Exploring the use of behaviour change in the design of a mobile application for food waste reduction: considering users' culture and life stage

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Abstract

Food production generates approximately 26% of all greenhouse gas emissions, yet one third of the food produced is wasted, domestic household waste being a major contributor. Research has investigated domestic food waste and some technological interventions have been developed. However, previous work has given little attention to what drives people to waste food in their specific cultural contexts and different life stages. In addition, previous technological interventions for food waste reduction have given little explicit attention to behaviour change theories in their development.

In this programme of research, an extensive literature review was conducted to establish a comprehensive foundation to understand food waste issues; this led to the development of a set of food waste statements which were refined throughout the research. Initially, two studies investigated individuals' attitudes and practices around food consumption and waste, considering their *Culture* and *Life stage*. Participants were from three cultures: Arab, British, and Chinese, and at three life stages: university students, family members, older people. These studies showed that *Overbuying food* was the only *High importance* food waste driver for all individuals regardless of life stage, while *Eating and socialising* was also of *High importance* for family members.

The third study investigated the groupings of food waste issues and developed a statistically-based model of food waste drivers for British individuals. Then a low fidelity prototype for a multi-functional mobile app to support food waste reduction, WasteLess, was designed to explore the use of behaviour change theories. The fourth study evaluated the app with individuals from two cultures (Arab and British) and at the three life stages. It focused on three areas: likelihood of using WasteLess functionalities, Behaviour Change Wheel (BCW) interventions and persuasive technology techniques, and design issues. *Checking and managing food at home* was the most likely WasteLess function to be used, while *Community aspects of food waste reduction* was the least likely. Of the BCW interventions and persuasive technology techniques, *Competition* and *Cooperation* had low potential to support individuals compared to *Enablement*, *Education*, *Personalization*, *Reduction*, *Tracking*, and *Reminder*. In relation to design issues, clarity of information and visual representation, accuracy of information provided, and technological barriers were the main issues for potential users of the WasteLess app.

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To Mum and Dad,

For their endless love, support and encouragement

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Declaration

I, Mashael Aljubairah, declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for a degree or other qualification at this University or elsewhere. All sources are acknowledged as references.

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Chapter 1
Introduction

The production of food generates approximately 26% of all greenhouse gas (GHG) emissions globally (Poore & Nemecek, 2018). The livestock sector alone is responsible for approximately 15% of all emissions, the equivalent of tailpipe emissions from all the world's vehicles (Wellesley et al., 2015). Although estimates vary considerably, it is clear that at least one third of all food produced is wasted (FAO, 2013), resulting in the expenditure of yet more natural resources and GHGs. There is no doubt that food waste causes much environmental damage. Wasting food wastes resources such as energy and water (Institution of Mechanical Engineers, 2013), and contributes indirectly to biodiversity loss (FAO, 2013). Food waste sent to landfill generates about 125 m^3 of landfill gas (Adhikari et al., 2006, cited in Melikoglu et al., 2013). In addition, landfill gas contains about 65% methane and 40% carbon dioxide. According to Einola et al. (2008, cited in Melikoglu et al., 2013), methane has more global warming potential (21 times) compared to carbon dioxide over a period of 100 years. Landfill contributes around 8% annually to global GHG emissions (Adhikari et al., 2009, cited in Melikoglu et al., 2013).

Food waste from domestic households is a major contributor to the food waste problem, particularly in Western countries (Parfitt et al., 2010). For example, in the UK it is estimated that 70% of food waste comes from this source (WRAP, 2021), costing the average household approximately GBP 730 (approximately USD 900) annually. Household food waste can be categorised into three types (WRAP, 2012): *avoidable food waste* such as leftovers, *possibly avoidable food waste* such as fruit skins, and *unavoidable food waste* such as bones. The scope of this research is limited to avoidable food waste only. Among the three waste types, WRAP (2012) reported that *avoidable food waste* accounts for 60% of total household food waste, costing the average household approximately GBP 470 (approximately USD 580) annually. Some non-Western countries such as Saudi Arabia also have a severe food waste issue. Baig, Al-Zahrani, et al. (2018) reported that almost 80% of purchased food in Saudi Arabia is

wasted. To address this problem, the United Nation's Sustainable Development Goal proposes that "By 2030, halve per capita global food waste at the retail and consumer levels" (United Nations, 2015, p. 27).

Food waste is a major societal level problem which needs to be addressed at numerous levels, governmental, institutional and individual. Digital technology has an important role to play in addressing the problem. Kosseva (2013) mentioned that in Western countries minimising food waste is associated with consumers' eating attitudes and behaviours. Aschemann-Witzel (2015) also noted that consumer behaviour is estimated to be the major influence of food waste in Saudi Arabia. While not wanting to "victim blame" individuals for their actions (Evans, 2011), people need to become more aware of how much food they waste and to be supported in how to reduce and avoid this level of waste. As has been noted, a considerable benefit of wasting less food is that people will save money (Visschers et al., 2016), which should be a strong motivation to reduce food waste, but this currently does not appear to be sufficient motivation or people are simply not aware of the savings they could make. Digital technology therefore has an important role to play in supporting individuals in understanding how much food and consequently how much money they waste, towards helping them reducing their food waste.

1.1 Research motivation

Norton et al. (2017) noted that researchers in Human Computer Interaction (HCI) have been interested in issues associated with food and sustainability for some time. Food waste reduction is situated within the area that has become known as sustainable HCI (see Chapter 2, Section 2.3).

Food waste is a multi-disciplinary problem, at the intersection of social sciences, particularly behavioural change theory, and HCI (see Figure 1.1). Therefore, there is a need for a comprehensive multi-disciplinary approach that builds bridges between disciplines in order to inform researchers and designers in the area of sustainable HCI who are interested in designing technological interventions for food waste reduction. Towards this goal, there is a need to better understand the nature of the food waste problem, and to investigate the possible drivers leading to food waste that can be related to individuals' everyday activities. In addition, it is important to consider

culture and life stage that could have effects on individuals' lifestyles and practices around food and food waste. Furthermore, using behavioural change theories to inform the design of the technological interventions could help individuals to change their behaviour towards food waste reduction.
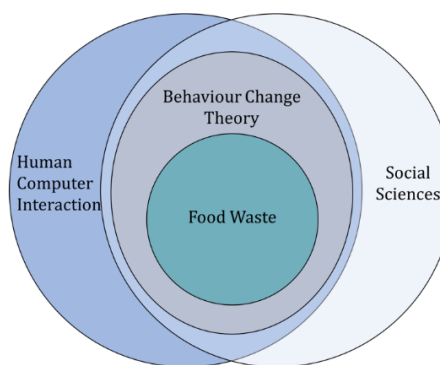
Figure 1.1 Food waste issue at the intersection of disciplines

In moving towards a comprehensive approach to inform the design of technological support for food waste reduction, there is a number of gaps in the current literature which will be addressed in this programme of research in relation to understanding the food waste problem and its possible drivers. *Food waste drivers*, are defined in this programme of research, as "reasons or causes which drive individuals to food waste". There is a gap in the current research literature in terms of identifying a comprehensive range of possible drivers that lead individuals to waste food in their households. The majority of previous research has been limited in terms of the aspects investigated related to food waste. There is only one study I found that conducted a meta-review of the food waste issue and food waste drivers (Hebrok & Boks, 2017). However, it was unclear how these researchers extracted their proposed set of drivers from different studies (see Chapter 2, Section 2.2.1). The lack of a comprehensive and robust foundation for describing the set of food waste drivers hinders the development of technological interventions for food waste reduction. Therefore, this research gap was the first motivation for this programme of research. To address this gap, a wide range of food waste drivers discussed and investigated in the literature were identified, drawing on literature from different disciplines and taking into account two factors, different cultures in which the research was conducted and the life stages of individuals studied.

In relation to the first factor, *Culture*, is a complex topic, and used in many disciplines with many definitions. For the purposes of this programme of research I used as a definition "… culture is learned … is associated with groups of people and its content includes a wide range of phenomena including norms, values, shared meaning and patterned ways of behaving" (Birukou et al., 2013, p. 3). In addition, Birukou et al. note that "Culture is a slippery and ubiquitous concept". *Culture* is one factor that I believe will have an important effect on individuals' attitude and practices related to food and food waste. Some researchers have noted that cultural differences influence individuals' behaviour around household food consumption and food waste (e.g., Mattar et al., 2018; Hebrok & Boks, 2017). To understand the role that culture plays in individual attitudes, practice, and drivers around food and food waste, it is necessary to compare these attributes with individuals from different cultures. Although there is a body of research which has investigated individuals' attitudes, practices, and food waste drivers, little attention was given to culture by previous researchers (see Chapter 2, Section 2.2.1 to 2.2.4).

There has been a very small corpus of research which has compared food waste issues in different cultures (see Chapter 2, Section 2.2.5), but the only studies I found compared these issues within Western cultures. To the best of my knowledge, none of the studies compared Western and non-Western cultures. However, individuals from Western cultures (e.g., the United Kingdom) and non-Western cultures (e.g., Arab or Chinese) might have very different attitudes and practices in relation to food and food waste. These cultures have different religious and cultural traditions which may influence individuals' views on rituals around food and hospitality (see Chapter 2, Section 2.2.5). Therefore, this research gap was the second motivation for this programme of research. To address this gap, investigation and comparison of individuals from different cultures was conducted in relation to attitudes, practices and drivers related to food and food waste.

Life stage, is the second factor, which is defined in this programme of research as an individual's situation in terms of their typical living environment and other individuals with whom they are living, for example being a student living away from home for the first time at university; being an adult, living with a partner and young children; or

being a retired person, very often with adult children who have left home but living with a partner or alone. In addition, age was also used as indicator for the life stages. Researchers have highlighted the possible influence of individuals' age on food waste attitudes and practices (Hebrok & Boks, 2017; Nikolaus et al., 2018; Quested et al., 2013; Schneider, 2008; Tsai et al., 2020). However, previous research also paid little attention to *Life stage* (see Chapter 2, Section 2.2.6).

In particular, individuals at different life stages may have different types of pressure in relation to food management and waste issues (see Chapter 2, Section 2.2.6). Therefore, this research gap was the third motivation for this programme of research. To address this gap, investigation and comparison of individuals at different life stages was conducted in relation to attitudes, practices and drivers related to food and food waste.

Considering the interaction between *Culture* and *Life stage* in relation to food waste was another gap in the previous research. The research, which has been undertaken in different Western countries (e.g., Bravi et al., 2020), was generally conducted about specific life stages. However, the two studies I found which investigated different life stages (Przezbórska-Skobiej & Wiza, 2021; Van Boxstael et al., 2014), were conducted in a specific culture. However, *Culture* and *Life stage* might interact in their effects on individuals in relation to food and food waste attitudes practices and drivers. Therefore, this research gap was the fourth motivation for this programme of research. To address this gap, investigation and comparison of individuals at three different life stages (students, family members living with children, and older people) and from two very different culture (British and Arab) was conducted in relation to attitudes, practices and drivers related to food and food waste.

Furthermore, the previous research lacks a comprehensive model of food waste drivers that can be used by HCI researchers and developers as a foundation to develop interventions for food waste reduction (see Chapter 2, Section 2.2). Such a model can be used to group and study more easily the food waste issues for a particular user group, and to allow researchers to devote more attention to the areas of concern in developing their interventions. Therefore, this research gap was the fifth motivation for this programme of research. To address this gap, a statistical model of food waste

drivers was proposed based on a comprehensive set of food waste drivers, using data collected from British individuals at different life stages.

In relation to using behavioural change theories, little explicit attention has been given to these theories by researchers developing technological interventions for food waste reduction (see Chapter 2, Section 2.3.3). However, using behaviour change theories in digital technologies to encourage individuals in their pro-environmental activities and sustainable lifestyles is another important part of the current programme of research. Researchers (e.g., Hekler et al., 2013) have emphasized the advantages of using behavioural change theories in HCI domains such as sustainability for technical systems. Therefore, this research gap was the sixth motivation for this programme of research.

To address the sixth gap, investigation of the possibility of applying behavioural change theories to inform the design of a multi-functional technological intervention for food waste reduction, WasteLess, was conducted. One of the advantages mentioned by Hekler et al. (2013) in relation to informing the design of technological systems is to get ideas for which functionality can be created to provide support. Two theories of behaviour change were used in this programme of research: the Behaviour Change Wheel (BCW) (Michie et al., 2011) and the persuasive technology approach (Fogg, 2003; Oinas-Kukkonen & Harjumaa (2008, 2009) (see Chapter 2, Section 2.3.1.1 to 2.3.1.3).

In relation to functionality to support individuals in food waste reduction, each of the previous technological interventions only provide very specific functionality to support users in one aspect of food waste reduction (see Chapter 2, Section 2.3.2). In addition, these interventions were evaluated with only small and specific samples of individuals, without taking into consideration the two important factors highlighted above (*Culture* and *Life stage*). Therefore, the potential of using different functionality to support food waste reduction was the seventh motivation for this programme of research.

To address the seventh gap, exploring the possibility of designing a multi-functional technological intervention for food waste reduction, WasteLess, was conducted. This

includes providing a wide range of functionalities and supports during different food-related activities: food shopping, management, cooking, and provide support for food waste. In addition, a statistical model of food waste reduction functionalities was proposed based on a comprehensive set of food waste reduction functions, using data collected from a large UK sample with a small Arab sample of potential users.

In relation to BCW intervention functions and persuasive techniques, there is a lack in the previous research about the potential of these techniques to be used by individuals to motivate them in relation to food waste reduction in technological interventions. Although some of the previous technological interventions applied some techniques (e.g., Competition was used in "BinCam", and Education was used in "EatChaFood"), this was not explicitly stated or evaluated (see Chapter 2, Section 2.3.3). However, behaviour change theories such as persuasive technology (e.g., Fogg, 2003; Michie et al., 2011; Oinas-Kukkonen & Harjumaa, 2008, 2009) have proposed techniques which can be used for technological interventions to promote behaviour change in the area of food waste reduction. Therefore, the potential of using these techniques in technological interventions for food waste reduction was the eighth motivation for this programme of research. To address this gap, I followed the recommendations from Hekler et al. (2013), by using the two theories I applied in this research to guide the evaluation of WasteLess and interpreting of the results. This led to my investigation of the likelihood of using different behaviour change techniques by individuals for food waste reduction.

To address these gaps, the aims and objectives of this programme of research are outlined in the next section.

1.2 Research aims, objectives & research questions

This programme of research presented in this thesis aimed to investigate how to use behaviour change theories to inform the design of a digital technological intervention, the WasteLess app, to support food management and reduce food waste. To do this, it first investigated what drives individuals to waste household food, considering their culture and life stage. A further aim was to investigate the potential of app-based functionality and BCW intervention functions and persuasive technology techniques in

the area of food waste reduction by an initial evaluation of a low fidelity prototype of the WasteLess app.

To achieve these aims, this programme of research is divided into five phases: analysis, understanding and investigation, validation, design, and evaluation (see Figure 1.2). For each phase, the objectives, studies, and research questions are presented below.
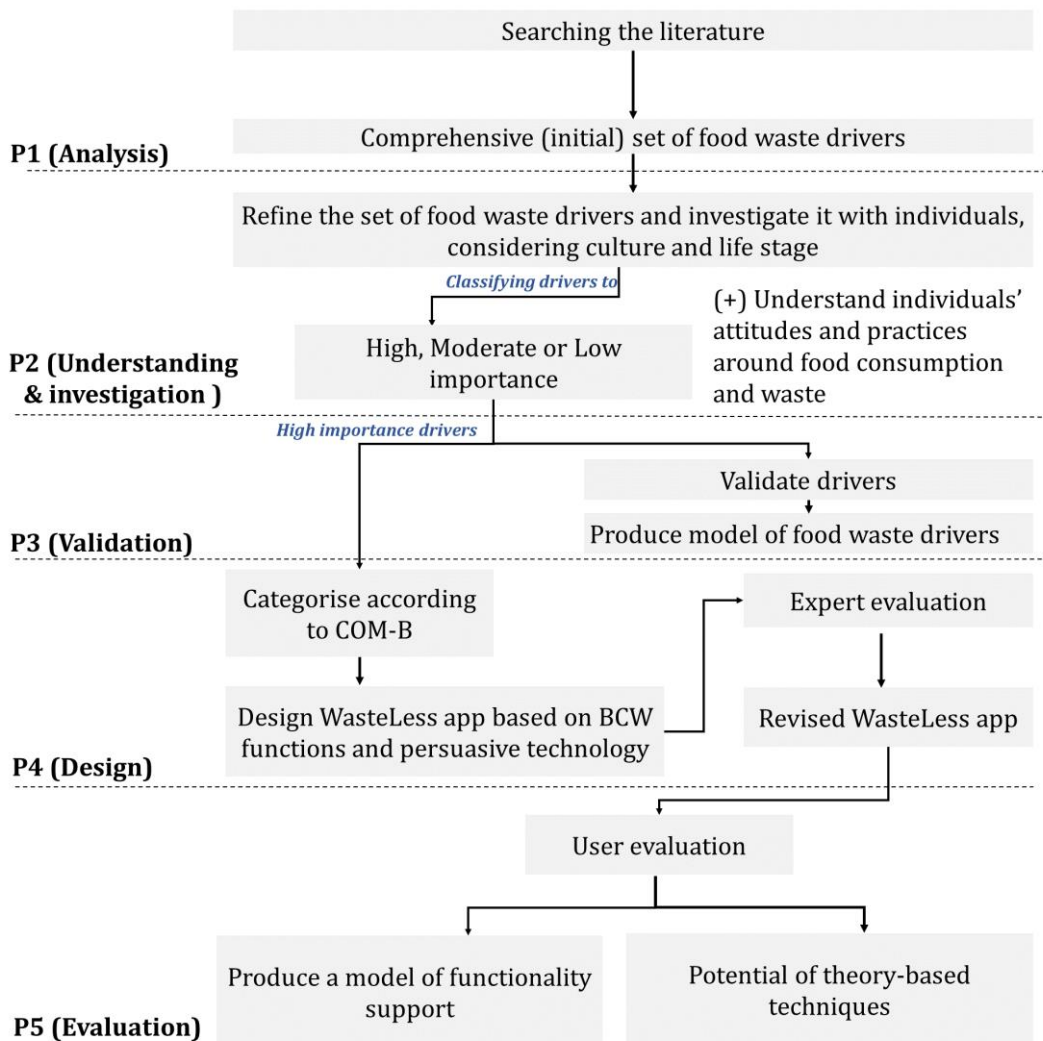
Figure 1.2 Objectives of each phase in this programme of research

The objective of the first phase – **analysis** – was to establish a comprehensive foundation to understand the food waste issue. This was achieved by reviewing the literature and producing an initial broad set of drivers for food waste issue (see Chapter 2). This set of food waste drivers, which was the output of this phase, was the input of the next phase.

The objectives of the second phase – **understanding and investigation** – were to understand individuals' attitudes and practices around food consumption and waste, considering aspects of culture and life stage. In addition, it was to refine the set of food waste drivers and investigate it with different groups. The objectives of this phase were achieved by the first and second studies in this programme of research. This phase addressed the first research question (RQ) in my programme of research:

RQ1: What are the similarities and differences in food consumption and waste practices, attitudes, and behaviours among people in different cultures and at different life stages?

> RQ1.1: What are the similarities and differences among postgraduate university students from three different cultures in terms of their practices around food consumption and food waste and the drivers which lead them to waste food?
>
> RQ1.2: What are the similarities and differences among individuals from different cultures living in family situations with children and older people in terms of their practices around food consumption and food waste and drivers that lead them to waste food?
>
> RQ1.3: What are the similarities and differences among individuals at three different life stages and from two different cultures in terms of their practices and attitudes around food consumption and food waste and drivers that lead them to waste food?

The first study investigated the attitudes and practices of food consumption and waste for students from three different cultures (Arab, British, and Chinese), through focus groups and interviews (RQ1.1, see Chapter 3). The second study investigated the attitudes and practices of food consumption and waste for family members living with children and older people from two cultures (Arab and British), through interviews and a survey (RQ1.2, see Chapter 4). To understand the attitudes and practices of food consumption and waste for three life stages (students, for family members living with children and older people) and from two cultures (Arab and British), a comparison of data collected from the first and second study was conducted (RQ1.3, see Chapter 4). As part of the investigation in this phase, classification of the food waste drivers according to *High*, *Moderate* or *Low* importance was conducted, for individuals at

different life stages and from different cultures. The *High* importance food waste drivers was the input for the next phase.

The objective of the third phase – **validation** – was to validate the drivers, investigate the fundamental groupings and produce a model of food waste drivers for British individuals. The objectives of this phase were achieved by the third study in this programme of research, through an online study (see Chapter 5). This study addressed RQ2 in my programme of research:

RQ2: What are the similarities and differences among British individuals at different *Life stages* in terms of food shopping and waste and important food waste drivers?

RQ2.1: What are the similarities and differences among British individuals at different *Life stages* in terms of food shopping and waste?

RQ2.2: What are the underlying and important food waste drivers for British people?

