not four. The quote could as well be interpreted as concerning the social organisation of everyday life, as the user was “*unable*” to use the last two eggs for some reason. Hence the quantities, the material aspects of the package and the norm of having smallest packages of six eggs in the supermarket, also contributed to food being thrown out in the end.

DISCUSSION

Given research to date that points to the complexity of food waste and the difficulties people have in accounting for how it comes about, the focus of this paper is the design and evaluation of a mobile food waste diary to support reflection. In summary, 843 diary entries were submitted over 18 months and indicators of different levels of reflection were visible in the comments submitted with food waste entries. It is interesting to note two levels of user effort. Firstly, the entries are not passively measured or automatically added to a database. Instead they have to be entered manually, triggered by the event of wasted food, and requiring initial effort to remember to take out the application to use it. Secondly free text was added by participants not only in the comments but also

about self-defined food types and reasons, despite the provision of a category list: 49,1% of entries defined their own 'reasons' for wasting food, and 27% of the food types were self-defined. Moreover half of the entries included comments additional to their entries.

This points to the significant additional effort people were prepared to put into personalising and reflecting on what food they throw away and why. It also shows the value of people wanting to be more specific, personal and detailed when manually entering data. This can enable reflection amenable for making connections as they are more personal and connected to real life. We suggest that this additional effort might encourage a more active engagement with reflection and sense-making of the data as also noted by Li et al. [16], as for many entries the predefined options were not used. This supports a design approach to offer *open-ended* and free interactions in personal informatics systems that aim to support reflection, approaches as also proposed by Baumer [1] and specifically highlighted in Sengers's and Gaver's work [24].

The focus on waste itself, as a result of the socio-technical and the conceptual intention behind the food waste diary, provides a deeper insight about food waste as being strongly connected to the social and material circumstances in which food practices are embedded. Thus the data from the mobile application enabled us to gain a deeper insight into the issue of food waste, at least as evidenced by this particular set of motivated users. In these instances social circumstances such as 'bad communication' or material circumstances of 'packaging' were reflected upon and presented as rationales for wasted food. These rationales point to the interrelated nature of everyday life and food practices. The rationales that people provided were manifested in the comments and self-defined reasons users submitted. Reportive accounts or descriptive reflections were most common, where users described in more detail what they threw away (*description (R0)*) or why (*descriptive reflection (R1)*). Instances of *dialogical (R2)* and *transformative reflections (R3)* were less often encountered but offered deeper insights about the relationships between food waste, previous experiences, habits, knowledge and intentions to change, e.g., "I don't want to buy so much any more".

Processes of reflecting with technology

Schön's concepts of *reflection-in-action* and *reflection-on-action*, though concerned with design processes, are interesting here as they describe two different processes about when and how reflection can take place. *Reflection-in-action* takes place while people are enacting in an activity and making connections. *Reflection-on-action* takes place after a process or artifact has been completed, as a reflection on what has happened [23]. We will borrow these concepts for reflection supported by the mobile food waste diary. Reflection can take place at the moment when people are discarding food and reflecting on why they are, as reflection-in-action. While wasting, a user might already reflect on submitting the data to the food waste diary.

Schön's concept of *reflection-on-action* describes final thoughts and reflections enabling us to think back about past

processes. For reflection-on-action, we can discern two different forms of reflection in the use of the food waste diary. First we could observe instances of *reflection-through-recording* when manually entering data through making connections between experiences, occurrences and why something is thrown away, how much the food costs, what different actions it might provoke and so forth. The second point of reflection-on-action can take place after an entry has been submitted through *reflection-through-revisiting*.

The speculation here, and evident in instances of the data, is that manually entering the reasons for food waste supports the reflective process through *reflection-through-recording*. We further speculate that this is likely to lead to increased understanding, addressing the barriers to reflection raised by Li et al. [16] when data is automatically recorded:

"Barriers in the Reflection stage prevent users from exploring and understanding information about themselves. These problems occurred because of lack of time or difficulties retrieving, exploring, and understanding information." [16, p. 562]

Changing routines

Intentions to change certain aspects to waste less were visible in instances of *transformative reflection (R3)*, where users noted down their thoughts. Taking a critical perspective, we might argue here that the intention to change does not imply that change is going to happen, and we are only able to study the *intention to change* here.

The food waste diary application was offered to people who were genuinely interested in making visible for themselves certain aspects of food waste. As suggested by Qusted [19], the availability of such a tool can be important when looking for opportunities to change and increased visibility:

"Opportunities to break habits have also been utilised: in addition to moments in peoples lives where they are more amenable to change [], increased visibility of food waste in the home is also a good opportunity to change behaviour. Examples include completing a food diary or placing all food waste generated over a week in a separate receptacle." [19, p. 50]

Qusted et al. suggested that major life events or a dedicated time to use a diary can elicit transformations in catching people at this point of taking an opportunity to break habits and wanting to gain more transparency on what and how much food they waste. Assuming that inherent motivation is significant, recruiting people who are genuinely interested is key and was our main motivation for this study. All in all 843 entries emphasise that there are some people who desire to reflect on food waste practices and some of the comments point to deeper reflective processes that have taken place. The entries are a testimony of people's desire and enactment of reflection on discarded food. Nevertheless, an investigation into whether personal informatics can actually enhance self-knowledge or change in everyday life, necessitates an evaluation whether personal informatics systems support such changes [18, 16]. Here we can make a start by pointing to potential indicators of such change, but as a methodological

trade-off will need a different study to say how it translates to action.