The output of this phase was a valid model of food waste drivers. However, the input of the next phase (design) was only the output of the second phase. This is because the third phase (validation) and fourth phase (design) were conducted in parallel in this programme of research, due to the time restrictions.

The objective of the fourth phase – **design** - was to explore the possibility of applying BCW and persuasive technology to inform the design of a digital technological intervention for food waste management and reduction for specific user groups. To achieve the objective of this phase, a design of a low fidelity prototype for a multi-functional mobile app, WasteLess, was conducted (see Chapter 6). This included categorising the mitigation of food waste drivers according to COM-B, and using the BCW intervention functions and persuasive technology. The design of the low fidelity prototype for the WasteLess app addressed RQ3 in this research:

RQ3: To what extent can the design of a mobile app (WasteLess) provide comprehensive support for food-related practices and techniques for behaviour change?

RQ3.1: To what extent can the design of a mobile app (WasteLess) provide comprehensive support for food-related practices?

RQ3.2: To what extent can a mobile app (WasteLess) incorporate the full set of food waste drivers elicited in Studies 1 and 2 of this programme of research?

RQ3.3: To what extent can a mobile app (WasteLess) incorporate theory-based techniques for behaviour change (i.e., the BCW and persuasive technology techniques)?

An expert evaluation was conducted, and a revised version of the low fidelity prototype of the WasteLess app is the output of this phase and input to the next phase.

The objective of the fifth phase – **evaluation** – was to evaluate the proposed technological interventions in this programme of research, the low fidelity prototype of the WasteLess app. In addition, it was to investigate the underlying groups of app-based functionality supports for food management and waste reduction and to produce a model of these functions. Further, the evaluation investigated the potential of different app-based functionality supports for food management and waste reduction for potential users at different life stages. In addition, it investigated the opinions of potential users at different life stages and from different cultures about the BCW intervention functions and persuasive technologies support. Finally, it investigated the potential of using theory-based techniques for food management and waste reduction. The objectives of this phase were achieved by the fourth study in this programme of research, through an online evaluation of the low fidelity prototype of the WasteLess app (see Chapter 7). This study addressed RQ4 in my programme of research:

RQ4: For potential users at different life stages and from different cultures, what are their opinions of different WasteLess functionalities, different BCW interventions and persuasive technology techniques, and the design of the app?

RQ4.1: What are the different groups of functionality proposed for the WasteLess app and their importance for potential users at different life stages?

RQ4.2: To what extent do the opinions of potential users at varying life stages and from different cultures support the BCW intervention functions and persuasive technologies proposed for the WasteLess app?

RQ4.3: For potential users at different life stages, which are the most important app-based interventions and persuasion technology approaches to support food waste reduction?

RQ4.4: What are the usability and accuracy issues with the prototype of the WasteLess app?

The evaluation, conducted in this phase, enabled me to create a set of lessons learned to help researchers and designers for the functions and interventions which appear to be promising, which need to be evaluated in future research. Such future research would involve further usability and acceptability testing of a fully functional version of the app, followed by a field study with actual deployment of the app with users. The true effectiveness of the behaviour change interventions would require a field study of many months and a follow up study, as one would want to investigate whether participants changed their behaviour and whether that behaviour change was sustained beyond the lifetime of a field study. This work was beyond the scope of the current programme of research.

1.3 Research methods

This programme of research used mixed methods approach involving both qualitative and quantitative research methods.

In the first phase – **analysis** – I conducted a literature review and came up with a comprehensive set of initial statements around food waste drivers (35 statements). This set was central to further work in this programme of research. This also includes reviewing the literature of food waste issue considered two variables: *Culture* (Western or non-Western culture), and *Life stage* (students, family members, or older people).

In the second phase – **understanding and investigation** – used a mix of qualitative and quantitative methods including focus groups, interviews, and surveys. This enabled me to understand and investigate individuals' attitudes and practices around food consumption and waste. Focus groups was the first method of choice as it encourages more discussions about the topic which can lead to richer data. Although it had been initially planned to use focus groups with all participants, due to the constraints in the availability of some participants, interviews were used as the second

option if focus group was not possible. However, for participants in Saudi Arabia, no focus group nor the interview were possible, therefore, surveys were used. The subject matter was kept as close as possible in all methods. The first and second studies were conducted with individuals at different life stages and from different cultures.

The first study collected data from postgraduate university students from three different cultures (see Chapter 3). The rationale behind studying university students was that they are at early stage in their independent adult lives in relation to shopping for food and cooking for themselves. In addition, it would be useful to support them at this life stage in creating good habits in relation to food-related practices and food waste. In terms of culture and to investigate the role it may play, the first study collected data from students from three cultures: Western (British) and two non-Western (Arab and Chinese). These cultures are very different in terms of religion and cultural traditions around food and hospitality.

The second study extended the research in the first study by collecting data from individuals at two different life stages from the students, family members living with children and older people from two different cultures, Arab and UK (see Chapter 4). The second study did not collect data from Chinese individuals at these two life stages because I did not have access to participants at these two life stages. The rationale behind the second study was to explore if that pattern of similarities and differences in the first study extended to later life stages. Individuals living in family situations with children as well as older people may have different pressures than students (see Chapter 2, Section 2.2.6).

A range of question types were used to collect different types of data: close-ended questions to collect information about their general attitudes and self-reported behaviour around food practices and food waste (to answer RQ1.1 in Study 1 and RQ1.2 in Study 2). Open-ended questions were also used to: (1) gather detailed information of their experience around reducing food waste and using any apps to do so; and (2) trigger the initial discussion about food waste, and possible causes of food waste. However, to investigate the food waste drivers (to answer RQ1.1 in Study 1 and RQ1.2 in Study 2), a qualitative analysis, a codebook thematic analysis (Crabtree & Miller, 1999) was conducted on the written and verbal data collected via the first and second

studies. Embedded in these data collection methods was a PostIt exercise which collected participants' comments in relation to food waste statements and asked them to vote on the most important issues for them. Then, quantitative analysis using a ranking approach was conducted to investigate the importance of food waste drivers for each individual groups.

To further investigate the role of culture and life stage, and the possible interaction between these two variables; the data collected from the first and second studies were further analysed (see Chapter 4, Section 4.3.3). This included data of individuals at three life stages (students, family members living with children, and older people) and from two different cultures (Arab and British). This mainly included conducting quantitative analysis for the studied groups after merging them based on culture and life stage (to answer RQ1.3). The rationale behind this analysis was to provide evidence-based similarities and differences between individuals at different life stages and from different cultures in terms of their attitudes and self-reported practice around food and food waste. In addition, a quantitative analysis using ranking approach was conducted to investigate the importance of food waste drivers for individuals at each different life stage and from each culture (to answer RQ1.3). A mixed analysis of variance (ANOVA) was conducted to investigate the possible interaction between culture and life stage in terms of the importance of the main food waste drivers (to answer RQ1.3).

In the third phase – **validation** – to validate the drivers, investigate the fundamental groupings and produce a model of food waste drivers, the third study (see Chapter 5) was conducted. This study was conducted to validate the food waste drivers that appeared to be *High importance* in Study 1 or Study 2 in the second phase (understanding and investigation), with larger sample size of participants. This used a largely quantitative research methodology with the data collection method of online surveys of British individuals. Data collected from this study were analysed using quantitative analysis. Principal components analysis (PCA) (Dunteman, 1989) was used to find the groupings of food waste drivers, simplify the data and reduce the large number of food waste drivers to a smaller, manageable number of dimensions (to answer RQ2.2). In addition, the PCA was used to create a statistical model of food waste

drivers based on the data collected from British individuals. Then, confirmatory factor analysis (CFA) (Brown, 2006) was conducted to assess the fit of the resulting model, as well as its validity and reliability. Furthermore, quantitative analysis was used to investigate the importance of food waste components for British individuals at different life stages (to answer RQ2.2).

The quantitative analysis was also used in Study 3 on data collected using close-ended questions to gather information around food shopping and food waste practice (to answer RQ2.1).

In the fourth phase – **design –** to explore applying BCW and persuasive technology, in order to inform the design of a digital technological intervention for food waste management and reduction for specific user groups. This was achieved by designing a low fidelity prototype for the WasteLess app to support food waste reduction, (see Chapter 6) (to answer RQ3). The design of the WasteLess used a low fidelity prototyping method, with horizontal compromise (i.e., providing a wide range of functions, but with little details). This was because the main focus of the design was to evaluate the idea of functions with a range of potential users at early stage of development process. It would have been ideal if I had used the results of Study 3 of the refined set of food waste drivers; but due to time restrictions, the design of the WasteLess app was conducted in parallel with conducting Study 3. Therefore, the design of the WasteLess was based on the *High importance* food waste drivers in Study 1 or Study 2 in the second phase (understanding and investigation).

The design of the WasteLess includes application of the Behaviour Change Wheel (BCW) (Michie et al., 2011; Michie et al., 2014). BCW provides a systematic method to understand the nature of behaviour, as well as providing intervention functions to tackle it. The application of BCW includes defining the problem in behavioural terms, by providing a set of food waste drivers (this was done as part of second phase). Selecting the target behaviour and categorised them according to COM-B model. Then, identifying the relevant BCW intervention functions such as *Education, Persuasion and Enablement*, to be used following the COM-B. In this stage, I also inspired by persuasive techniques by Fogg (2003) and Oinas-Kukkonen and Harjumaa (2008, 2009) such as

Personalization, *Reduction*, *Cooperation*, *Cooperative*, and *Tracking*. The application of BCW helps to establish user functional requirements of the WasteLess app.

An expert evaluation of the WasteLess low fidelity prototype was conducted by three experts, using the Collaborative Heuristic Evaluation (CHE) (Petrie & Buykx, 2010) method. This was important before moving to evaluation with potential users, because it helps to get feedback from experts about the design of user interface, and usability problems that might hinder users from using the app. In addition, expert evaluation can help to reduce the possibility of participants struggling with obvious usability problems in the later user evaluation which might colour their overall opinion of the prototype.

In the fifth phase – **evaluation** – to evaluate the proposed technological intervention in this programme of research, the low fidelity prototype of the WasteLess app, the fourth study (see Chapter 7) was conducted. This used mixed quantitative and qualitative research methods, with the data collection method being an online study. The study involved individuals at three different life stages (students, family members, and older people) and mainly form British culture (10% of them from Arab culture).

The evaluation close-ended questions to gather information about general attitudes and practices around food and food waste. To evaluate WasteLess, Likert items were used for participants to rate the likelihood they would use each function. However, to collect participants' more qualitative views, most Likert items were followed by an open-ended question inviting participants to elaborate on their rating. This enabled me to understand more about why participants had provided particular ratings and gather a wider range of information.

Codebook thematic analysis (Crabtree & Miller, 1999) was conducted on the data collected as additional comments in an open-ended question to investigate participants views around intervention functions and persuasive technologies within the WasteLess functions (to answer RQ4.2). However, inductive thematic analysis (Braun & Clarke, 2006) was used to investigate the design aspects related to the prototype of the WasteLess app (to answer RQ4.4). Quantitative analysis was conducted on data collected from the Likert scale of the likelihood (to answer RQ4.1). Principal components analysis (PCA) (Dunteman, 1989) was used to find the groupings of

WasteLess functionalities, and create of model of app-based functionalities. Then, confirmatory factor analysis (CFA) (Brown, 2006) was conducted to assess the fit of the resulting model, as well as its validity and reliability. Furthermore, ANOVA was used to investigate the importance of app-based functionalities for individuals, and the importance of app-based interventions and persuasions (to answer RQ4.1 and RQ4.3).

1.4 Researcher positionality

I, the author, am Saudi, who was born and grew up in Saudi Arabia. Saudi culture therefore is my own native culture. From my personal experience, I know that food waste is a big problem in Saudi Arabia, and usually Saudi culture is blamed as a strong contributor to this issue. This is because Saudi culture, and other Arab cultures, places a strong emphasis on providing hospitality to family members and guests and providing a very generous amount of food as part of that hospitality, which is usually too much food which leads to waste.

The level of food waste in Saudi Arabia and the tradition of providing too much food in the first place motivated me to consider culture in the context of food waste in this programme of research. Further, being a Saudi could have influenced my approach to this research in a number of different ways. First, in the focus group in Study 1 and the interviews in Study 2, I could perhaps better understand and empathise with the views and beliefs of the Arab participants around food practices and food waste. In addition, I used Arabic with Arab participants in focus group and interviews. This could well have facilitated the interaction with the Arab participants and made them more comfortable and confident during discussion, as I am insider their cultural group. Second, in the interpretation of results, I could understand and explain why some practices or issues are important for them or not. However, I am an outsider to the other cultural groups investigated in this programme of research (British and Chinese). As I came to the UK for postgraduate study (Master and PhD), and I spent a total of around seven years living in the UK, this helped me to understand about English culture. In addition, I used English with British participants which could have made them comfortable as it is their native language. However, I know little about Chinese culture, and I used English which might have been less comfortable for them.

As a Muslim, I know the view of Islam about food waste. I also know how this relates to the motivations of Muslims to not wasting food. But I lack knowledge of other religions and whether such motivations exist for participants from the other cultures or not.

As an international postgraduate student in the UK, I know the pressures and stresses of the lifestyle at this stage of life. However, I am outsider of other life stage groups (family members living with children and older people). So, I have no experience of the pressures that come from living with children, or the life experiences older people have and how they influence their feelings about food waste. However, I have some knowledge from my relative and friends who are from these two life stage groups.

As a woman, I may have more knowledge about food preparation and cooking compared to men at my life stage. This might influence my vision of the issue and the proposed solutions. In addition, men might have quite different lifestyles compared with women (e.g., Saudi men probably go out more than Saudi women). So, they may have different experience and methods for food and food waste.

However, reviewing the literature has helped me to know more about the groups for which I am an outsider. Also talking to students from the other groups has helped me understand their cultures more.

Finally, as my previous training is in computer science and not the social sciences, this might influence how I approach the literature, develop theoretical positions and analyse data.

1.5 Key contributions of the research

A detailed list of contributions of this research is given in Chapter 8 (see Section 8.1). The **contributions** of this thesis can be summarized as follows:

- ***The first contribution*** was providing a comprehensive review and analysis of existing literature on individuals' food practices, food waste and food waste reduction
  - Understanding of the issues of food waste: This includes producing a set of 35 statements around different food-related activities: food shopping, food storage and management, preparation and cooking food, and eating and socializing around food (see Chapter 2).

- o Identifying two major gaps in the previous research. First, very little previous research has systematically addressed cultural differences in food waste attitudes and practices; and second, there has been very little systematic research investigating differences in food waste practices between individuals at different Life stages (see Chapter 2).

- *The second contribution* was investigating the similarities and differences between individuals in relation to food consumption and waste, considering their Culture and Life stage

  - o Investigating the similarities and differences between postgraduate university students from one Western culture (British) and two non-Western cultures (Arab and Chinese) in relation to food consumption and waste (see Chapter 3).

  - o Investigating the similarities and differences in relation to food consumption and waste between individuals at two life stages: family members living with children (under 18) and older people; this was investigated in both a Western culture (British) and a non-Western culture (Arab) (see Chapter 4).

  - o Investigating the similarities and differences between individuals at all three life stages: students, family members living with children (under 18) and older people; and from one Western culture (British) and one non-Western culture (Arab) in relation to food consumption and waste, this involved further analysis of all the data from Studies 1 and 2 (see Chapter 4, Section 4.3.3).

- *The third contribution* was validating the food waste drivers and practices for British individuals, considering their *Life stage*

  - o The development of a statistically-based model of food waste drivers for British individuals, and using the proposed model to assess the importance of different food waste components for British individuals at different life stages (see Chapter 5).

- *The fourth contribution* was the exploration of the use of behaviour change theories in the design of a mobile app for food waste reduction

  - o Application of two behaviour change theories, the Behaviour Change Wheel (BCW) (Michie et al., 2011) and persuasive technology approaches (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2008, 2009), to inform the design of a low fidelity prototype for a mobile app to support food waste reduction, the WasteLess app (see Chapter 6).

- o Exploring the design space for the development of a mobile app to support individuals for food waste reduction (see Chapter 6).
- *The fifth contribution* was the evaluation of the low fidelity prototype of the WasteLess app
  - o Developing a statistically-based model of food waste functionality based on data collected from a large UK sample with a small Arab sample of potential users, and using the model to investigate the potential of using different app-based functionality for individuals at different life stages to support food waste reduction (see Chapter 7).
  - o Investigating the opinions of potential users at different life stages and from two different cultures about the BCW interventions and persuasive technology supports provided in the WasteLess app (see Chapter 7).
  - o Investigating usability and accuracy issues raised about the WasteLess app (see Chapter 7).

1.6 Statement of ethical approval of research

The Physical Sciences Ethics Committee (PSEC) at the University of York approved all studies conducted for this programme of research. Data confidentiality of participants was guaranteed, as well as I acknowledged that none of the recruited participants for the studies would be from any of the vulnerable groups (e.g., children under 18 or people who are severely ill).

1.7 Thesis structure

This thesis is organised into eight chapters and a number of appendices, the latter containing material used in the various studies. The remaining chapters are organised as follows:

Chapter 2 presents a review of the literature related to individual and household food waste behaviour and drivers; as well as theoretical and practical works to support food waste reduction.

Chapter 3 presents a mixed methods study to investigate attitudes and self-reported practices of food consumption and waste in postgraduate university students from

three cultures. Participants in this study were students from three cultures: Arab, British, and Chinese.

Chapter 4 presents a mixed methods study to investigate attitudes and self-reported practices of food consumption and waste in families and older people from two cultures. Participants in this study were family members who were living with children (under 18 years old) in the UK and in Saudi Arabia, and older people both in the UK and in Saudi Arabia.

Chapter 5 presents a mainly quantitative online study to investigate and validate the fundamental groupings in the food waste drivers that were identified by Study 1 (see Chapter 3) and Study 2 (see Chapter 4). Respondents of this study were British individuals recruited through the Prolific participant recruitment website.

Chapter 6 presents the design of the low fidelity prototype of the WasteLess mobile application to support food waste reduction. This includes the application of Behaviour Change Wheel (BCW) theory and persuasive technology. It also includes expert evaluation of the design using collaborative expert evaluation (CHE).

Chapter 7 presents a mixed methods online study to evaluate the design and potential of WasteLess app with a range of potential users from mainly the UK (with small sample of Arab participants), and at three life stages (students, family members and older people).

Chapter 8 presents an overall discussion and conclusions for this programme of research, including the main contributions, lessons learnt, limitations of the research, and suggestions for future research.

Chapter 2

Literature review

2.1 Introduction

This chapter presents the literature review, which was the first phase in my programme of research. The literature review covers empirical research and theoretical approaches to food practices and food waste drivers, as well as research on technological interventions to support food waste reduction.

As explained in Chapter 1 (Section 1.1), a food waste driver is defined as a cause which drives individuals to food waste. Based on the review of previous research presented in this chapter about food waste drivers, a comprehensive set of potential food waste drivers to be used in this thesis is identified. These drivers are further refined and investigated in this thesis with individuals from different cultures and at different life stages. This in turn allowed me to identify the key food waste drivers, and highlight the implications for technological interventions to support food waste reduction (see Section 3.4.1 in Chapter 3 and Section 4.4.1.1 and 4.4.2.1 in Chapter 4). In addition, it helped me to establish the requirements for developing a technological intervention to support household food waste reduction to those specific groups (see Chapter 6, Section 6.3.1).

This chapter includes the following sections. Section 2.2 focuses on food waste drivers, and covers literature reviews and theoretical studies, as well as empirical research on food waste drivers, and age and cultural influences on food waste drivers. Section 2.3 focuses on research on food waste reduction including theoretical approaches: the Behaviour Change Wheel and persuasive technologies. It also covers HCI research on technological interventions to support food waste reduction. Section 2.4 presents the conclusions and the set of food waste drivers to be investigated in this programme of research.

2.2 Research on food waste drivers

This section discusses the research on food waste drivers. It includes theoretical and literature review work (Section 2.2.1), reseach which used the Theory of Planned Behaviour (Section 2.2.2), and other empirical research (Section 2.2.3). In addition, it highlights food waste drivers in non-Western countries (Section 2.2.4), and cross-cultural comparisons of food waste drivers (Section 2.2.5), as well as age and life stage as factors in food waste drivers (Section 2.2.6).

2.2.1 Theoretical discussions and a literature review

Schneider (2008) discussed residual household waste based on review of previous research, although this was not presented as a systematic review. The discussion includes original and partly used food, food waste drivers, and factor influence food waste. "Original food" refers to unopened packaging if food sold packed, or unused food if food sold loose such as full vegetables, while "partly used food" such as half loaf of bread. Schneider discussed individuals' buying behaviour as a reason of food waste at the point of purchase. This buying behaviour can occur to individuals who go shopping for food without having idea of the food already available at home and they are offered with special prices at food retailer. Schneider also discussed a number of factors which influence food waste. For example, individuals' age, with individuals over than 50 years tending to waste less food compared to younger individuals. This explained due to the fact that for the "post war generation", saving and recycling were especially significant. In addition, retirees spend more time at home or they might be financially restricted. A further factor discussed is full-time employment. Individuals in full-time employment might have less time and/or do not want to plan and use their food supply. Monetary effects also discussed as a significant factor. For example, higher income households are able to afford to waste food more compared to lower income households.

Quested et al. (2013) discussed the insights into the behaviour associated with food waste prevention and generation based on research conducted by WRAP (Waste & Resources Action Programme) and its partners in the UK. They highlighted that food waste is not a single behaviour, and it is best to view it as a consequence of different behaviours which related to different aspects of food activities such as planning, shopping, storage, preparation and food consumption. Thus, by the time a food item

being wasted, the chance of preventing that food waste has typically passed. For example, extending shelf-life of fresh food (e.g., fruit and vegetables) by storing them in particular conditions, can help to reduce food waste if individuals buy large quantities of food. Quested et al. (2013) discussed different motivational factors for food waste reduction. While saving money was discussed as a strong motivating factor, guilt also could play an important role in motivating food waste reduction. In addition, they discussed a number of behaviours which could contribute to food waste reduction, for example:

- Advance meal planning
- Before shopping, check levels of food in fridge and cupboards
- Make shopping lists
- Store food (e.g., meat and cheese) in suitable packaging

- Store apples and carrots in the fridge
- Use freezer to extend food shelf-life
- Portion pasta and rice
- Use up leftovers
- Use food date labels

Based on a case study with British individuals over 65 conducted by WRAP in 2008, Quested et al. recommended further investigation of individuals over 65 years old. Among different population groups, there is small difference in the quantity of generated food waste (which could be due to the number of individuals in a household). However, for controlled household size, individuals over 65 generate about 25% less food waste than other segments of the population. This was motivated by moral and financial considerations. British people over 65 were more likely to hold the view that food waste is just something wrong. The researchers hypothesised that people over 65 have been influenced by different experiences including food scarcity during Second the World War, and education on food management and cooking which could be informally built up over time.

A theoretical discussion by Block et al. (2016) used a number of psychological theories in an attempt to understand reasons for consumer food waste behaviour. They discussed a number of causes which may influence consumers to waste food during

planning or undertaking shopping activities. First, the "planning fallacy" (Kahneman & Tversky, 1977) which refers to consumers' underestimating the time required to consume the food that they plan to purchase and consequently purchasing more food than would probably be eaten. Second, the "optimism bias" (Lovallo & Kahneman, 2003) which refers to consumers thinking that negative events are less likely to occur to them than to others (e.g., if a consumer has a planned event this event will not be cancelled). Third, consumers find that appealing food items influence them during shopping by increasing their desire for the food without carefully thinking about when and how they will eat them. Fourth, "naive diversification bias" which refers to consumers purchasing multiple versions of a food item and only eating their favourite one. Fifth, consumers usually think that food in bulk packaging is better value for money, so buy larger amounts but then do not eat it all. these authors discussed psychological causes related to food preparation and eating. First, consumers may make the decision on what to prepare or eat based on what comes to mind easily. To illustrate, generally consumers remember the food items they purchased most recently and forget the food they purchased earlier, which leads them to waste the food purchased earlier. In this case, a potential intervention to remind consumers of earlier food purchases or increase visibility of those purchases could be helpful. Second, consumers depend on date labelling for food safety and may not eat food after the "use by" or "best by" date, without establishing for themselves whether the food is still safe to eat. Third, consumers' feelings in relation to food such as feel disgusted when eating food past its expiry date.

Hebrok and Boks (2017) conducted an extensive literature review of research on food waste drivers covering 112 peer-reviewed papers and reports from several projects which were published between 2000 and 2015. They do not state that this is a systematic literature review, nor do they refer to any of the methodologies for conducting these reviews (Grant & Booth, 2009). However, from this corpus of material, they analysed 23 inter-related food waste drivers. The food waste drivers identified are: cultural and social norms; packaging; everyday routines and practices; awareness; leftovers; age; values; edible/inedible; lifestyle; material properties; planning; preferences; attitudes; abundance; infrastructure; value; knowledge; storage; ideals; food risk; portioning; convenience; and household constellation. The

authors do not explain how they extracted this set of drivers from the literature, and clearly they are a very heterogeneous set of concepts. The authors emphasized that food waste can occur during different food-related activities such as shopping routines, storing, cooking, and eating. Further, the authors did not provide a clear definition for each driver, instead they discussed how these drivers could affect each other and hence affect food waste. For example, abundance of food available at low cost as well as age affect how food is valued. In addition, the drivers discussed in the paper are at different levels of abstraction. For example, storage is a very abstract driver compared to leftovers, in terms of leading to food waste.

Table 2.1 Summary of the literature reviews and theoretical discussions

Reference	Main food waste drivers	Research method
Schneider (2008)	Shop without having idea of available food at home. Shoppers offered with special prices at food retailer.	Theoretical discussion based on previous research
Quested et al. (2013)	Food waste related to food activities such as planning, shopping, storage, preparation and food consumption.	Theoretical discussion based on previous research
Block et al. (2016)	Over purchasing (planning fallacy) Events will not be cancelled (optimism bias) Appealing food products Eating only favourite food (naive diversification bias) Value pricing and bulk packaging Eating most recent food purchases, forgetting earlier purchases Prepare food that comes to mind easily Over dependence on food labelling Emotional reaction to food	Theoretical discussion based on psychological theories (so no evidence provided for these drivers)
Hebrok and Boks (2017)	cultural and social norms; packaging; everyday routines and practices; awareness; leftovers; age; values; edible/inedible; lifestyle; material properties; planning; preferences; attitudes; abundance; infrastructure; value; knowledge; storage; ideals; food risk; portioning; convenience; and household constellation	Literature review

2.2.2 Research on food waste drivers using the Theory of Planned Behaviour (TPB)

A body of empirical research has investigated drivers of household food waste, using the Theory of Planned Behaviour (TPB) (Ajzen, 1991) has been applied to individuals' attitudes and behaviours around food waste. Although the TPB was not used in this

programme of research, a brief explanation of the theory is provided due to the number of papers which used this theory in understanding food waste drivers. Figure 2.1 shows the variables proposed by TPB: "attitudes toward the behavior" in this domain of research refers to individuals' attitudes towards food waste; "subjective norms" refers to social pressures on individuals to engage in food waste reduction; and "perceived behaviour control" refers to individuals' perceptions of their ability to reduce food waste. According to TPB, these three variables have direct effects on "intention", and individual's willingness to reduce food waste, and this can lead to actual food waste "behavior", actions taken by individuals to reduce their food waste. However, due to the limitations of TPB in conceptualizing the influences leading to inidividual food waste behaviour, a number of researchers have extended the theory with additional variables and investigated them.
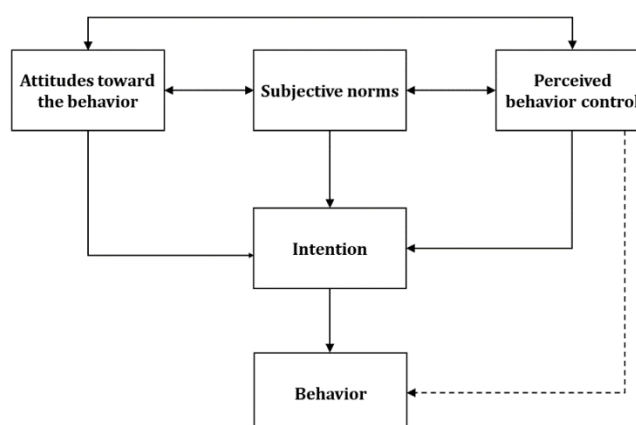
Figure 2.1 The Theory of Planned Behaviour (based on information from Ajzen, 1991)

For example, Visschers et al. (2015) conducted a mail-based survey of 796 Swiss people to investigate food waste drivers. The sample details of this study was limitted to providing a mean age of participants (57 years), and 78% of them were living without children (see Table 2.3 for more demographic details; this table provides summaries of all the empirical studies conducted in Western countries). The results on the amount of self-reported food waste highlighted that the foods most wasted were fruits, vegetables and bakery products; whereas the least wasted foods were ready-to-eat products. Participants who reported positive attitudes and norms in relation to food waste and less perceived risks when consuming leftovers reported higher intentions to reduce food waste, and reported wasting less food. However, the findings

also revealed a number of potential conflicts in relation to food waste. For example, people might not wish to waste food, but they might not want to put their health at risk by eating leftovers or food after its use-by date.

Stancu et al. (2016) conducted a web-based survey of 1062 people in Denmark to investigate key drivers of avoidable household food waste. The study involved participants aged from 18 to 74 years old, including a mix of students, employees and retired people; some of the participants were living with children under 16 years old (see Table 2.3 for demographic details). The researhers extended the TPB with some variables to examine their effect on self-reported food waste. They found that the main food waste drivers were perceived behavioural control and consumers' routines related to shopping and using of leftovers. Planning routines had also indirect effect on self-reported food waste. However, perceived behavioural control and moral norms did not have effects on consumer self-reports of their intention to avoid food waste, whereas attitudes and injunctive norms did.

Russell et al. (2017) conducted a survey of 172 British people to investigate food waste behaviour. The information provided about the sample was very limited, only a median range of age was 50 to 59 years old, and 59% of them were female. The researchers extended the TPB with "consumer emotions" and "habits". Participants' self-reports of their habits and past food waste behaviour had a strong positive relationship with their self-reports of food waste behaviour. In addition, participants' negative emotions in relation to food waste were associated with their strong intention to reduce food waste, but surprisingly intention was also associated with self-reports of high amount of food waste.

All the studies in this section used TPB as the main theoretical approach. However, these studies have not incorporated a number of variables that have been already demonstrated to affect food waste behaviour in other research. For example, visibility missing of food stock discussed by Ganglbauer et al. (2015). Further, the studies used surveys which only provide self-reports of behaviour. A socially sensitive issue such food waste can be subject to social desirability biases. These can occur because food waste behaviour is strongly related to moral aspects (Visschers et al., 2015), thus participants might under report undesirable behaviours or the amount of food waste,

because of "feelings of shame" (Giordano et al., 2018). Further, self-reported surveys rely on individuals' perceptions and awareness about their behaviour, and food waste may seem somewhat unimportant compared to other activities in people everyday life as it happens without very much attention (Kormos & Gifford, 2014). Researchers who conducted the studies discussed in this section have highlighted such issues, and some of them applied techniques to minimise the effect of social desirability bias. Stancu et al. (2016) modified some measures of TPB to be more appropriate for food waste issues; for example, they asked about intention not to waste instead of intention to waste in order for questions to be more natural to answer. Similarly, Visschers et al. (2016) assured the anonymity and confidentiality of the responses to minimise the stress of reporting the amount of food waste. Also, they asked about the amount of food waste in the beginning of the questionnaire before asking participants about their intention towards food waste reduction and attitudes around food waste. Further, they used different formats of assessment, frequency scale to assess food waste, and 7-point Likert scales to measure the intention, attitudes and norms. Russell et al. (2017) relied on participants' memory to report their food waste behaviour over the previous week which may not have been very accurate.

2.2.3 Empirical research on food waste drivers beyond the Theory of Planned Behaviour

A number of other researchers have investigated food waste drivers, but not used TPB to interpret their results. Some have used surveys, others have used focus groups, interviews and diary studies.

Van Boxstael et al. (2014) conducted an online survey of 907 Belgian consumers to explore their attitudes to and understanding of shelf-life labels. Their sample included young adults (aged between 18- and 30-year-old), middle-aged adults (aged between 31 and 65 years), and older adults (aged 65 and above). In addition, a comparison was made according to age and gender. The older adults were more familiar with both "best before" and "use by" shelf-life labels than the young adults. In relation to gender, no significant differences were observed. On checking food for its edibility, most respondents reported using a combination of checking food visually and smelling it. For particular food groups, checking both visually and smelling was used by young and

middle-aged adults more than older adults. Similarly, checking food edibility by tasting was used by young and middle-aged adults more than older adults. However, checking food edibility using shelf-life labelling was used by older adults more than young and middle-aged adults. In relation to gender, significant difference was observed, particularly in checking shelf-life date, which was more common for women than for men.

Mallinson et al. (2016) focused specifically on the convenience food issue, surveying 928 18 – 40 year old British people about their attitudes to food waste and convenience foods. They used cluster analysis to divide their participants into five profiles: "epicures", "traditional consumers", "casual consumers", "food detached consumers" and "kitchen evaders". Epicures reported the lowest use of ready meals, were dismissive of the time-saving aspect of convenience foods, and the highest level of family involvement. Epicures also reported the least likelihhod of owning convenience-related kitchen equipment like microwaves, but the highest likelihood of owning coffee machines or food processors. Epicures reported the least waste among the groups as well as reported high concerns about discarded food. Traditional consumers reported having some pressure of time, they appreciated saving time. Traditional consumers repoerted being enthusiastic to try new foods and were price conscious. They also reported a low likelihood of usig ready meals, and reported higer levels of waste comparing to epicures. However they reported high levels of concerns about discarded food. Casual consumers reported being positive about convenience food, as well as owning microwaves and only moderately pressed for time. They reported the highest waste among the groups and moderate concerns about discarded food. Food detached consumers reported negative about convenience foods. They reported some level of waste moderate concerns about discarded food. Kitchen evaders reported being the most reliant on convenience foods. They reported highl levels of waste moderate concerns about discarded food.

Bravi et al. (2019) conducted a survey of 904 young Italian consumers to explore their main food waste drivers. About three-quarters of the participants were students, others were employed or unemployed. Ready meals, sauces, and beverages were the most wasted foods. A principal components analysis of a set of 5-point Likert items revealed three main components of food waste drivers: (1) unfinished food items, (2)

food not opened, which might be associated to the excessive food purchases or to the frenetic pace of life which leads eating outside the home and not consuming food before it expires; and (3) discarded food. A confirmatory factor analysis on the data revealed two components of food waste drivers: (1) lack of time to cook food and (2) immoderate use of food, which meant excessive purchasing and consumption of food compared to what participants actually needed. However, this study found that supermarket offers did not influence food waste.

Przezbórska-Skobiej and Wiza (2021) conducted a survey of 266 students and university employees in Poland to investigate food waste issues. Students were less likely than employees to use a shopping list and have a more emotional approach such as cravings to purchasing food, particularly making impulse purchases based on cravings or feeling hungry during shopping. The reasons for food waste for both students and employees were preparing large meal portions and food spoilage due to long storage. Overlooking the expiry date for food items was also a reason for students, and purchasing large amounts of food was a reason for employees. In addition, environmental consequences of food waste were of the greatest importance for respondents.

Stancu and Lähteenmäki (2022) conducted a survey of 508 Danish consumers to investigate the role of individuals tendency to marketing stimuli as well as disgust sensitivity, and self-identities in excessive buying and discarding food past the best before date. They used confirmatory factor analysis to create a model with included of food waste behaviour, motivation to reduce food waste, ability to reduce food waste, excessive buying, pro-environmental self-identity, frugal self-identity, good homemaker self-identity, hedonic eater self-identity, impulsive buying tendency, mindful buying tendency, and disgust sensitivity. Additional variable was added to the model "discard food past best before". The results illustrated that excessive buying driven by impulsive buying tendency and lack of mindfulness associated to shopping. However, discarding foods past the "best before" date driven by disgust sensitivity (where individuals discard food without checking its edibility).

Other researchers have used different methods including focus groups, interviews and diary studies to study food waste drivers.

Koivupuro et al. (2012) conducted a diary study with 380 Finnish households to study the impact of socio-demographical, attitudinal and behavioural factors on food waste. Factors which influenced the quantity of food waste were household size (larger households wasted more food), gender of the person responsible for food shopping (households in which a woman was the primary person responsible wasted more than those in which a man was responsible), frequency of buying discounted food products (surprisingly, food waste was greater in households in which discounted food products were not often bought). In addition, participants who expected to be able to reduce food waste significantly actually produced significantly more food waste. Factors which had no clear influence on food waste were age of the oldest person in household; area, form and type of residence; educational level and type of work of the adults in the family; and shopping, food preparation and eating habits.

Clear et al. (2016) investigated food practices of two different groups selected according to their methods of food acquisition in order to understand the role of digital interactions to support sustainable food consumption. The authors conducted focus groups with 27 sustainable "food pioneers" (aged from 20s to 70s), and telephone interviews with 24 "mainstream consumers" recruited in branches of a UK supermarket (aged from 30s to 70s). "Food pioneers" refers to individuals who shop for food sustainably e.g., find alternative ways to source their food, prepare it and eat. "Mainstream consumers" refers to individuals with regular patterns of food consumption in the UK. The findings showed different values and meanings associated to food and meals in individuals' lives, which therefore may need technological support to help with food choices and pro-sustainable practices. For mainstream consumers, "proper meals" were associated with tradition and what families "always done"; however other food like soup was not viewed as a "proper meal". Clear et al. (2016) discussed the possible cultural significance in considering proper meals, such as the Sunday roast, for British society. In relation to food procurement, mainstream consumer participants do a big shop in supermarkets that covers a week's shopping demands, while food pioneer participants shopped at places other than supermarkets. For food pioneers, sustainability of food practices is reflected in where they shopped. Clear et al. recommended HCI to support sustainable life transitions including practices, celebrations, properness and sharing experiences.

Ganglbauer et al. (2013) interviewed 17 individuals in Austria and the UK about their food waste attitudes and behaviours and asked them to give a "home tour" to show how they stored and prepared food. Although they collected data from different countries, they did not make any cross-cultural comparisons. Participants were aged from 24 to 71 (see Table 2.3). Food waste drivers included forgetting what one has in the fridge or pantry and overbuying. The researchers then developed two interesting interventions to study food waste behaviour in more detail: a FridgeCam (Ganglbauer et al., 2013) which allowed users to view the interior of their fridge remotely (see Section 2.3.2 for for more detail about this intervention), and a food waste diary app (Ganglbauer et al., 2015) which allowed users to record and reflect on food waste moments.

Aschemann-Witzel et al. (2015) conducted semi-structured interviews (some face-to-face, some online) with 11 experts in Denmark, Sweden, Italy, Netherlands, and the UK about causes of household food waste. Although data were collected from experts in different countries, no cross-cultural comparisons was made apart from some examples of specific countries. According to these experts, the main food waste drivers were lack of planning and management of purchases, storage, preparation and reuse of food and meals. In addition, they mentioned people's misinterpretation and confusion of date labelling, when they do not understand the meaning of different date labelling such as "use by" and "best before", and then they do not follow the advice of the labels appropriately. This could lead individuals to throw out a food item instead of consuming it to avoid having any health risk. This issue increased with lack of knowledge about actual and assumed food safety risks.

Nikolaus et al. (2018) conducted focus groups with 58 university students in the USA about their perceptions, beliefs and behaviours about food waste. They elicited 11 food waste drivers which influenced behaviour including personal values, management of food, reuse value of food, and prioritization of convenience. These are summarized in Table 2.2.

Table 2.2 The 11 food waste drivers discussed by Nikolaus et al. (2018)

Driver	Description
Personal values	When individuals want to reduce their food waste because of personal beliefs such as feeling guilty about wasting food or feeling that it is unacceptable behaviour as other people may be in need.
Management of food	Planning such as guidance to consume food purchased first like "first in, first out" was popular among participants who live off-campus.
Reuse value of food	Food reusing practices such as transforming leftover food into new meals which were popular practice among students who live off-campus, as they mentioned it was practice of their parents.
Prioritization of convenience	When food waste could be produced because saving food is inconvenient like issue with carry leftovers or store it. In addition, students eating preferences may lead to wasting food, such as "culture of fresh" when food items that kept at home for long time can be wasted even if they are still safe to be eaten.
Sensory/value of food	That favourite food such as restaurant dishes were less likely to be wasted, however, food such as side dishes, or junk food were considered less valuable and thus more likely to get wasted.
Portion sizes	Have smaller porting meals to mitigate food waste. This also includes purchasing fewer food items and go shopping frequently instead of purchasing bulk options.
(Dis)connection with cost	The connection between wasting food and wasting money.
Social influence	Minimising food waste is part of the culture, such as when parents teaching their children not to waste and to eat their plate. Also, students reported that their friend behaviour in relation to food waste motivated them to waste less.
(Dis)connect with preparer	The connection with food preparer, as students reported that they feel it was impolite to waste food if they had a personal relationship with the food preparer.
Sharing	Sharing food with people such as family or friend to minimise food waste.
Concerns about food safety and expiration dates	Food waste that produced due to people concerns of being ill such as using expired dairy products.

Clark and Manning (2018) conducted semi-structured interviews with 50 university students in the UK to investigate the food waste drivers which influence their awareness and behaviour. Some relevant food waste drivers were related to buying habits such as do not making shopping lists and being influencing by offers. In addition, students reported cooking too much of food, not using food in time, purchasing too much of food, and a lack of freezer space all had an impact on their food waste. Students also reported that they wanted to eat what they prefer and not what they should eat such as leftovers. Some students reported misunderstanding labels such as "use by" or "best before". Also, vegetables being the most thrown away food, fruit the second most thrown item, and milk the third most thrown item.