Broader notions around change

We also engage here with the general critique of technology interventions aimed at individuals or households. This is important as behaviour change or motivational theories, where data is presented as feedback in a quantified way, are often critiqued [25] for singling out specific behaviours, aiming to address it without considering the broader circumstances. These approaches are often too simplistic and treat human beings as being guided by rational choice rather than negotiating the complex circumstances we live in and in which our food practices are intertwined [25]. A second point of critique is more systemic: Supporting change on any level, e.g., through reflection, carries the critique of not being radical enough for sustained change. Erickson et al. [8] speculate that a radical change in using less energy for example might only be possible through ‘crisis or prices’ or both at the same time. In terms of food waste, there is data that also points to this argument. For example, the 13% reduction of food waste between 2006/7 and 2010 in the UK can be connected to increased food and drink prices and reduced incomes during that time [21].

Nonetheless the fact that the application was used and seemed useful for some, suggests that we should not entirely abandon individual technology approaches; the food waste diary shows that such approaches can have benefits as well for self-motivated individuals. There is nothing inapt about supporting people who want to reflect on why, how much and which food they waste, being aware this might not lead to fundamental change and might only reach a certain set of people. The users of the food waste diary application submitted entries because they wanted to know how much they throw away and some mentioned the intention to change routines. They did so through manually capturing, making connections and reflecting on those entries.

Design considerations

As designers of interventions we have to be critical about the choices we make; in addressing individuals we should respect people’s choices in the complexity of everyday life. The food waste diary application was not designed to recommend any actions, but for enabling people to capture their own connections between experiences, reasons, occurrences, types of food, or optionally costs. We argue for an approach of personal informatics where a holistic and open technology experience is offered to users, where they can creatively define, also in addition to automatic tracking of data, why and what type of data they want to enter for reflection. We also argue for it being ok to accept that we only have a view through the application, albeit a useful view, and not how the application connected to everyday life and change, as a useful trade-off for accessing authentic use and users.

The role of *emotions* as found in our material can be considered and embraced, even those that are uncomfortable [1, 18, 26]. Reflection on experiences is not just a rational and cognitive process. Experiences are always coupled with emotions

and these are important in developing self-awareness. How can emotions be respected or considered in the design of such systems?

The social and material circumstances involved in the everyday negotiations and trade-offs in saving or wasting food point to the potential of technologies for helping us be more aware of these connections. An application could elicit reflection not only about the behaviour, but the *circumstances entailed* in shaping our behaviours and the connections across space and time.

Strengths, limitations and future work

As noted previously, we made a conscious decision and positive choice to offer the application worldwide at the Apple and Google Play market for free to collect data from intrinsically motivated people to use the application. We also intended to keep the threshold to use the application as low as possible, hence users were not obliged to register with email address and password. This came with the trade off that we were not able to recruit diary users for a more in-depth interview study. Such a study would enable us to gain deeper insights on reflection-through-revisiting and help us to understand if a transformation of individual or collective household actions took place after transformative reflections.

We intend therefore to carry out further research on the process of reflection-through-revisiting and as future work we intend to recruit users of the food waste diary for an interview study through a pop-up screen on the mobile application. This will enable us to understand how the diary is used as part of their broader strategies in addressing food waste and its potential for reflection in a direct conversation with participants.

CONCLUSION

The case study on the food waste diary application probes on people’s food waste experiences, reasons and the connections they make. While the design intention is to open the space to instigate reflection, it also informs a richer understanding of the complexity and competing concerns that lead to wasted food. The quantitative findings inform us about ‘popular’ reasons for food waste (“over-buying”) and that interestingly, half of the entries provided a personalised ‘reason’. This points to the effort people are prepared to make and the complexity of the phenomenon of food waste, where simplistic answers to where and how something is thrown away do not exist for most cases. The complexity becomes visible in some instances of the qualitative thematic analysis of free comments, uncovering the unintended nature of food waste in everyday life through its social and material organisation and unexpected occurrences. The intention of supporting reflection was visible in some instances of submitted entries where deeper insights about the relationships between food waste, previous experiences, habits, knowledge, occurrences and intentions to change were offered. Qualitative interviews with users of the food waste diary are a subject for future research to better understand the role of reflection and how the diary facilitates it while entering the data manually

(*reflection-through-recording*) and revisiting it for reflection (*reflection-through-revisiting*).

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