Ghinea and Ghiuta (2019) used questionnaires and face-to-face interviews with 100 Romanian university students to investigate their food waste behaviour. Most students bought their food at supermarkets. Students reported that they were sometimes attracted by special offers in shops and that they always checked the expiry date of eggs, meat, milk and dairy products. Also, they reported throwing away these products if they exceeded their shelf life even if there was no sign of deterioration or if the products looked bad.

McAdams et al. (2019) conducted interviews with 16 retired Canadian residents to understand their past experiences and behaviour in relation to food waste. Women participants considered themselves as "homemakers", who were responsible for the household, including reducing food waste. Also, it was common in their childhood to have had "table rules", for example eating everything on their plate and eating together as a family. Participants also reported that they had grown up when cooking and ingredients were simpler and that the Great Depression of the 1930s and World War II had influenced their attitudes to food throughout their lives. Their feelings about not wasting food were established in their childhoods.

Herzberg et al. (2020) conducted a diary study with 6853 households in Germany to assess household food waste, reasons for food waste and potential influences of socio-demographic factors on food waste. Fresh fruit and vegetables, and bread were the main wasted foods. In addition, reasons for food waste were particular quantity problems when shopping for small households (e.g., package sizes too big), but other quantity problems for larger households and households with children (e.g., cooking or preparing too much food).

Table 2.3 provides summaries of the empirical research papers on food waste reviewed in Sections 2.2.2 and 2.2.3 which have highlighted many food waste drivers. However, some research did not provide sufficient demographic information about participants in their studies (e.g., Ganglbauer et al., 2015). While the majority of the research did not consider life stage (Visschers et al., 2016), some studies focused on particular life stage such as young adults (e.g., Bravi et al., 2019). Further discussion about considering life stage in relation to food waste can be found in Section 2.2.6.

Furthermore, these studies were conducted in Western countries such as the USA and European countries including the UK. These countries have somewhat similar cultures with respect to food (see Chapter 1, Section 1.1), which will probably result in having similar household food waste drivers. For example, the UK and other AngloSaxon countries (e.g., Canada, Australia) as well as many European share a food culture that until recently has regarding fruit and vegetable that looks less than perfect as "bad". So, fruit which is bruised is wasted, when it is probably fine to eat and vegetables are similarly wasted, when they will be fine cooked. This attitude is now changing with greater awareness of food waste, with initiatives in the UK and Europe (but apparently not yet in the USA) to use "ugly" or "less than perfect" fruit and vegetables. In addition, the UK and the USA share a food culture which relies a lot on convenience and processed foods, rather than cooking from scratch. However, other countries, such as Asian or Arab countries, have very different cultures, which therefore may result in having very different food waste drivers. Thus, next section will discuss food waste drivers in cultures beyond Western ones.

Table 2.3 Summary of empirical research on food waste drivers in Western countries

Country	Participants					Research method	Variables about food waste issue highlighted in the study	Reference
	Life stage	N	Age	Gender	Living w/children			
Switzerland	No specific life stage	796	Mean: 57	59% F, 38% M, 3% Unknown	No children: 78% w/children: 22%	Survey	Consumer attitude and norms, large household, consumer age, good provider identity, consumer concerns about risk of eating leftovers	Visschers et al. (2016)
Denmark	No specific life stage	1062	18-74	53% F, 47% M	(Some) living with children under 16	Survey	PBC, consumer routine related to shopping and re-using of leftovers	Stancu et al. (2016)
United Kingdom	No specific life stage	172	Median range: 50-59	59% F	No info	Survey	Subjective norms, PBC, consumer habit, consumer emotion	Russell et al. (2017)
Belgium	Different life stages	907	18-30 31-65 65+	59.4% F, 40.6% M	No info	Survey	Understanding shelf-life labels.	Van Boxstael et al. (2014)
Italy	Young people	904	18- 35	No info	No info	Survey	Unfinished Products, Not Opened Food, Discarded Food, Lack of Time to Cook Food, Immoderate Use of Food	Bravi et al. (2019)
Poland	University students (S), employees (E)	S (187) E (79)	S (19-26) E (19-55+)	S(72.7% F, 27.3% M) E(69.6%F, 30.4% M)	No children: S (97.4%), E (38%) W/children: S(2.6%), E(62%)	Survey	University students: preparing very large meal portions and food spoilage due to very long storage, overlooking of the expiry date. Employees: preparing very large meal portions and food spoilage due to very long storage, purchasing large amounts of food	Przezbórska-Skobiej and Wiza (2021)
Denmark	No specific life stage	508	18 to 86 Mean: 49	49% F 51% M	W/children: 22%	Survey	Impulsive buying, disgust sensitivity, individuals' frugal, environmental and hedonic self-identities	Stancu and Lähteenmäki (2022)

Finland	No specific life stage	380 households (1054 people)	Mainly <65	No info	Living w/ children: 48%	Dairy study	Frequency of buying discounted food products.		Koivupuro et al. (2012)
UK	No specific life stage	51	20-70	No info	No info	focus groups and interview	Food value, tradition of proper food		Clear et al. (2016)
Austria, UK*	No specific life stage No cultural comparison	17	24 -71	58.8% F, 41.1% M	No children: 64.2% w/children: 35.7%	Semi-structured interviews and in-home tours	Lack of shopping list, household available storage space, and geographical accessibility		Ganglbauer et al. (2013)
USA, Germany, Britain, Austria*	No specific life stage No cultural comparison	845 (entries)	No info	No info	No info	Online food waste diary app	Over-buying, visibility missing of food stock, changing of cooking plan, food is overcooked or out of date, migraine trigger, busy lifestyle, did not feel like eating, household member did not like it		Ganglbauer et al. (2015)
USA	University students	58	18-24	63.7% F, 36.2% M	No info	Focus groups	Reuse value, management of food, personal values, and prioritization of convenience and newness.		Nikolaus et al. (2018)
UK	University students	50	No info	58% F, 42% M	No info	Semi-structured interviews	Not make shopping lists, influencing by offers, cooking too much of food, not using food in time, purchasing too much of food, lack of freezer space, eat what they prefer not what they should eat, misunderstanding of date labels		Clark and Manning (2018)
Romania	University students	100	18-34	68% F, 32% M	No info	Face-to-face interviews	Expiration date, the products kept in the fridge for too long, products look bad, improper storage, have remained only scraps, not like a specific ingredient or product.		Ghinea and Ghiuta (2019)
Canada	Retired	16	72 - 98	62.5% F, 37.5% M	No info	Interview	It is about how past experience influence them to save food		McAdams et al. (2019)
Germany	No specific life stage	6853 households	<40 and 60+	No info	No info	Diary study	Package sizes too big, cooking or preparing too much food		Herzberg et al. (2020)

Notes: * No cross-cultural comparisons were made in the study.

2.2.4 Research on food waste drivers in non-Western countries

Mattar et al. (2018) noted that cultural differences influence individuals' behaviour around household food consumption and food waste. Thus, considering household food waste drivers from different cultures could be important, because drivers to food waste might be vary between cultures.

To illustrate, Arab countries have their own specific cultures which is distinct from those of Western countries. Baig, Gorski, et al. (2018) conducted a literature review identifying the main contributors of food waste in Saudi Arabia. The search yielded 19 peer reviewed articles and 9 gray literature items. Due to the limited number of resources, the authors searched in other sources such as Arabic language non-academic sources such as newspapers and magazines, which yielded a further 21 items. The main source of material was the Saudi Arabia results from a 2017 multi-country survey on wasted food, which was commissioned by the Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation (COMCEC). This survey involved 111 households and 94 food services in Riyadh (the capital of Saudi Arabia). The survey found that almost 60% of Saudi participants said that they were concerned about food waste. However, participants showed low levels of knowledge and understanding of the relationship between food waste and its environment effects. Over 70% of food service employees reported that they thought food waste is not an issue, rather it is natural and food is biodegradable. Another important finding was that participants stated that they were willing to reduce food waste if they knew more about the issue and also they were willing to learn about methods and tips to help them reduce food waste.

The authors reported that the most wasted food items were fruit and vegetables, followed by bread and cereals, then meat, legumes and eggs. An interesting point to highlight about the culture in Saudi Arabia is that the responsibility for food related activity is separated between men and women. Baig, Gorski, et al. (2018) noted that generally food shopping is the responsibility of men whereas food preparation and cooking is the responsibility of women. Baig, Gorski, et al. (2018) recommended communication between partners to align food buying with planned meals. Therefore, I think interventions for cultures where food practices are split in this way could

consider the division of different responsibilities between men and women and provide strategies for men to reduce food waste in relation to food shopping and strategies for women to help them mitigate food waste that are related to cooking and food management. This is especially because Arab people usually get married at quite an early adult age. Jarrah (2020) also reported the results from Saudi General authority for statistics, the average age of Saudi women who get married for the first time was about 20.5 years old, whereas Saudi men prefer to get married at the age about 25 years old.

In addition, Aljamal and Bagnied (2021) stated that Saudi government has provided mechanisms to cope with rises in food prices, which include price caps and subsidies to help people purchasing food with relatively low prices. But such policies that help preserve affordable prices may therefore contribute to high levels of waste. This could be because these policies or mechanisms can encourage people to buy and prepare more food than they need to consume (UN FAO, 2014). Therefore, such issues in Saudi Arabia can be addressed to same extent with Islamic teaching. For example, by encouraging consumers to think about other people who have nothing to eat during Ramadan. Yoreh and Scharper (2020) discussed extravagance in Islam, providing evidence: "God does not like wasteful people" (The Qur'an 6:141). In addition, prophet Muhammad, peace be upon him, emphasized that "the prohibition of extravagance applies in small matters as well as large, and in times of abundance as well as scarcity" (2003, p.199, cited in Yoreh & Scharper, 2020).

Generally, Saudis are very generous in hospitality and when they have special occasions such as Eid or a wedding, they prepare too much food as a gesture of welcome. Baig, Al-Zahrani, et al. (2018) noted that people who save food are seen as unwelcoming and misers in Arab culture. In addition, Khan and Kaneesamkandi (2013) discussed how food waste increases significantly during special periods in Saudi Arabia, and it has been reported that Saudi Arabia generates approximately 600 tons of food waste every day during Ramadan and Hajj. Mohammed I (2014) also reported that during Ramadan people in Saudi Arabia waste almost one-third of four million dishes prepared every day, valued at the equivalent more than GBP 250,000.

Saudi consumers' food shopping behaviours also can contribute to their food waste. Baig, Al-Zahrani, et al. (2018) reported that Saudi consumers usually purchase food in

large packages. They also reported the results of a survey conducted by YouGov[1] that found that almost 80% of Saudi participants throw away food every week in order to make room for new purchases.

Aktas et al. (2018) conducted a survey of 305 people living in Qatar (aged 18 to 74 years), although they came from many countries, to understand consumer food waste behaviour, using an extended TPB with some variables specific for Arab cultures (see Table 2.4 for further details of the sample). The researchers extended TPB in relation to food waste with six variables:

- Food choice motives: consumers eating preferences, e.g., if a consumer likes to eat fresh food, this will have an effect on the buying behaviour;
- Financial attitudes: consumers who are more price conscious;
- Planning routines: plans for shopping such as making a shopping list;
- Food surplus: buying more food than what consumers actually need;
- Social relationships: the effect of social activities on food consumption such as welcoming guests at home;
- Ramadan which is a month when Muslim consumers change their eating behaviour.

The findings showed that consumers' self-reports of their positive attitudes regarding food waste correlated positively with their self-report of their intention to reduce food waste. In addition, there was a positive relationship between consumers' self-report of their subjective norms (i.e., the perception of social pressures about that individual should or should not behave in a particular way regaring food waste) and their self-report of their intention to reduce food waste. Furthermore, consumers' self-report of their perceived behavioural control and their intention were negatively correlated (i.e. if a consumer found it difficult to control food waste, their intention to reduce food waste was low). Moreover, consumers' self-reports of their intention to reduce food waste had a negative relationship with their self-reports of their food waste behaviour. In addition, consumers' self-reports of their perceived behaviour control had a postive relationship with their self-reports of their food waste behaviour. Furthermore, consumers' self-reports of their food choice motives and financial attitudes had

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[1] YouGov is an internet-based market research firm

positive relationships with their self-reports of their planning routines. At the same time, consumers' self-reports of their planning routines had a negative relationship with their self-reports of their food surplus. However, consumers' self-reports of their social relationships had a positive relationship with their self-reports of their food surplus. Finally, consumers' self-reports of their eating routines during Ramadan had a positive relationship with their self-reports of their food waste behaviour.

Yagoub et al. (2022) conducted a survey of 201 university students in the United Arab Emirates (UAE) to understand their perceptions about food waste. Students reported overbuying as the most common reason for food waste, their attitudes ("attitudes" is not elaborated in the paper), poor food management, and issues with expiry dates. Furthermore, the students reported that expecting guests was the most common reason for having extra food cooked. The researchers noted cultural issues associated with food waste, as it is considered a sign of generosity to host people (e.g., family and friends) at any time without prior notification. According to the researchers, this is especially on Friday, and many students reported they have the highest level of food waste on that day.

Moving to a different Muslim country, Bhatti et al. (2019) conducted a web-based questionnaire of 227 young Pakistani consumers during Ramadan and Eid to investigate factors that affect food waste. The study extended the TPB by including the variables "environmental concern" and "time pressure". Positive individual attitudes toward food waste were associated with a higher level of intention to reduce food waste. In addition, injunctive norms for waste food were positively associated with intention to reduce food waste. The study also found that intentions to reduce food waste were negatively associated with self-reported food waste behaviour, while time pressure and environmental concern were positively related with attitudes toward food waste.

East Asian countries such as the People's Republic of China and Taiwan also have their own cultures which could affect their practices around food consumption and food waste. For instance, Teng et al. (2021) mentioned that a culture of "gift-giving" is popular in countries such as China and Taiwan, where people can use this practice as a tool to emotionally connect with others. However, the gift-givers often give more food than the receivers need, which may cause food waste.

Teng et al. (2021) conducted semi-structured interviews with 27 Taiwanese residents to investigate barriers to reducing household food waste. The participants were between 30 and 50 years old, and were family members living with one or two children (see Table 2.4). A content analysis found four key barriers to reducing food waste:

- Lack of knowledge of assessing edibility: participants said they assess food edibility by seeing the food's external properties and using their knowledge, especially as traditional shops in Taiwan do not have shelf-life labels for the food products, and these shops considered the main points of purchasing food;

- Unexpected food from someone: which can come from the "gift giving" tradition in Taiwan, mentioned above;

- Unexpected dining schedules: such as having take away or going out for dinner with family or friends;

- Lack of environmental awareness: many participants thought that their kitchen waste can be re-used in feeding animals, not knowing that the subsequent treatment of that waste poses a significant threat to human health and the environment.

Tsai et al. (2020) conducted a survey of 368 Chinese students from 48 universities to understand the factors of food waste behaviour among young Chinese adults. The details of the sample include the age range, which was between 18 and 25 years old (see Table 2.4). The researchers used TPB, combined with environmental concerns to predict the food waste behaviour of emerging adults. "Environmental concerns" refer to an individual's views of environmental issues, and the degree of concern in relation to environmental problems. Participants' self-reports of their attitudes correlated positively with their self-report of their behavioural intention towards food waste. In addition, there was a significant positive correlation between participants' self-report of their perceived behaviour control (i.e., the difficulty of completing a specific behaviour) and their self-reports of their behavioural intention to reduce food waste. Furthermore, participants' self-report of their environmental concerns and self-reports of their attitudes toward food waste behaviour. Moreover, participants' self-reports of their environmental concerns have a positive correlation with their self-reports of their subjective norms (i.e., a person's psychological tendency which might be influenced by social pressure).

Table 2.4 Summary of empirical research on food waste drivers in non-western countries

| Country | Participants | | | Research method | Variables about food waste issue highlighted in the study | Reference |
	Life stage	No.	Age/Gender/Living w/children			
Qatar	No specific life stage	277	Age: 18-74 Gender: 56% F, 22% M, 22% Unknown Living w/children: No info	Survey	Consumer food choice motives, consumer financial attitudes, consumer planning routines, food surplus, social relationships and Ramadan	Aktas et al. (2018)
United Arab Emirates	University students	201	Age: No info Gender: 71.6% F Living w/children: No info	Survey	overbuying attitudes, poor management, and expiry date.	Yagoub et al. (2022)
Pakistan	Young people	227	Age: (Median) 23 Gender: 44.9% F, 55.1% M w/children: No info	Web-based questionn aire	TPB, environmental concern, Time pressure	Bhatti et al. (2019)
Taiwan	Family members living with children	27	Age: 30–50 Gender: 92.5% F, 7.4% M	Semi-structed interview	lack of knowledge of assessing edibility, unexpected food from someone, unexpected dining schedule, and lack of environmental awareness	Teng et al. (2021)
China	Students	368	Age: 18-25 Gender: 51.36% F, 48.64% M		TPB variables, environmental concerns	Tsai et al. (2020)

The previous sections have considered research in Western countries (Sections 2.2.1 to 2.2.3) and non-Western countries (Section 2.2.4), the following section will consider research which has compared food waste drivers between different countries.

2.2.5 Cross-cultural comparisons of food waste drivers

Another way of investigating the effect of culture on food waste drivers is to explicitly study differences between cultures. A small number of studies has made such investigations, but none have compared Western and non-Western countries. However, individuals from Western cultures such as United Kingdom, and non-Western cultures like Arab or Chinese might have very different attitudes and practices in relation to food and food waste. For example, the large Sunday roast of meat, potatoes, vegetables,

gravy and often Yorkshire pudding is an important food tradition still widely practiced in British society (Clear et al., 2016, Section 2.2.3); the "gift-giving" tradition in China and Taiwan where people receive unexpected amounts of food from others that might be more than their needs (Teng et al., 2021, Section 2.2.4); and the Arab view about people who save food and not providing too much food in occasions like Eid as unwelcoming and misers (Baig, Al-Zahrani, et al., 2018) as well as the large amounts of food waste generated during special seasons in Saudi Arabia, such as Ramadan and Hajj (Khan & Kaneesamkandi, 2013) (Section 2.2.4).

Mondejar-Jimenez et al. (2016) conducted a survey of 380 Italian and Spanish university students to investigate their difficulties with food waste and differences between the two countries, using TPB (see Table 2.5 for further details of the sample). The results highlighted the relationships between the components of TPB, and additional variables such as concern about food waste and marketing/sale strategies in shops such as promotional deals on food products. In addition, the study highlighted differences between Italian and Spanish students in terms of their consumption and waste behaviour which were due to their different food eating cultures and habits. For example, although perishable foods such as bread, fruits and vegetables were reported to be the main wasted food types for both groups, Italian students said they wasted pasta, Spanish students said they wasted convenience food.

Grasso et al. (2019) conducted a survey of 1518 Danish and 1511 Spanish consumers to examine socio-demographic predicators of food waste behaviours such as age, gender, household size, education, marital and employment status (see Table 2.5). They modelled food waste behaviour using confirmatory factor analysis, with the final model resulting in three latent variables:

- Shopping routine: buying too much of food when shopping, and buying unintended food products, buying larger packages of food than their need, and buying higher amount of food if they offer good value for money;
- Self-reported food waste: how much food thrown away of food, milk and diary products, fresh fruits and vegetables, meat and fish, as well as bread and other bakery products;

- Food waste behaviour covers both latent variables shopping routines and self-reported food waste, as well as the issues about food preparation (cooking or preparing too much of food for a meal).

They found that being unemployed, working part-time, and older were associated with less food waste behaviour in both Denmark and Spain. However, for Danish participants, being male was associated with more food waste behaviour as well as living in a household with four or more people.

Bravi et al. (2020) conducted online questionnaires with 3323 younger consumers from the UK (58.4% of the participants), Italy (26.4%), and Spain (15.1%) to investigate the factors which affect food waste. 37% of the participants were students, while the others were workers or unemployed (see Table 2.5). The results highlighted that a too-frenetic rhythm of life was the main food waste driver in all three countries. However, the habit of leaving leftovers uneaten appeared specifically in the UK, whereas too-large portions appeared more in Spain. Further, purchasing too much food was more relevant in the UK. In addition, Italian and Spanish participants often planned their shopping by making shopping lists, though this practice appears less common among British individuals. In relation to reusing food, the study found young people from the three cultures were likely to reuse uneaten food. However, for organising food, Spanish individuals were more involved in organizing the food to use the items are about to expire.

Heng and House (2022) conducted a survey of 4361 individuals from USA (25.1% of the participants), Canada (22.9%), UK (26.3%), and France (25.4%), to understand and compare consumer behaviour of food waste between these countries (see Table 2.5). The results highlighted that participants in all four countries reported the issue of fresh fruits and vegetables spoiling more quickly than expected. However, US and Canadian participants agreed buying too much is one of the reasons they threw away fresh fruit and vegetables. UK participants reported the lowest incidence of using shopping lists of all the countries. However, US participants reported the least knowledge of knowing to preserve food appropriately and were the lowest in believing food waste would damage the environment. Further, across all countries using appearance to check food edibility increased the frequency of food waste. An interesting finding is that for US

participants, having children had a significant negative impact on their food waste behaviour, while for UK participants it had significant positive impact.

Kansal et al. (2022) conducted focus groups with 151 people from five different cultural groups of Australian householders to investigate the influence of children on food waste (see Table 2.5). On average, the participants have lived in Australia for 24 years. Thus, it is not clear to what extent these groups reflect the food cultures of their original culture or Australian food culture, or a mixture of the two. The groups were Anglo participants (17.1% of the participants), Sri Lankan (19.1%), Bangladeshi (22.4%), Greek (23.0%), and Indian (18.4%). The results highlighted that children applied pressure on their parents, which can lead to overbuying, and over preparation or provision of food. Impulse buying in supermarkets is also a problem, so even if parents have a shopping list, their children may pick extra food. In addition, parents reported how fussy their children are about what they want to eat, preferring specific brands, sizes, shapes, or appearance of fruits and vegetables. Further, children's food choices dominate household food purchases, with children deciding what food to buy, prepare. This can be why parents over buy food, by considering their children's preferences. Further, parents wanted to provide their children with fresh and healthy food. So, they preferred to eat leftovers rather than give them to their children. The study also highlighted the impact of culture on children's food choices. So, for the migrant groups, the parents tended to prefer their traditional foods, while children born and brought up in Australia preferred Australian food. Therefore, parents cook both traditional and Australian food, which also resulted in over-provision and ultimately food waste.

Table 2.5 Summary of Cross-cultural research on food waste drivers

Country	Participants			Research method	Variables about food waste issue highlighted in the study	Reference
	Life stage	**N**	**Age/ Gender/Living w/children**			
Italy and Spain	University students	380	Age: mean 20.62 Gender: 58% F, 42% M Living w/children: No info	Survey	Concern about food waste, moral attitude, subjective norms, perceived behavioural control, intention, marketing/sale strategies.	Mondejar-Jimenez et al. (2016)
Denmark and Spain	No specific life stage	Denmark (1518) Spain (1511)	Age: (Denmark): mean 50.1 (Spain): mean 37.0 Gender: (Denmark): 48.4% F, 51.6% M (Spain): 48.8% F, 51.2% M Living w/children: No info	Survey	Shopping routine, Self-reported food waste, Food waste behaviour	Grasso et al. (2019)
Italy, Spain, and the UK	Young people	3323	Age: 18- 35 Gender: No info Living w/children: No info	Online questionnaire	Too-frenetic rhythm of life, leaving leftovers uneaten, purchasing of excess food, making shopping lists	Bravi et al. (2020)
USA, Canada, UK, and France	No specific life stage	USA (1098) Canada (1003) UK (1150) France (1110)	Age: 20-60+ Gender: N/A Living w/children: (USA): 42.2% (Canada): 35.0% (UK): 45.4% (France): 41.3%	Survey	Buying too much, low incidence of using shopping lists, minimum knowledge of knowing to preserve food appropriately	Heng and House (2022)
Anglo, Sri Lankan, Bangladeshi, Greek, and Indian	No specific life stage	Anglo (26) Sri Lankan (28) Bangladeshi (34) Greek (35) Indian (28)	Age: 18-60+ Gender: 41% F, 59% M Living w/children: 58.6%	Focus group	Children impulse buying, fussiness for food, and changing preference. Parent, wanted their children to eat fresh and healthy food, Australian vs traditional food choices.	Kansal et al. (2022)

2.2.6 Age and life stage as factors in food waste drivers

The research on food waste drivers across different Western and non-Western countries has been conducted on individuals at different life stages. However, the following research studies did not conduct on a specific life stage:

- Aktas et al. (2018)
- Ganglbauer et al. (2013)
- Ganglbauer et al. (2015)
- Grasso et al. (2019)
- Heng and House (2022)
- Herzberg et al. (2020)
- Kansal et al. (2022)
- Koivupuro et al. (2012)
- Russell et al. (2017)
- Stancu and Lähteenmäki (2022)
- Stancu et al. (2016)
- Van Boxstael et al. (2014)
- Visschers et al. (2016)

On the other hand, the following research studies were conducted with younger adults and university students:

- Bravi et al. (2020)
- Clark and Manning (2018)
- Ghinea and Ghiuta (2019)
- Mondéjar-Jiménez et al. (2016)
- Nikolaus et al. (2018)
- Tsai et al. (2020)
- Yagoub et al. (2022)

But I only found one study on family members living with children and one study on retired or older people:

- Teng et al. (2021) for family members
- McAdams et al. (2019) for retired or older people

Finally, I only found two studies which compared individuals at different life stages:

- Przezbórska-Skobiej and Wiza (2021)
- Van Boxstael et al. (2014)

Individuals at these different life stages have different attitudes, problems and behaviours in relation to food waste. Individuals at younger stage of life such as university students are just starting out on independent life may lack food management and cooking skills. Hebrok and Boks (2017) reported the possible influence of age on shopping and meal planning, where younger persons more seldom to make shopping lists comparing to older persons. They also noted that age is a significant influence on how individuals are valuing food. Tsai et al. (2020) mentioned that young people spend less time on cooking food and prefer fast food, as well as they have little idea about ingredients, but older people have more cooking skills and more time to engage in cooking activities. Further, Nikolaus et al. (2018) found that younger people (aged 18- to 24-year-old) often have low awareness or knowledge of food waste issue, and this can be linked to the lack of visual effects of food waste. It would be also useful to support students at this life stage in creating good habits in relation to food-related practices and food waste.

Family members living with children on the other hand, may have pressures of time and money, as well as child "pester power" and "picky" eating. Some researchers (e.g., Hebrok & Boks, 2017; Kansal et al., 2022) highlighted the possible impact of living with children which may impact individuals in relation to food waste. However, older people may have more time, but concerns about money and lack motivation to prepare complex meals if their children have grown up and/or left home or a partner has died. Some researchers highlighted the distinction of individual at older stage of life. For example, Schneider (2008) discussed that individuals' age, with individuals over than 50 years tend to waste less food compared to younger individuals. This explained as for "post war generation", saving and recycling were especially significant. In addition, retirees spend more time at home, or they might be financially restricted. Quested et al. (2013) also discussed that British individuals over 65 generate about 25% less food waste than other population. This was motivated by moral and financial considerations. British people over 65 were more likely to hold the view that food waste is just something wrong. Researchers hypnotized that people over 65 have been influenced by different experiences including food scarcity during Second the World War, and education on food management and cooing which could be informally built up over time. However, Quested et al. (2013) recommended further investigation of individuals over 65 years old. Therefore, older people group can not be excluded from future

investigation of food waste and food waste reduction, as long as it contributed to the issue.

Therefore, it is important to consider individuals at different life stages to understand the food waste issue.

In addition, as illustrated in Section 2.2, there is no research in the existing work studied the two variables in relation to food waste. Some research focused on studying food waste for diffident cultures (e.g., Bravi et al., 2020; Heng & House, 2022; Kansal et al., 2022; Mondéjar-Jiménez et al., 2016). However, these studies conducted for individuals either at specific life stages or for very wide range of individual age. For example, both Bravi et al. and Mondéjar-Jiménez et al. focused on young adults. Bravi et al. studied Italian, Spanish, and UK young adults, while Mondéjar-Jiménez et al. studied Italian and Spanish students. However, other research (e.g., Heng & House, 2022; Kansal et al., 2022) did not conduct on a specific life stage. On the other hand, some research focused on studying food waste for diffident life stages (e.g., Przezbórska-Skobiej & Wiza, 2021). Przezbórska-Skobiej and Wiza studied students and employees in Poland to investigate food waste. However, other research was more focused on either particular culture or life stage (e.g., Clark & Manning, 2018; McAdams et al., 2019; Teng et al., 2021; Tsai et al., 2020; Yagoub et al., 2022).

Thus, investigating food waste drivers for individuals at different life stages and from different cultures could help in understanding food waste issues and highlighting the user requirements for developing a technological intervention to help with food waste reduction.

This section has focused on research about food waste drivers. Some research which was presented in different sub-sections (Sections 2.2.2 to 2.2.5), proposed models of food waste. For example, the model proposed by Aktas et al. (2018), used TBP which has been the main theory used in research on food waste (see Section 2.2.4). The model was limited as it mainly covered the variables of the TPB. This problem also applied to the research by Mondejar-Jimenez et al. (2016), Stancu et al. (2016), and Tsai et al. (2020) (see Section 2.2.5, 2.2.2, and 2.2.4, respectively). In addition, some research collected data from very specific groups (e.g., Aktas et al., 2018). Other researchers (e.g., Bravi et al., 2019; Grasso et al., 2019; Stancu & Lähteenmäki, 2022) have not

based their work on a limited theory like TPB, but used confirmatory factor analysis in proposing a model for food waste (see Section 2.2.3 and 2.2.5). However, they only focused on particular variables for food waste motivation such as "Lack of time to cook food" and "Immoderate use of food" (Bravi et al., 2019).

The next section will present research on interventions to support food waste reduction, which have largely been undertaking by HCI researchers. However, before presenting that research, I will discuss how food waste research has been situated within the domain of HCI research.

2.3 Towards food waste reduction

Research on food waste reduction is situated within the area that has become known as "sustainable HCI". Sustainable HCI has two different strands of work (Mankoff et al., 2007). The first strand of work is to consider sustainability as part of the material design of products. For example, research on the energy use of the systems developed by HCI researchers and practitioners. As designers and developers of systems, we need to consider the energy consumption of devices such as personal computers, for example when running a screensaver, or leaving a computer in standby mode. Another example can be device re-use, for example the ability to reprogram radio-frequency identification (RFID) tags to be used for different purposes. This could help to save tags from being thrown away if they are no longer used for the purpose that they were originally designed for (Friedman, 2004, cited in Mankoff et al., 2007).

The second strand of "sustainable HCI" is supporting users in pro-environmental activities and sustainable lifestyles by providing them with usable and acceptable digital technologies in areas of importance. As digital technologies become more and more integrated into people's daily lives, they can be used as intervention channels in everyday decisions which contribute to environmental impact. Mankoff et al. (2007) provided the example of sensors that were placed around London to alert people's mobile phones if the level of pollution was high. Hand-held mobile devices were developed to help people using this information to track local air pollutants. Such information systems could encourage individual behaviour change, for instance, to monitor energy use in the home to reduce energy consumption (Crowley et al., 2011; Schwartz et al., 2013). A number of interface designs were proposed to encourage

behaviour change in relation to energy consumption (Crowley et al., 2011). For example, providing users with real-time data to display their energy use for the day, week, month, or year. In addition, users have the ability to set a goal for their energy use reduction by either 1%, 2%, or 5% per month. One particular line of work within the second strand of "sustainable HCI" is in relation to food. Blevis and Morse (2009) introduced this line of work but supporting food waste reduction was never mentioned in a number of papers about this topic by this group of researchers (Blevis & Morse, 2009; Hirsch et al., 2010; Choi & Blevis, 2010; Raturi et al., 2017). The papers focused on designing technology for a sustainable food production system, considering food production techniques and sustainable land use. However, other HCI researchers around the world have started working on using digital technology interventions to support food waste reduction in different ways (see Section 2.3.2).

This next sections discuss the research on food waste reduction. It includes theoretical approaches for food waste reduction (Section 2.3.1), research on technological interventions to support food waste reduction (Section 2.3.2), and critiques of these technological interventions (Section 2.3.3).

2.3.1 Theoretical approaches for food waste reduction

This section presents theoretical work about behaviour change which were used in this programme of research in designing and evaluating an app to support food waste reduction. This section includes two sub-sections covering the persuasive technology approach and the Behaviour Change Wheel (BCW).

2.3.1.1 Persuasive technology approach

Persuasion is a well-known behavioural change approach, which can be applied to change individuals' attitudes and behaviour without using of any force or deception (Fogg, 2003). According to Hamri and Pakkanen (2014) 90% of studies using persuasive technologies have achieved positive outcomes. This high success rate emphasizes the importance of incorporating such an approach to influence individuals' attitudes and behaviour in relation to food waste reduction. Harjumaa and Oinas-Kukkonen (2007) discussed different forms of persuasion including interpersonal persuasion, computer-mediated persuasion and human-computer persuasion. Interpersonal persuasion refers to people persuading others by interacting and

communicating directly with them. Computer-mediated persuasion refers to people persuading other but by using computers as the means of communication people, such as sending e-mails or messages. Fogg (2003) refers to the idea as "human-computer persuasion" which he defines as using computer technology by having people interact with the technology rather than with another human being. So, in this case, the persuasion originates with the computer, not a human being.

Fogg (2009) provided overall guidelines for designing persuasive technology systems including simplifying the target behaviour into a series of less complex behaviour, and careful selection of the target audience (i.e., an audience who are familiar with the technology). In earlier research, Fogg (2003) also proposed seven design principles for persuasive technology (see Table 2.6).

In 2008 and 2009, Oinas-Kukkonen and Harjumaa extended Fogg's work by adding 22 further design principles and discussed how these principles can be practically transformed into system requirements. Principles which can be applied in food waste reduction interventions are illustrated in Table 2.6.

A number of persuasive technology approaches exist. However, the effectiveness of each approach may vary. To illustrate, some approaches such as reminders might have potential to motivate older people to reduce food waste, however it might be less effective for younger people who are busy working and/or living with children. However, the reduction approach might have more potential for people who have less time. Therefore, further investigation of the potential persuasive approach for more specific groups of people to be applied in a technological intervention is required.

Table 2.6 Persuasive technology principle which can be applied in food waste reduction interventions
(Fogg: Fogg, 2003; O-K & H: Oinas-Kukkonen & Harjumaa, 2008, 2009)

Source	Persuasive technology principle	Brief explanation
O-K& H	Personalisation	Providing users with personalised features or content.
Fogg	Tailoring	Offering specific information to users to help them perform a particular behaviour (e.g., providing healthy recipes based on their age or gender).
Fogg	Tunnelling	Leading users to follow pre-planned actions which make it easy for them to go through a process.
Fogg	Reduction	Simplifying the target behaviour by reducing the complexity of a task to a single or few easy steps (e.g., generating a shopping list with a single click).
O-K& H	Rewards	Providing users with rewards to encourage them achieving the target behaviour (e.g., consumers who become better food saver receive grocery vouchers).
Fogg	Conditioning	Changing users' behaviour by using the principles of "operant conditioning" (Fogg, 2003), which is a method applies positive reinforcement (or rewards) to improve the target behaviour. For example, individuals who reduced their food waste can be rewarded with praise such as "thank you for saving the world".
O-K& H	Reminders	Remind users to perform the target behaviour (e.g., as part of consumer routine of food shopping, remind users of what food items they got at home and how many days are remaining to be expired).
Fogg	Suggestion	Providing users with information relevant to their current activity (e.g., suggesting appropriate meals at lunchtime).
O-K& H	Social comparison	Providing users with a way to compare between their achievements and others in terms of the target behaviour.
O-K& H	Cooperation	Providing a way for users to cooperate towards performing the target behaviour.
O-K& H	Competition	Providing a way for users to compete with each other (e.g., user competition such as prize winner for user who produces the least food waste in a month).
Fogg	Self-monitoring	Allowing users to learn about themselves in order to change their behaviour and perform the target behaviour.
Fogg	Surveillance	Observing other people's behaviour in order to change a person's behaviour in a particular way.
O-K& H	Recognition	Publicity recognise users who perform the target behaviour (e.g. food saver of a month).

2.3.1.2 The Behaviour Change Wheel (BCW)

Michie et al. (2011) proposed the Behaviour Change Wheel (BCW) to allow designing and selecting interventions based on the analysis of the nature of the behaviour. Michie et al. (2011) did a systematic literature review, identifying behavioural change frameworks, and evaluated them based on three measures:

- Comprehensiveness: the framework must apply to any intervention has been or can be developed;

- Coherence: the categories are examples of the same type and specificity of entity;

- And, a clear link to an overarching model of behaviour.

Michie et al. (2011) identified 19 frameworks and analysed them. The BCW comprises of three layers: source of behaviour (COM-B), nine intervention functions, and seven policy categories (see Figure 2.2). The BCW starts with theoretical understanding of a behaviour to define what needs to be changed in order to achieve the behavioural target, as well as what intervention functions are likely to be effective to use for that change.
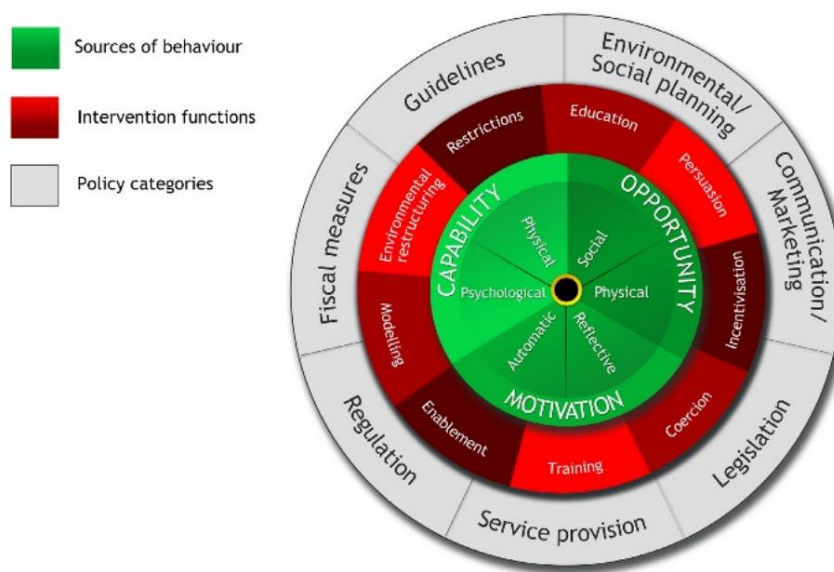
Figure 2.2 The Behaviour Change Wheel (source: Michie et al., 2011)[2]

The source of behaviour layer comprises the COM-B framework which proposes that behaviour is driven by the following components "Capability", "Opportunity", "Motivation" and "Behaviour" (see Figure 2.3):

- "Capability" refers to individual capacity (psychological (C-Ps) and physical C-Ph) such as having the required knowledge or skills to perform the target behaviour (e.g., reducing food waste).

- "Opportunity" refers to external factors around the individual which may encourage or hinder the behaviour (physical (O-Ph) and social (O-So)).

- "Motivation" refers to all psychological processes which energise the behaviour, including individual emotional responding and habitual processes (reflective (M-Re) and automatic (M-Au)).

In addition, three components can influence each other. Therefore, an intervention which can change one or more of the components could make change in individual behaviour.

In Figure 2.3 the double headed arrows between "Behaviour" and the three components indicate the potential influence between them. To illustrate, capability, motivation, as well as opportunity can influence behaviour, and enacting a behaviour can change the three components. For example, when people engage in a behaviour that require skill, such as learning how to store food properly, practicing the behaviour will improve their capability, which in turn will increase their motivation to engage in behaviour such as food waste reduction.
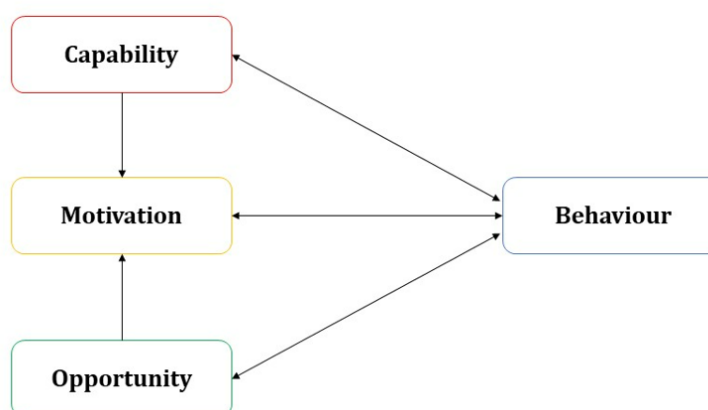
Figure 2.3 The COM-B system (source: Michie et al., 2011)

The intervention functions layer comprises of nine functions: *Education, Persuasion, Incentivisation, Coercion, Training, Restriction, Environmental restructuring, Modelling*, and *Enablement.* The definitions of these intervention functions and the links between the components of "COM-B" and possible intervention functions are provided in Table 2.7.

The policy categories layer (Michie et al., 2011) comprises of seven polices: *Communication/marketing, Guidelines, Fiscal, Regulation, Legislation, Environmental/ social planning, Service provision.*

Table 2.7 Intervention functions and links with the components of "COM-B" model (source: Michie et al., 2011)

Intervention functions	Definition	Model of behaviour: sources					
		C-Ph	C-Ps	M-Re	M-Au	O-Ph	O-So
Education	Increasing knowledge or understanding		x	x			
Persuasion	Using communication to induce positive or negative feelings or stimulate action			x	x		
Incentivisation	Creating expectation of reward			x	x		
Coercion	Creating expectation of punishment or cost			x	x		
Training	Imparting skills	x	x				
Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)					x	x
Environmental restructuring	Changing the physical or social context				x	x	x
Modelling	Providing an example for people to aspire to or imitate				x		
Enablement	Increasing means/reducing barriers to increase capability or opportunity	x	x		x	x	x

Notes: C-Ph: physical capability; C-Ps: psychological capability; M-Re: reflective motivation; M-Au: automatic motivation; O-Ph: physical opportunity; O-So: social opportunity. Link of intervention function and component is indicated with an x.

A guidance for developing an intervention using BCW is provided by Michie et al. (2014). This includes eight steps (see Figure 2.4):

- Step 1 (Define the problem in behavioural terms): is to be specific about the target individuals, and the behaviour itself;

- Step 2 (Select the target behaviour): is to include the long list of the possible behaviour, which is related to the problem needs to be addressed; and selecting the key behaviour to change;

- Step 3 (Specify the target behaviour): includes what needs to be done to perform the change, and who needs to do it;

- Step 4 (Identify what needs to change): includes conducting behavioural analysis, according to COM-B;

- Step 5 (Identify intervention functions): is to use the guidance by the BCW to select the intervention functions for behaviour related to each component in COM-B;

- Step 6 (Identify policy categories): is use the policy categories which support the intervention functions;

- Step 7 (Identify behaviour change techniques): is to consider the techniques related to intervention functions;

- Step 8 (Identify mode of delivery): is to decide about the mode of delivery of the intervention.
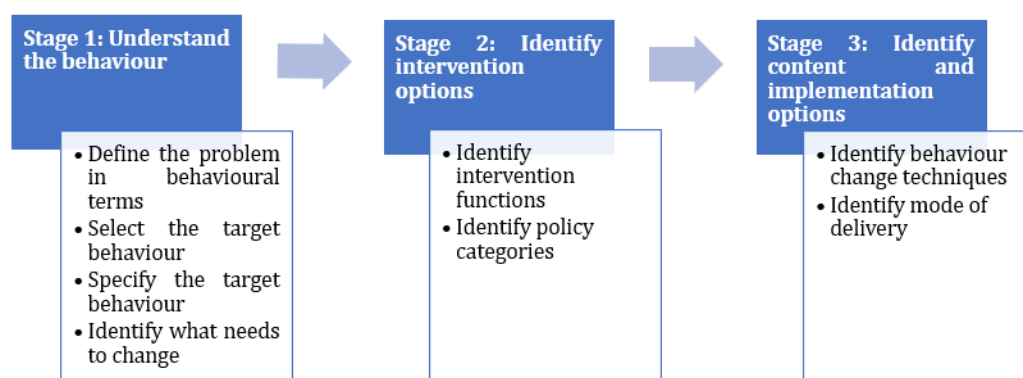
Figure 2.4 Behaviour change intervention design process (based on information from Michie et al., 2014)

2.3.1.3 Other behaviour change theories

Although there is a number of behaviour change theories such as the Theory of Planned Behaviour (TPB) (Ajzen, 1991), gamification (Deterding, 2011), and the Transtheoretical Model (TTM) (Prochaska & Velicer, 1997), the BCW, which was developed in the healthcare domain, was the most suitable to be used in depth in this programme of research. In addition to the fact that the BCW was proposed as a comprehensive framework, it provides a systematic method to understand the nature of behaviour, and provides intervention functions and policies. Finally, the reliability of the BCW was tested in two areas of public health: tobacco and obesity (Michie et al., 2011). Ojo et al. (2019) also applied BCW to understand the drivers of office worker behaviour and created an intervention to reduce sitting in the workplace. Thus, BCW has the potential to be a good fit for the comprehensive approach proposed in this programme of research. In addition, BCW was developed as an evidence-based tool to help design and choose intervention functions according to the nature of the behaviour. Therefore, it has good potential to support the design of technological interventions to encourage and motivate individuals to change their behaviour for an issue such as food waste. In relation to food waste, using BCW can help to inform the design of which functionalities is needed to tackle a range of food waste drivers.

Persuasive technology (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2008, 2009) also provides a variety of design principles that can be integrated with the BCW intervention functions, to provide support and motivation for users to reduce their food waste. Some of these principles have been applied in previous technological interventions (e.g., BinCam uses competition; FridgeCam uses Reminder), although they did not explicitly refer to persuasive technology. Therefore, it would be useful to investigate the potential of these persuasive technology to be used in food waste reduction.

 In comparison, the TPB is limited in encompassing the number of drivers which lead to individual food waste behaviour (for further details about TPB, see Section 2.2.2). In addition, the TPB assumes that the individuals' intentions alone will lead to performing the target behaviour. In relation to food waste, this might not the the case, as performing food waste reduction can be affected by not only individuals' interntions but also their knowedge and external factors which could either facilitate or hinder food waste reduction. Such limitaions can be also applied to gamification, which is defined as "the use of game design elements in non-game contexts" (Deterding, 2011). Gamification is a useful tool which can help to motivate and keep people engaged and active to promote a positive behaviour change such as mental healthcare and quitting smoking (Bassanelli, 2022). However, motivation is not the only issue behind wasting food. People might be motivated but they have no knowledge of how to actually reduce their food waste, or the circumstances around them do not help them in food waste reduction. Therefore, gamification for food waste issues is considered as limited in potential.

The Transtheoretical Model (TTM) (Prochaska & Velicer, 1997) has been applied in domains such as quitting smoking or losing weight. The TTM consists of six sequential stages: pre-contemplation, contemplation, preparation, action, maintenance and termination. However, the TTM only describes stages, not processes for change. In relation to food waste reduction, although investigating individuals' current stage in relation to reducing food waste can be useful to select suitable mechanisms and motivational approaches to motivate them. However, food waste is affected by many drivers and factors. Although the TTM has received considerable attention by researchers, especially the idea that individuals pass through the stages in changing

their behaviour (Armitage, 2009), this part of the model has been criticised by a number of researchers. For example, Bandura (1997) noted that human functioning is too multifaceted and multidetermined to be categorised into a small number of discrete stages, and moving through the stages can be subject to human diversity. In addition, Lenio (2006) noted that the TTM focuses on the decision-making abilities of individuals rather than the social influences on behaviour.

2.3.2 Research in technological interventions to support food waste reduction

A number of researchers have proposed a range of persuasive technologies and interventions to help people change their food waste behaviours. This section will review this body of work.

BinCam (Thieme et al., 2012) is a smartphone camera placed on the underside of the lid of the kitchen waste bin (see Figure 2.5). This then streams photos of the bin contents to the Facebook-based BinCam app. It also includes BinLeague to visualize two score for each bin, "gold bars" represents prevention of food waste, and "leaves on a tree" represents recycling achievements. BinCam was designed to motivate behavioural change in terms of food waste and recycling practices through reflection. Thieme et al. (2012) conducted a five-week study of BinCam using pre and post questionnaire, as well as focus groups. This including 22 young adults (16 were students and 6 were self- employed or unemployed) aged between 18 and 35 years old, living in shared households (5 to 7 occupants), and 50% of them were female. However, they did not explicitly mention where they conducted the study, some of the authors are based in the UK and one in Germany, so it is impossible to tell where the study was conducted. Both Theory of Planned Behaviour (TPB) and Transtheoretical Model (TTM) (Prochaska & Velicer, 1997) discussed as a theoretical grounding, but these theories are not explicitly used in interpreting the results. Post-study focus group found that the following advantages of BinCam:

- It is a good idea and useful for increasing their reflection on waste management;
- Providing exciting and fun experience of doing recycling activity;
- Effortless in terms of no need to change their routine;

- Easy and nice visualization of "gold bars" and "leaves on a tree" in the BinLeague for tracking the progress of household in terms of recycling and money saving on food waste;

- Competition via BinLeague was found as a motivation of some participants, however, other felt less willing on the competition;

- Raising user awareness of their food waste, particularly when hearing the click if the BinCam take pictures helping them to think about it next time of whether it is correct they put it in the bin or not;

- Participants said they were started to improve their behaviour by for example share leftover food with their housemates, and cook appropriate amount of food and try to eat it instead of theow it away.

However, privacy issue was found by the focus group as the disadvantage, as participants did not like to be monitored (especially to be seen by the council).
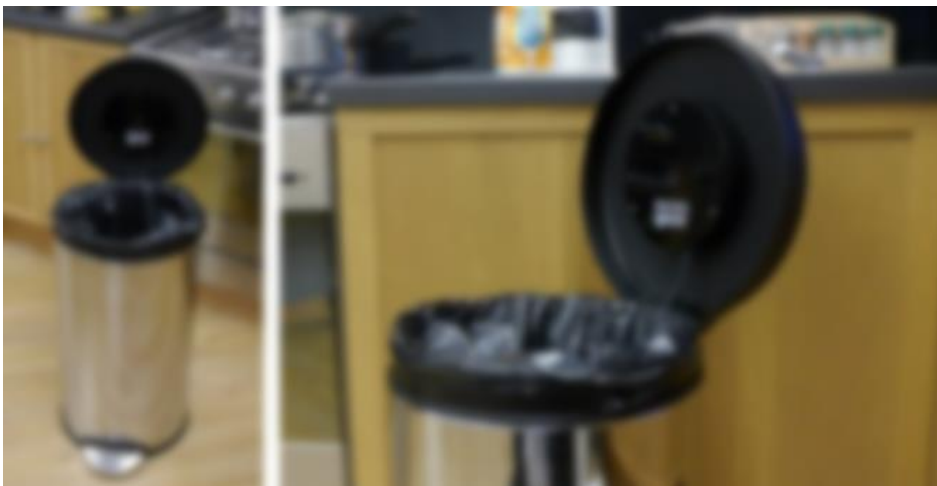
Figure 2.5 BinCam bin (source: Thieme et al., 2012)[3]

Comber et al. (2013) revised the design of BinCam, incorporating elements of gamification, improved data visualization and social support. This includes *BinMan*, a virtual person has a personal profile on Facebook and manged by the administrator of BinCam to improve the social component by for example posting information related to recycling along with answering questions. The precision of the *BinLeague*, has been improved. The *BinProfiles*, added bin statistics to display information such as daily bin usage number of items in the bin in different categories (landfill, recyclable, compost

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[3] All images which are copyright ©ACM (in Figures 2.5-2.10) are reproduced at lower resolution to protect the copyright of the authors. Used with permission for educational purposes.

and food waste items). *BinChallenges,* is to increase user interest as needed, which managed manually by BinCam administrator via for example providing activities which maybe engaging and promote some waste-related actions. BinAchievements, is to give immediate feedback to users against some fixed gaols. Comber et al. (2013) conducted a six-week evaluation study of BinCam using pre and post questionnaire, as well as focus groups and interviews. One member of a household selected randomly to for individual interview, and the rest of household members were invited to take part of a focus group. This including 34 young adults (students) in the UK, aged between 18 and 27 years old, living in shared households (5 to 6 occupants), and 20 of them were female. They did not provide explicit theoretical foundation, however they referred briefly to Flow experiences. The findings of post-study interviews and focus group were quite similar to what Thieme et al. (2012) found in relation to improving participants awareness, however, in this study participants reported that the awareness motivated them to change.

Farr-Wharton et al. (2012, 2014b) explored the possibility of using a simple colour coding system in fridges to help people organize the contents of the fridge, to allow them to become more aware of what food they already have, to motivate them to consume food before it reaches the expiry date. The colour coding system they implemented consists of two complementary parts. The first part is a colour coding scheme which includes a set of coloured plastic sheets to enable people to categorise and organise different food types in the fridge (see Figure 2.6-A). The second part is a paper map attached on the front of the fridge showing the location of the types of food in the fridge, using the colour scheme (see Figure 2.6-B). Farr-Wharton et al. (2012) conducted a four-week study of the colour-coding system using interviews and visual ethnography. This includes seven households in Australia (four couples, two families with children, and one shared household). No theoretical foundation was mentioned in the paper. They found the advantages of the system in increasing participants' consciousness of their available food at home especially for those in the household who were not involved in shopping or in storing food, leading them to more efficient consumption of their available food (Farr-Wharton et al., 2012).
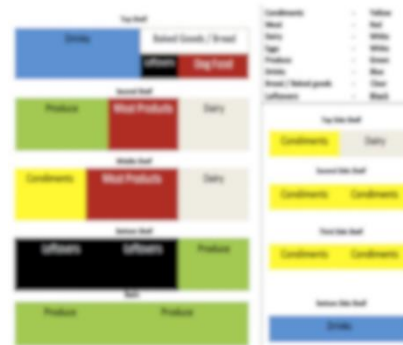
A Colour-coding scheme   **B** Colour-coding map

Figure 2.6 Colour-coding system applied on a household fridge (source: Farr-Wharton et al., 2012)

FridgeCam (Farr-Wharton et al., 2014b; Ganglbauer et al., 2015) takes photos of the inside of the fridge every time the door is opened (see Figure 2.7). Then household occupants can see the photos at a particular web address, and download the most recent 15 photos from a website. Farr-Wharton et al. (2014b) conducted two studies to evaluate the effectiveness of the colour-coding system and FridgeCam. In this evaluation, FridgeCam was used to investigate how enhancing individual's food supply knowledge can minimise food storage, while colour-coding system was used to investigate how enhancing individual awareness of food location can encourage consuming of forgotten foods. Each intervention was evaluated over four-week along with observations and interviews. In the first study (evaluation of FridgeCam), four households were involved (two shared, one family, and one couple). However, they did not explicitly mention where they conduct the study, as all the authors are based in Australia, I assume the study was conducted there. In the second study (colour-coding system), seven households were involved (four couples, two families, and one shared household). They did not provide explicit any theoretical foundation, however they referred to gamification. Participants reported in the interviews the following advantages of FridgeCam:

- Providing information of what food they have in their fridge (kind of tracking support);
- Remind them of what food they have in their fridge, especially for daily used food items such as cheese and milk.

However, the evaluation highlighted a number of disadvantages:

- Visibility of all items in the fridge was difficult, and the camera is not adjustable;

- Important information such as expiry date and the actual quantity of food remaining in a package was not always clear;

- Participants had privacy and security concerns about what other people may say about them if they were able to see the fridge pictures and if their image was captured accidently by the camera.

In the second study (evaluation of colour-coding evaluation), participants reported the following advantage:

- They experienced a perceived increase in knowing the location of food items in their fridge.

However, the evaluation highlighted a number of disadvantages:

- Participants reported that they needed to enrich the colour-coding map by adding food pictures to each colour;

- Certain level of conflict especially if one of the household members did not want to use the system or placed food in the wrong location. Such difficulties can be relevant to the food waste reduction issue, as effective food waste reduction requires effort and cooperation of all members of a household.

Figure 2.7 Example of photos taken by FridgeCam installed in a participant's fridge (source: Farr-Wharton et al., 2014b)

Building on the colour coding system, Farr-Wharton et al. (2013) developed EatChaFood, a mobile application to allow people to explore what food items they already have at home and where they are stored; it also provides information such as how to judge if food is still good to eat or not. EatChaFood takes a regular photo of the contents of the household fridge that is overlaid with the colour-coding scheme developed by Farr-Wharton et al. (2012), see Figure 2.8. The app provides an alert feature for food expiry, as well as a recipe function to give users suggestions as to how to consume food before it reaches the expiry date.

LeftoverSwap facilitates food sharing by connecting potential givers and receivers. It allows users to upload a photo of unwanted food items with a description, and a map showing the location of food items (see Figure 2.9). Fridge Pal is a mobile application to help people manage their household food items and plan meals (Figure 2.10). It provides features such as making and managing shopping lists, adding food items, and viewing and managing items in their inventory.
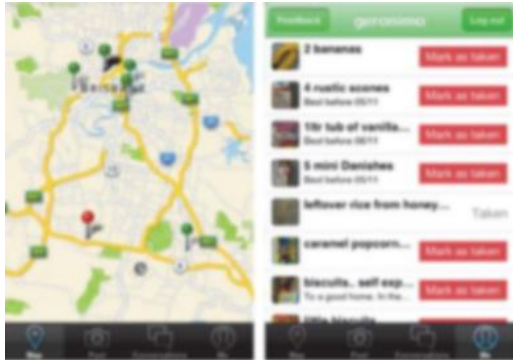
Figure 2.9 LeftoverSwap (source: Farr-Wharton et al., 2014a)

Figure 2.8 EatChaFood app
(source: Farr-Wharton et al., 2013)
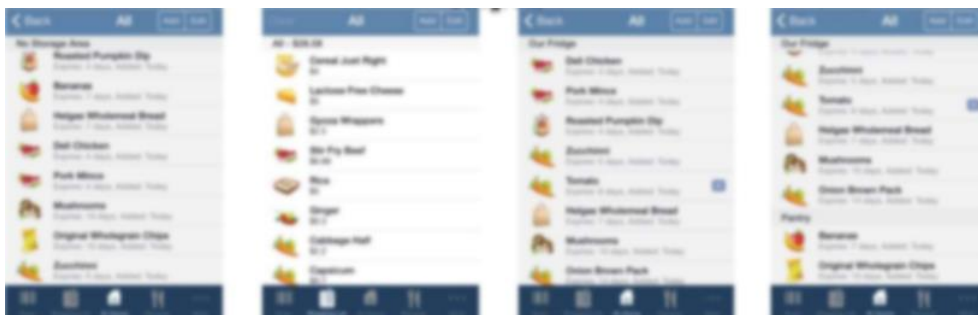
Figure 2.10 Fridge Pal- four most common user interfaces (source: Farr-Wharton et al., 2014a)

Farr-Wharton et al. (2014a) conducted a three-week evaluation using observations and interviews of three mobile apps: EatChaFood as well as two commercial applications, LeftoverSwap and Fridge Pal. They investigated how each intervention can influence individual knowledge of household food supply, location and literacy. No theoretical foundation was mentioned in the paper. Four participants used EatChaFood (aged between 22 and 38), seven participants used LeftoverSwap (aged between 22 and 35), and four participants used Fridge Pal (aged between 19 and 38). However, they did not explicitly mention where they conduct the study, as all the authors are based in Australia, I assume the study was conducted there. The advantages and disadvantages

of each app evaluated by Farr-Wharton et al. (2014a) are illustrated in Table 2.8. However, for food sharing (particularly in EatChaFood and LeftoverSwap), was a controversial concept, with related to issues of trust. However, there were some situations mentioned by participants in which they would be comfortable to share food with others. For example, if they knew the person and they trusted them; if the person is recommended by a well-known person, and if the shared food is packaged. Generally, participants prefer the idea of giving food rather than taking it.

Table 2.8 Advantages and disadvantages found in the evaluation conducted by Farr-Wharton et al. (2014a)

	EatChaFood	Fridge Pal	LeftoverSwap
Advantages	Notify users of products that are expiring soon. Increase food literacy by providing number of days a food product can stay edible under refrigerated conditions. Increase food literacy by providing recipes to use their available food.	Notification feature to remind users of old food items stock behind newer items, to use it before it gets expired. Increase food literacy by providing number of days a food product can stay edible under refrigerated conditions. Increase food literacy by providing recipes to use their available food.	Could Increase food literacy and increase knowledge by communication between app users about food and whether it can be still consumed or not.
Disadvantages	Data entry issue. It would be an additional app, unless if the app can be used in conjunction with other apps, or the app can combine the functionalities of a number of apps. Participants suggested to categorise recipes according to preparation time (quick, moderate and longer), so they can choose which better for their situation. Visibility issue of the fridge photo, thus participants suggested having inventory list and a photo of their interior fridge. Participants suggested incorporating of all available storage areas (e.g., pantry, fridge, and freezer).	Data entry issue. Some products were nor recognised by the barcode scanner. Provide inaccurate information of automatic food expiry. Participants found the notification invasive.	Participants suggested to be able to provide their preferred food items, and notify them if people shared them. Participants suggested to the app can incorporate everyday technology (e.g., emails), to notify users of available food.

Table 2.9 provides a summary of the technological interventions discussed in this section. These interventions were either designed as mobile applications or they

extensively used a mobile application for providing functionality. These projects highlight the value of mobile applications as a platform to be used for food management and waste reduction interventions.

However, there is some limitations related to the interventions. First, interventions have been limited in scope, in terms of which food waste related issue they were aiming to mitigate and what support was provided. However, the nature of food waste issues is undoubtedly complex. Although the interventions had positive outcomes, all the studies conducted by Farr-Wharton et al. aimed to reduce food waste only by increasing consumer awareness of the food available. The issue of food waste can be driven by a number of drivers (see Section 2.2), which can be sometimes also affected by other factors such as culture and life stage. The proposed interventions could provide support for food waste reduction via very specific features that might not have effective results if they were applied in non-ideal environments such as when other drivers of food waste exist. Therefore, comprehensive intervention that could consider a number of food waste drivers and factors would be helpful.

Second, food waste can be influenced by factors such as an individuals' culture and life stage (see Section 2.2.4 and 2.2.6). Although the proposed interventions were evaluated in these studies, the researchers used very small samples of participants (between four and 34 participants; and between four and seven households) for these studies. Such small samples would not provide adequate assessment of effectiveness of the effectiveness of the proposed interventions. Further, studies conducted with younger participants, aged between about 18 and 38 (e.g., Comber et al., 2013; Farr-Wharton et al., 2014a; Thieme et al. ,2012), while others (e.g., Farr-Wharton et al., 2012; Farr-Wharton et al., 2014b) were conducted with households but no information was provided about participant age. In addition, while not all studies provided information about for which country or culture they did their research, other studies (Comber et al., 2013; Farr-Wharton et al., 2012) were conducted in Western countries such as Australia and the UK. This shows that researchers do not investigate or take into consideration the two factors discussed earlier in this chapter (i.e., culture and life stage) which could have a significant effect on participants' behaviour regarding food waste and food waste reduction.

Third, previous work on technological interventions generally lacked a clear grounding in any theory of behavioural change. This has been confirmed by the analysis conducted by Hedin et al. (2019). The next section presents a critique of existing technological interventions for food waste reduction in relation to behaviour change theories.

Table 2.9 Summary of technological interventions on food waste reduction

Study reference	Intervention	Intervention type	Main purpose	Evaluation method/s	Sample	Location
Thieme et al. (2012)	BinCam	App	User reflection on recycling and waste behaviour.	Focus group	Number 22 participants Gender female (50%) Age 18- 35 (22) Living shared households (22)	? Germany/ UK?
Comber et al. (2013)	BinCam	App	Engagement and ser reflection on recycling and waste behaviour.	Pre and post study questionnaires, Focus group, Interviews	Number 34 students Gender female (20) Age 18- 27 (34) Living shared households (34)	UK
Farr-Wharton et al. (2012)	Colour-coding system	Paper-based approach	Increase household members' awareness of their available food.	Interviews and visual ethnography	Number 7 households. Living couple households (4) Family households with one child (1) Family households with two children (1) Shared household (1)	Australia
Farr-Wharton et al. (2014b)	FridgeCam	Android device app	Improve people knowledge of their household food supply.	Interview and observation	Number 4 households. Living family household (1) Couple household (1) Shared household (2)	?Australia ?
Evaluated by Farr-Wharton et al. (2014a)	EatChaFood	Mobile application	Enhances the household members knowledge of what food items they already had at home and where they did store it	Interview and observation	Number 4 participants Gender all males. Age 22-38 (4) Living shared household (2) Family household with one child (1) Family household with two children (1)	?Australia ?
Evaluated by Farr-Wharton et al. (2014a)	Fridge Pal	Mobile application	Help people to mange their household food items and plan meals.	Interview and observation	Number 4 participants. Gender female (1), Male (3) Age 19-38 (4) Living shared household (2) Family household with one child (1) Family household with parents and siblings (1)	?Australia ?
Evaluated by Farr-Wharton et al. (2014a)	LeftoverSwap	Mobile application	Help people to share their food with others.	Interview and observation	Number 7 participants. Gender female (1), Male (6) Age 22-35 (7) Living shared household (5) Family household (1), Couple household (1)	?Australia ?

2.3.3 Critique of existing technological food waste interventions in relation to behaviour change theories

Hedin et al. (2019) conducted a systematic review of 15 food waste interventions, including all the interventions discussed in the previous section. They argued that the research showed a lack of a clear grounding in behavioural change theories. Although some studies referred to such theories, the did not explicitly use the theories in developing or evaluating their interventions. For example, Farr-Wharton et al. (2014b) referred to gamification, Ganglbauer et al. (2015) referred to reflection, and Thieme et al. (2012) referred to the Theory of Planned Behaviour (TPB) and Transtheoretical Model (TTM). However, researchers such as Hekler et al. (2013) have emphasized the advantages of using behavioural change theories in HCI domains such as sustainability or technical systems. For example, they can be used to inform the design of technical systems and to elicit ideas for which functionality can be created to provide support for users. In addition, they can be applied to guide the evaluation of a technological intervention and interpreting of the results. Bluethmann et al. (2017) also recommended to use theory to improve the effectiveness of behaviour change interventions, in discussing physical activity as the application domain. In addition, Bartholomew and Mullen (2011) said theory is important for behaviour change research because it helps researchers identify causal factors of the behaviour and propose appropriate mechanisms to promote change based on the theory. In addition, theory helps researchers to describe the pathways through which change is happening, making the results more helpful in informing subsequent research and development.

Hedin et al. (2019) also analysed the 15 food waste interventions according to the COM-B and BCW theory. Table 2.10 illustrates the interventions in terms of COM-B components. It shows that Physical Opportunity (O-Ph) has been given considerable attention by researchers of previous interventions as a source of issues related to food waste (see Section 2.3.1.2 for more details of COM-B components). Furthermore, Hedin et al. (2019) analysed the previous food waste interventions according to BCW intervention functions. Because Hedin et al. (2019) mentioned that *Education, Persuasion and Enablement* are the three most used intervention functions in BCW, I extended the analysis provided by Hedin et al of the existing technological interventions by using these BCW intervention functions and the persuasive technologies proposed by Fogg (2003) and Oinas-Kukkonen and Harjumaa (2008,

2009), see Table 2.11. The functionality supports provided by the exiting interventions is provided in Table 2.12. The existing interventions (e.g., Comber et al., 2013; Farr-Wharton et al., 2014a; Farr-Wharton et al., 2014b; Ganglbauer et al., 2015; Thieme et al., 2012) were rather specific in terms of providing supports for food waste reduction. However, as mentioned by Ganglbauer et al. (2013), food waste is a complex issue and can arise during multiple food-related practices such as shopping, storing, and cooking.

For example, FridgeCam (Farr-Wharton et al., 2014b) supports physical opportunity (see Table 2.10) as it facilitates the external environment to help users perform food waste reduction. To do so, it uses enablement and persuasion as BCW Intervention functions (see Table 2.11). This is achieved by helping users to check their available food stock when they are away from home. In particular, FridgeCam allows users to take photos of the inside of their fridges and see those photos later (see Table 2.12) (see Section 2.3.2 for more details of this intervention).

Table 2.10 Capability, opportunity, motivation, behaviour (COM-B) components in technological food waste reduction interventions (source: Hedin et al., 2019)

Reference	Intervention	C-Ph	C-Ps	O-Ph	O-So	M-Re	M-Au	Sum
Comber et al. (2013) Thieme et al. (2012)	BinCam		x		x	x	x	4
Farr-Wharton et al. (2014b)	FridgeCam			x				1
Farr-Wharton et al. (2014a)	EatChaFood		x	x				2
Farr-Wharton et al. (2014a)	Fridge Pal		x	x				2
Farr-Wharton et al. (2014a)	LeftoverSwap			x				1
Ganglbauer et al. (2015)	Food waste diary app					x		1
Total		0	3	4	1	2	1	11

Notes: C-Ph: physical capability; C-Ps: psychological capability; M-Re: reflective motivation; M-Au: automatic motivation; O-Ph: physical opportunity; O-So: social opportunity. Components used in each intervention are indicated with an x.

Table 2.11 Existence of intervention function (Education, Persuasion, Enablement) in a food waste reduction intervention modified from Hedin et al. (2019), and extended to include persuasive techniques proposed by Fogg (2003) and Oinas-Kukkonen and Harjumaa (2008, 2009)

Reference	Intervention	BCW Intervention functions			Fogg and Oinas-Kukkonen and Harjumaa persuasive techniques						Sum
		E	P	B	*p*	*r*	*t*	*n*	*co*	*ct*	
Comber et al. (2013) Thieme et al. (2012)	BinCam		x				x			x	2
Farr-Wharton et al. (2014b)	FridgeCam		x	x			x	x			3
Farr-Wharton et al. (2014a)	EatChaFood,	x	x	x			x		x		4
Farr-Wharton et al. (2014a)	Fridge Pal	x	x					x			2
Farr-Wharton et al. (2014a)	LeftoverSwap		x	x					x		2
Ganglbauer et al. (2015)	Food waste diary app		x					x			1
Total		2	-	3	0	0	3	3	2	1	14

Notes: E means Education, **P** Persuasion and **B** Enablement. *p* means personalization support, *r* reduction support, *t* tracking support, *n* reminder support, *co* cooperation support, and *ct* competition support. Intervention functions used in each food waste reduction intervention are indicated with an x.

Table 2.12 Existence of functionality support in a food waste reduction intervention

Reference	Intervention	Functionality support
Comber et al. (2013) Thieme et al. (2012)	BinCam	Provide continuous stream of photos to show items in the household bin. Allow to visualize two scores: recycling achievement and preventing food waste.
Farr-Wharton et al. (2014b)	FridgeCam	Provide photos of the interior of household fridge.
Farr-Wharton et al. (2014a)	Fridge Pal	Make and manage shopping lists. Add food items manually from previous shopping lists or By using a barcode scanner. View and manage food items added to the inventory and divided into different storage areas (e.g., fridge, freezer and pantry). Search recipes using food added to the inventory. Push notifications to alert users of products close to expiry.
Farr-Wharton et al. (2014a)	LeftoverSwap	Connects people to share food with those who take shared food.
Farr-Wharton et al. (2012) Farr-Wharton et al. (2013) Farr-Wharton et al. (2014a)	EatChaFood	Add food items to an inventory. View all food in an inventory categorised by food types. Search recipes using inventory items. Provide information such as how to judge if food is still good to eat or not. Provide an alert feature for food expiry. Share food with other users.
Ganglbauer et al. (2015)	Food waste diary app	Allow to record information (e.g., what and why wasted food) and to review a history of information.

2.4 Conclusions and food waste drivers to be explored in this programme of research

The literature review identified a range of possible food waste drivers which enabled me to investigate them with different user groups. Table 2.13 illustrates the possible food waste drivers, which I elicited from the literature. I was also inspired by Quested et al. (2013) and Hebrok and Boks (2017), and organized them into those relevant to a number of different food-related activities: food shopping, food storage and management, preparation and cooking food, and eating and socializing around food. Then I created concrete examples of these drivers for use in the next phase of the research, understanding and investigation.

Table 2.13 Food waste drivers elicited from the literature and concrete examples

Activity	Reference	Food waste driver (FWD)	
		Reviewed in the literature	**Concrete example**
Food shopping	Block et al. (2016)	Consumer desire to obtaining products without careful thinking.	I buy food because it is prominently displayed in the supermarket (e.g., at the end of the aisle).
	Mondejar-Jimenez et al. (2016)	Marketing or sale strategies.	I buy food that is prominently advertised (on TV, in the supermarket).
	Ganglbauer et al. (2013); Herzberg et al. (2020); Stancu et al. (2016)	Overbuying of food.	I buy packages of food that are too big for my needs - because smaller packages are not available.
	Block et al. (2016); Grasso et al. (2019); Stancu et al. (2016)	Consumers usually think that food in value pricing and bulk packaging is better value.	I buy packages of food that are too big for my needs – because they seem better value.
	Aktas et al. (2018); Bravi et al. (2020); Clark and Manning (2018); Ganglbauer et al. (2013); Heng and House (2022)	Not having a shopping list.	I don't plan my food shopping (e.g., I don't make a shopping list, a meal plan).
	Block et al. (2016); Kansal et al. (2022); Stancu and Lähteenmäki (2022)	Consumers find appealing food products at retailers influence them during shopping by increasing their desire for obtaining the products.	I am tempted to buy food which looks appealing in the shop.
	Block et al. (2016)	Naive diversification bias: consumers purchase multiple flavours of the same food item and only eat their most favourite one.	I buy multiple items of the same food (e.g., different flavours) and then don't eat them.
	Block et al. (2016)	Planning fallacy: consumers underestimating the time required to consume food.	I buy healthy food and then don't eat them.

	Block et al. (2016); Heng and House (2022)	Optimism bias: consumers think that negative events are less likely to occur.	I am too optimistic that I will consume all the food I buy.
	Clark and Manning (2018); Ghinea and Ghiuta (2019); Grasso et al. (2019); Koivupuro et al. (2012); Mondejar-Jimenez et al. (2016); Schneider (2008)	Shoppers offered with special prices at food retailer.	I buy larger amounts of food when they are on offer (e.g., BOGOF – buy one get one free).
	Baig, Gorski, et al. (2018)	lack of good coordination between partners about food shopping and preparing or cooking.	I don't have a good Communication with partner about what meals will be prepared to know what to buy. [only for Arab participants]
	Baig, Gorski, et al. (2018)	valuation of food.	Food in our country is affordable, so I would not be affected when I buy more food. [only for participants in Saudi Arabia]
Food storage and management	Aschemann-Witzel et al. (2015); Block et al. (2016); Clark and Manning (2018); Van Boxstael et al. (2014)	Misinterpretation of date labelling: consumers may not eat food after the "use by" or "best by" date.	I don't know the difference between "sell by"/ "use by"/ "best before" date ["production" and "expiry" date for participants in Saudi Arabia].
	Ganglbauer et al. (2015)	Visibility missing of food stock.	I forget what I have in the fridge/cupboards and then buy more of the same.
	Ganglbauer et al. (2015); Przezbórska-Skobiej and Wiza (2021)	Visibility missing of food stock.	I forget what I have in the fridge/cupboards and then things are too old to eat.
	Hebrok and Boks (2017)	shopping and meal planning.	I can't be bothered making a shopping/meal plan.
	Ganglbauer et al. (2013)	Changing of cooking plans.	I make a shopping/cook plan for meals, but I don't stick with it.
	Aschemann-Witzel et al. (2015); Hebrok and Boks (2017); Heng and House (2022)	lack of food management skills.	I don't know what food can or cannot be frozen-how long things can be kept.
	Aschemann-Witzel et al. (2015); Hebrok and Boks (2017); Heng and House (2022)	lack of food management skills.	I don't know how to package some food to keep them edible for long time.
	Hebrok and Boks (2017), Aschemann-Witzel et al. (2015)	lack of food management skills.	I don't know what food is better to be kept in fridge and what food is better to be kept out.

Preparing and cooking food	Bravi et al. (2019); Ganglbauer et al. (2013)	Busy lifestyle, such as when consumers did not spend a lot of time at home.	I do not have time to cook.
	Hebrok and Boks (2017); Nikolaus et al. (2018); Stancu et al. (2016)	how consumers deal with leftovers.	I do not know what to do with leftover food.
	Hebrok and Boks (2017)	how consumers deal with leftovers.	I don't know about freezing leftover food (what can be frozen, how to do it, how long things can be kept).
	Hebrok and Boks (2017)	how consumers deal with leftovers.	I cannot be bothered saving leftover food.
	Clark and Manning (2018); Ganglbauer et al. (2013)	Available storage space.	I do not have a (big enough) freezer to keep leftover food.
	Hebrok and Boks (2017)	how consumers deal with leftovers.	I don't know what to do with ingredients left over when I cook a meal.
	Ganglbauer et al. (2013)	Food was overcooked.	I am not a good cook – I make things, but they don't taste good, so they go to waste.
Eating and socializing around food	Visschers et al. (2015); Yagoub et al. (2022)	Consumers wanted to serve ample food to their families or guests.	I often cook for family members/guests who then don't turn up for the meal.
	Hebrok and Boks (2017); Visschers et al. (2015)	Consumers do not want to risk eating leftovers.	Eating leftover food is risky for one's health, so I throw away any leftover food.
	Ganglbauer et al. (2015); Herzberg et al. (2020); Kansal et al. (2022)	Social reasons such as a household member did not like the food.	Family members/guests are picky eaters and don't eat everything I cook.
	Aktas et al. (2018); Khan and Kaneesamkandi (2013)	waste increases significantly during special seasons such as Ramadan.	I tend to waste food on special occasions like Christmas [Ramadan for Arab groups].
	Block et al. (2016)	Consumers eat based on what comes to mind easily.	I eat what I see immediately in the fridge/cupboards, not what needs using up.
	Ganglbauer et al. (2015)	Emotional reasons: did not feel like eating and no appetite.	I buy/cook food, but then don't feel like eating it.
	Visschers et al. (2015)	Consumers wanted to serve ample food to their families or guests.	I want to serve ample food to myself/family/guests, but that ends with waste.
	Clark and Manning (2018); Ganglbauer et al. (2015)	Emotional reasons: no appetite.	I want to eat what I feel like, not what I actually have in the fridge/cupboards.

This set of possible food waste drivers is the central of the subsequent work of this programme of research, which aims to address the following research gaps in the literature:

- Little research has compared cultures in understanding individuals' attitudes and practices related to food and food waste, the studies conducted focused on comparisons between Western different cultures. However, to the best of my knowledge, none of the studies compared Western and non-Western cultures.

- Little attention has been paid to life stage in understanding individuals' attitude and practices related to food and food waste, with the majority of the research not focusing on a specific life stage or set of life stages.

- To the best of my knowledge, there has been no consideration of the interaction between culture and life stage on individuals' food and food waste attitudes, practices and drivers.

- There is no comprehensive model of food waste drivers which can be used by HCI researchers and developers as a foundation to develop technological interventions for food waste reduction.

- Little explicit attention has been given by researchers to using behavioural change theories in developing technological interventions for food waste reduction.

- There is a lack of a model of app-based functionality supports.

- There has been little evaluation of the potential of using different functionality supports for food waste reduction.

- There is a lack of exploration of the potential of BCW intervention functions and persuasive techniques in technological interventions to motivate individuals to reduce food waste.

To address these gaps, the programme of research presented in this thesis aims to better understand what drives individuals to household food waste, considering aspects of culture and life stage. In addition, it aims to investigate how to use behaviour change theories can inform the design of a digital technological intervention to support food management and reduce food waste. A further aim is to investigate the potential of app-based functionality supports and theory-based techniques in the area of food waste reduction in an initial evaluation of a low fidelity prototype of an app to support household food management and food waste reduction.

The next chapter presents the first study in this programme of research.

Chapter 3

Study 1: A study of food consumption and waste related attitudes and practices by postgraduate university students from three cultures

3.1 Introduction

This chapter presents the first study in my programme of research, which was conducted to achieve the objective of the second phase of the research, understanding and investigation. The study was conducted to explore postgraduate university students' attitudes and practices in relation to food consumption and waste. In addition, it aimed to investigate with students an initial set of drivers that lead to food waste which were derived from the literature. The set of drivers refined through the research in this and the subsequent study was then used as foundation for designing a technological intervention to support food waste reduction.

The study targeted postgraduate university students from three different cultures: Arab[4], Chinese and British students. The rationale behind targeting university students was that they are at early stage in their independent adult lives in relation to shopping for food and cooking for themselves. It would be thus beneficial to support them at this life stage in creating good habits in relation to food-related practices and food waste. As I wished to compare individuals from different cultures, there is a very large number of international students from different cultures studying at postgraduate level in the UK, particularly students from China and the Arab countries, whereas at undergraduate level, the numbers of international students are limited. In addition, the majority of international students are studying for Masters and PhD degrees and are only in the UK for few years, so they are still very close to their home culture. Therefore,

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[4] Although there is no universally accepted group, the "Arab" countries typically refers to the 22 countries which are members of the Arab League and where Arabic is the main language (Philips, 2012). These are: Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestinian Territories, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates and Yemen.

to have comparable samples of students from the UK, China and Arab countries, I restricted the sample to postgraduate students. In terms of the three cultures selected, Arab, Chinese and British cultures are very different in terms of religion and cultural traditions which may influence people's views on food consumption and waste, and rituals around food and hospitality (see Chapter 1, Section 1.1; Chapter 2, Section 2.2.4). In addition, the University of York has a considerable number of postgraduate students from these three cultures who might be interested in participating in research studies.

The second phase, understanding and investigation, addressed the first research questions (RQ) in my programme of research:

RQ1: What are the similarities and differences in food consumption and waste practices, attitudes, and behaviours among people in different cultures and at different life stages?

RQ1.1: What are the similarities and differences among postgraduate university students from three different cultures in terms of their practices around food consumption and food waste and the drivers which lead them to waste food?

RQ1.2: What are the similarities and differences among individuals from different cultures living in family situations with children and older people in terms of their practices around food consumption and food waste and drivers that lead them to waste food?

RQ1.3: What are the similarities and differences among individuals at three different life stages and from two different cultures in terms of their practices and attitudes around food consumption and food waste and drivers that lead them to waste food?

This study was conducted to address RQ1.1, Study 2 to address RQ1.2, and further analysis of all the data from Studies 1 and 2 to address RQ1.3 (see Chapter 4, Section 4.3.3).

3.2 Method

3.2.1 Design

Focus groups and face-to-face interviews were conducted with postgraduate university students from China, a number of Arab countries and the UK. Due to constraints in the availability of participants, focus groups were conducted with the Chinese and Arab students and face-to-face interviews were conducted with the British students. The subject matter was kept as close as possible in both methods.

In the focus groups, participants first completed a questionnaire to collect demographic information and information about their general food-related and food waste practices. Then I led an initial general discussion about food waste issues to elicit participants' knowledge and attitudes to food waste. Then, a brief presentation was given by my supervisor (for the Chinese students) or myself (for the Arab students) about the importance of food waste to global warming. The presentation was given to explain the importance of the study, as many people do not know the magnitude of the domestic food waste issue. Thus, the presentation gave some simple facts and figures, that can make students take their participation more seriously and that the information they would provide can contribute to reducing the damage caused by food waste. This could help to make them think more when they provided their answer as it would make difference to the world. Although the presentation could influence students to consider the environmental impact of food waste, the students were also asked about their motivations and reasons for reducing food waste before the presentation.

Table 3.1 Initial set of statements about food-related practices and food waste used in Study 1

Preparing and cooking food	Eating and socializing around food
I do not have time to cook.	I often cook for family members/guests who then don't turn up for the meal.
I do not know what to do with leftover food.	Eating leftover food is risky for one's health, so I throw away any leftover food.
I don't know about freezing leftover food (what can be frozen, how to do it, how long things can be kept).	Family members/guests are picky eaters and don't eat everything I cook.
I cannot be bothered saving leftover food.	I tend to waste food on special occasions like Christmas [Ramadan for Arab participants].
I do not have a (big enough) freezer to keep leftover food.	I eat what I see immediately in the fridge/cupboards, not what needs using up.
I don't know what to do with ingredients left over when I cook a meal.	I buy/cook food, but then don't feel like eating it.
I am not a good cook – I make things, but they don't taste good, so they go to waste.	I want to serve ample food to myself/family/guests, but that ends with waste.
	I want to eat what I feel like, not what I actually have in the fridge/cupboards.
Shopping for food	**Food storage and management**
I buy food because it is prominently displayed in the supermarket (e.g., at the end of the aisle).	I don't know the difference between "sell by"/ "use by"/ "best before" date
I buy food that is prominently advertised (on TV, in the supermarket).	I forget what I have in the fridge/cupboards and then buy more of the same.
I buy packages of food that are too big for my needs - because smaller packages are not available.	I forget what I have in the fridge/cupboards and then things are too old to eat.
I buy packages of food that are too big for my needs – because they seem better value.	I can't be bothered making a shopping/meal plan.
I don't plan my food shopping (e.g., I don't make a shopping list, a meal plan).	I make a shopping/cook plan for meals, but I don't stick with it.
I am tempted to buy food which looks appealing in the shop.	I don't know what food can or cannot be frozen-how long things can be kept.
I buy multiple items of the same food (e.g., different flavours) and then don't eat them.	I don't know how to package some food to keep them edible for long time.
I buy healthy food and then don't eat them.	I don't know what food is better to be kept in fridge and what food is better to be kept out.
I am too optimistic that I will consume all the food I buy.	
I buy larger amounts of food when they are on offer (e.g., BOGOF – buy one get one free).	
I don't have a good communication with partner about what meals will be prepared to know what to buy. [only for Arab participants]	

Participants were then asked to comment and vote on an initial set of statements about food-related practices and food waste (see Table 3.1) in an PostIt exercise. These statements were drawn from previous research and organized into four different areas: preparing and cooking food; eating and socialising around food; shopping for food; food storage and management (see Chapter 2, Section 2.1.4). These statements would lead to the food waste drivers to be used as a foundation for the technological intervention towards supporting food waste reduction.

3.2.2 Participants

Participants were recruited via several methods: sending emails to student groups at the University of York, personal contacts with participants who were studying at the University, and placing flyers and posters around the University. The inclusion criteria for participants were to be a postgraduate student, from one of the three target cultures (China, UK, or Arab) and be between the ages of 18 and 40 years. A minimum time in the UK was not included as an inclusion criterion, but this information was collected from participants. The reason for not including that criterion was that not wanting to limit the number of students available.

Table 3.2 Demographic information for the participants in Study 1 (Number and percentage)

	Chinese Students N = 10	British Students N = 5	Arab Students N = 6	All Students N = 21
Gender				
Women	9 (90.0)	1 (20.0)	5 (83.3)	15 (71.4)
Men	1 (10.0)	4 (80.0)	1 (16.7)	6 (28.5)
Age				
Range (years)	23-28	25-33	22-40	22 – 40
Mean	24.7	27.4	32.1	27.4
Standard Deviation	1.6	3.2	6.3	4.8
Length of time in the UK				
1 year or less	8 (80.0)	0 (0.0)	0 (0.0)	8 (38.0)
Between 2 & 3 years	2 (20.0)	0 (0.0)	1 (16.7)	3 (14.2)
Between 4 & 5 years	0 (0.0)	0 (0.0)	4 (66.6)	4 (19.0)
Since birth	0 (0.0)	5 (100.0)	1 (16.7) *	6 (28.5)
Highest Educational qualification				
Bachelor's degree	9 (90.0)	0 (0.0)	1 (16.7)	10 (47.6)
Master's degree	1 (10.0)	5 (100.0)	5 (83.3)	11 (52.3)

Note: *Although one of Arab participants was living in the UK since birth, they were included in the study as they were raised in Arabic background culture.

The demographics of the participants are summarized in Table 3.2. 21 students participated in the study, with 15 women and 6 men, aged from 22 to 40 years (mean age 27.4 years). 10 participants (47.6%) were from China, five participants (23.8%) from the UK, and the remaining six participants (28.5%) were from a variety of Arab countries including Saudi Arabia, Egypt, Oman, and Libya. Detailed demographic information of participants is provided in Appendix A.1.1. All participants were offered an Amazon gift voucher for £10 in thanks for their participation.

3.2.3 Equipment and materials

An informed consent form was prepared, this comprised two sections, one for participants to sign at the beginning of the session to confirm that they had been briefed about what would be involved and what would happen to their data and one to be signed at the end of the session to confirm that they had been appropriately debriefed, had the opportunity to ask questions and had been offered a gift voucher for their time (see Appendix A.1.2).

A demographic and general questionnaire was used to collect participants' demographic information and information about their general attitudes and self-reported behaviour around food practices and food waste (see Appendix A.1.3). It comprised four sections: demographic questions; questions about shopping for food; questions about eating habits; questions about preparing food and cooking, and questions about food waste and food waste reduction. The questions were mainly close-ended questions, and some used 7 level Likert items to make it quick and easy for participants to complete. In addition, three questions were open-ended to gather detailed information of their experience around reducing food waste and using any apps to do so.

A pilot questionnaire was conducted with three participants to check if the questions were understandable and appropriate, as well as how long participants could take to answer the questionnaire.

A set of open-ended questions were used to trigger the initial discussion, these were about food waste, and possible causes of food waste (see Appendix A.1.4). These included why participants think food waste is important, what do they think about food waste in their society, and why they think they waste food.

A slide presentation about food waste was used to show the importance of reducing food waste including some key facts and figures (see Appendix A.1.5).

Materials for the PostIt and voting exercise were used to collect responses to the initial set of 33 statements about food-related practices and food waste. One additional statement ("I don't have a good communication with partner about what meals will be prepared to know what to buy") was included only for Arab students.

This statement was included for the Arab group as Baig, Gorski, et al. (2018) discussed the culture of separation of responsibility for food shopping and cooking between men and women in Saudi Arabia, which means that a lack of good coordination between them could lead to food waste (see Chapter 2, Section 2.2.4).

Each statement listed in Table 3.1 was printed on an A3 sheet of paper and attached to the wall of the room where the study was held. To make the exercise more understandable for participants, the sheets were grouped into four major topics (with appropriate labels): shopping for food; food storage and management; preparing and cooking food; and eating and socializing around food. The statements were in English for all groups.

Each participant was given a pad PostIt notes to write their comments about whether and how a statement might lead them to waste food. Each participant was also given a sheet of 10 sticky dots to "vote" for the statements they thought affected them most (in the first focus group, I gave Chinese students a whole sheet of dots, with different amounts of dots by mistake; the consequences of this are explained in Section 3.2.5.3). They could use all the dots on one statement or spread their dots across as many different statements as they liked.

For the interviews, the statements about food waste were printed on an A4 sheet for participants to complete (see Appendix A.1.6). The sheet included a table of food waste statements, with space for comments and votes to be added by participants next to each statement. Each participant was also given a sheet of 10 sticky dots to "vote" for the statements they thought affected them most.

The interview schedule included the same materials of consent form, demographic and general questionnaire, a set of open-ended questions for the initial discussion, a slide presentation about food waste, and an A4 sheet includes a table of food waste statements for participants to comment and vote on.

All discussions in the focus groups and interviews were recorded on a Philips DVT6010 digital audio recorder for later detailed analysis.

3.2.4 Procedure

The study was conducted between June and December 2019.

3.2.4.1 Procedure for the focus groups

The focus groups were conducted in a seminar room at the University of York. At the beginning of the session, participants were provided with a folder containing all the materials required (see Section 3.2.3). The nature of the study was explained to the participants, permission was asked to record the session, the confidentiality and anonymity of their data assured, and they were asked to complete the first section of the informed consent form. Participants then completed the demographic and general questionnaire. The English language was used in the focus group with the Chinese participants and British participants in the interviews, Arabic was used with the Arab participants in their focus group. First, I initiated the initial discussion with participants about their food waste and possible causes of this issue, using the open-ended questions (see Section 3.2.3), this lasted approximately 15 minutes. Then in the Chinese focus group (which was conducted first) my supervisor gave a short presentation about the importance of food waste and some key facts and figures using the slide presentation, this took approximate 5 minutes. I gave the presentation in the Arab focus group.

Figure 3.1 Photos of PostIt and voting exercises of focus groups in Study 1

The participants then undertook the PostIt exercise. They walked around the room looking at all the sheets with the food-related practices and food waste statements (Figure 3.1) and added comments and thoughts using their PostIt notes about whether and how a statement might lead them to waste food. They were encouraged to make as many comments as they wished. 15 minutes were allowed for this exercise. Participants were then voted for statements which they thought had the most effect on them using their dots. They could allocate their dots however they wished, putting all the dots on

one statement, or one dot on each of 10 statements or any combination in between. Participants were then thanked for their participation and asked to complete the second section of the consent form, including providing their email address to if they would like to receive an Amazon gift voucher for £10.

3.2.4.2 Procedure for the interviews

The interviews were conducted in a quiet room at the University of York. Participants were provided with the same materials folder as used in the focus groups with the addition of the sheet of the statements for comments and votes, and the same briefing procedure was used including asking them to sign the first part of the informed consent form. The participant then completed the demographic and general questionnaire. The interviews were conducted with British students, so they were conducted in English.

I started with an initial discussion with participants about their food waste and possible causes of this issue using the open-ended questions (see Section 3.2.3), this lasted approximately 7 minutes. Then, I made the same 5-minute presentation as was used in the focus groups. After that, participants were asked to complete the sheet with food-related practices and food waste statements by adding their comments (the equivalent to the first PostIt exercise in the focus groups). Participant were encouraged to make as many comments as they wished. 10 minutes were allowed for this exercise. On the same sheet, participants were then asked to vote for statements which they thought had the most effect on them using their dots (equivalent to the voting exercise in the focus groups). Participants could allocate their dots however they wished, putting all the dots on one statement, or one dot on each of 10 statements or any combination in between. Then, participants were thanked for their participation and asked to complete the second section of the consent form, including providing their email address if they would like to receive an Amazon gift voucher for £10. On average, interviews lasted 35 minutes.

3.2.5 Data analysis

The quantitative data collected from the questionnaire about food practice and attitudes to food shopping habits, cooking and their eating diet, as well as food waste, was analysed using Statistical Package for the Social Sciences (SPSS) version 28. For

the qualitative data, the data analysis was conducted manually, without use of any software.

3.2.5.1 Transcription and translation

The following text sources were originally in English, so were transcribed in English:

- Initial verbal discussions in focus group (Chinese students)
- Written PostIt note comments (Chinese students)
- Verbal answers to interview questions (British students)
- Written comments on food waste statements (British students)
- Written PostIt note comments (Arab students)

The following text source was originally in Arabic, so was transcribed in Arabic and then useful quotes were translated into English:

- Initial verbal discussions in focus group (Arab students)

3.2.5.2 Codebook thematic analysis

Among the three thematic analyses (i.e., coding reliability, reflexive, and codebook) (Braun et al., 2019), a codebook thematic analysis (Crabtree & Miller, 1999) was used to analyse all the text data sources. This is because the gaol of the study was specifically to investigate the key food waste drivers for specific individual groups, considering culture. In addition, the focus of the analysis was on the texts around the statements of food waste drivers which were discussed and investigated in the existing literature. Thus, starting with a structured codebook was more focused and time efficient than using the other methods.

According to Crabtree and Miller (1999), the steps to conduct the analysis follow this sequence:

(1) Create the codebook
(2) Code the texts
(3) Sort the coded segments, including creating counts of the frequency of different code occurrences to identify key areas
(4) Connect and corroborate related texts

Using these steps as a guide, I undertook the following process:

(1) I created a codebook in advance of conducting the analysis; this consisted of codes that were abstracted from the initial set of statements about food waste (see Appendix A.1.7)

Each code included one or more of the food waste statements to make a more abstract set of codes, because of the overlapping content in some of the statements. This formed a new list of main food waste drivers (the equivalent of themes in thematic analysis), and sub-drivers (the equivalent of sub-themes in thematic analysis) (see Table 3.3). For example, FWD1.1 "Packages too big" was abstracted from the following two food waste statements:

- Buy packages of food that are too big for my needs - because smaller packages are not available.
- I buy packages of food that are too big for my needs – because they seem better value.

MacQueen et al. (1998) suggest that the structure of a codebook should include six components: code labels, brief definitions, full definitions, inclusion criteria, exclusion criteria, and examples. However, some researchers, for example DeCuir-Gunby et al. (2011), use only three components (i.e., code labels, full definitions, and examples). For my analysis, I used four components: code labels, full definitions, descriptions (including inclusion criteria), and examples (see Appendix A.1.7).

Table 3.3 List of food waste drivers (FWD) and sub-drivers to be used as codes in the thematic analysis

Food Waste Driver
FWD1. Overbuying food
FWD1.1 Packages too big
Buying bigger packages of food than it is needed due to whether it is more economic than smaller one or there are no available small packages of food they want or like.
FWD 1.2 Over optimistic buying
Overly optimistic about what kind of food to buy (e.g., buying extra fresh food than it will be used) or how much food would be enough to buy (e.g., buying extra amount of food than it will be used).
FWD 1.3 Influenced by offers
Influencing by special offers and discounts on food such as Buy One Get One Free or any kind of offer which encourages overbuying.
FWD 1.4 Impulse buying
Feel desire to buy food that looks attractive whether at supermarkets or food shops.
FWD 1.5 Advertising (on TV, in store)
Influencing by advertisements or marketing strategies on food whether on TV or at supermarkets.
FWD 2. Shopping and meal planning
FWD 2.1 Failure to make a plan
Not making shopping lists or meal plans due to any reason such as doesn't have time to do or lack of motivation to do.
FWD 2.2 Failure to stick to a plan
Not committing to pre-planned shopping list or meals due to any reasons. For example, household member/s come back late from work and do not want to eat.
FWD 2.3 Communication about meal/shopping/planning
Lack of communication between household members when food shopper buy food that is not required for the meals will be prepared by a person who responsible for cooking in the household.
FWD 3. Food storage and management
FWD 3.1 Confusion about food labels
Misunderstanding of the meaning of different food labels such as "use by"," best before", and "sell by".
FWD 3.2 Lack of information about what food is in the fridge/pantry
Not knowing about what food available at home whether in fridge or cupboard leading to whether food become too old to eat or buying more of the food already available at home.
FWD 3.3 Lack of knowledge about storing food
Lack of knowledge or experience about how and where to store food at home; whether ingredients or leftover. For example, don't know if food can be frozen or not, how they can be packed and stored, and where they should be stored whether in fridge or cupboard.
FWD 3.4 Lack of space to store food
Not enough storage places to store food at household such as small freezer.
FWD 4. Food preparation and cooking
FWD 4.1 Lack of time/motivation to cook
Doesn't have time or is demotivated to cook food at home.
FWD 4.2 Lack of knowledge of how to use leftovers
Lack of knowledge or experience about how to use remaining food at household whether it is plate leftover or some ingredients.
FWD 4.3 Using leftover food is too much effort
Find saving or re-using leftover as bothering task.
FWD 4.4 Belief that leftovers are not healthy
Consumer belief about eating leftover food can be unhealthy or risky for their health.
FWD 4.5 Lack of cooking skills
Lacking skills and knowledge to cook food at household.

FWD 5. Eating and socialising
FWD 5.1 Catering for "picky" eaters Household member/s are picky and selective in which food to eat, and do not like some meals or ingredients.
FWD 5.2 Catering for special occasions Serving food on holidays, special occasions such as wedding, family or friend gathering, and events in different cultures such as Christmas, Ramadan or Chinese New Year where people might provide extra food for guests or family than usual.
FWD 5.3 Cooking a lot, but not eating it Cook or buy food but then get bored with eating it.
FWD 5.4 Impulse eating Eating food that is seen immediately or feel like in the fridge or cupboards and not what needs to be used up.

Before moving to Step 2 (coding the text), I felt it was important to conduct some testing of the codebook. Crabtree and Miller (1999) do refer to testing a codebook in various ways, but they do not include this as a specific step or sub-step within the codebook analysis process. For example, they mention conducting an initial exploration of the text before developing the codes (which was not relevant to my analysis), creating a preliminary codebook based on an initial conceptual model and/or literature review (my process) and then refining this if necessary, but they suggest that this is not always the case. At another point, they mention that initial codes can be refined and modified during the analysis process. Miles and Huberman (1984, 1994) recommended a more structured process of initially coding some pages of the text to test the codebook and then modifying the codebook accordingly. For this analysis, I did an initial test of the codebook with some data. However, I did not find any modifications were needed to the codebook.

(2) I then coded all the text manually, without use of any software. I was aware that I might find additional codes if new food drivers emerged in the text. However, I found that no codes needed to be added to the codebook.

I started by carefully reading and re-reading all the PostIt comments and categorised them under the appropriate code (main food waste driver plus sub-driver). I first decided which main food waste driver was appropriate, and then the appropriate sub-driver. In addition, I read and re-read the transcriptions of the initial discussions in English and categorised them under the appropriate code, and identified useful quotes for further use. In addition, I read and re-read the Arabic transcriptions of the initial discussions and categorised them under the appropriate code, and identified useful

quotes for further use. After that, I reviewed all the material that had been categorised under each code, in order to ensure that they were related to it.

(3) According to Crabtree and Miller (1999), counting the frequency of different code occurrences is a mean of identifying key areas for future investigation. However, in this analysis, I counted the frequency of both main food waste drivers and sub-drivers, and used the frequencies to establish levels of importance (high, moderate, or low) for each group (see Section 3.2.5.3).

I did not implement Step 4 of the Crabtree and Miller process, as in this study as I wanted to analyse the food waste drivers separately in order to investigate differences between the three cultural groups.

3.2.5.3 Quantitative analysis of votes and comments

The frequency of comments for each main food waste driver and sub-driver identified in the thematic analysis was calculated to indicate the importance of each driver and sub-driver. In addition, because participants voted for statements which they thought had the most effect on them in relation to wasting food (see Section 3.2.4), the number of votes given to each driver and sub-driver was also used as an indicator of the importance of each driver and sub-driver.

This analysis of comments and votes was conducted in four stages:

1. For each student group, I categorized all comments from the initial discussion and PostIt notes into a main food waste driver and sub-driver

2. I re-read all the comments for each sub-driver in order to check that the comments made sense in relation to that sub-driver (see Table 3.3), see Table 3.4 for an example of comments on one food waste driver.

3. I then categorized all the comments into those which supported the idea that this is a factor in food waste (e.g., "Healthy food goes bad quicker, and I don't finish it" (AS3)) (*support* comment) and those which rejected the factor (e.g., No, I am anxious about the use of plastic as well (AS5)) (*reject* comment).

4. I then counted the votes associated with each main food waste driver and sub-driver.

Table 3.4 Example of classifying participants' comments and votes for main food waste drivers

Main food waste driver: FWD1. Overbuying food	
Sub-driver/Text source	**Example comments/ Frequency of votes**
FWD1.1 Packages too big	
Initial discussion comments:	N/A
PostIt note comments	Reject: No, I am anxious about the use of plastic as well (AS5)
Votes	0
FWD 1.2 Over optimistic buying	
Initial discussion comments:	Support: Fruits and vegetables ruined very quick here (AS4)
PostIt note comments	Support: Healthy food goes bad quicker, and I don't finish it in time (AS3) Some food goes bad very quick (AS3) Don't shop when hungry (AS3) Yes, when I try to eat more fruit and vegetables to be healthy. I lose enthusiasm easily (AS4) Once I shopped yes→then no (AS6) Yes, they become bad very quick (AS4) Yes (AS5)
Votes	10
FWD 1.3 Influenced by offers	
Initial discussion comments:	N/A
PostIt note comments	Support: Yes, but I try to get the free one from other products. For example, buy fruit and get vegetable for free (AS2)
Votes	1
FWD 1.4 Impulse buying	
Initial discussion comments	N/A
PostIt note comments	Support: Always happened to me! (AS2) A lot of the time I am craving a food in the shop and then I don't crave it when I am back home (AS3)
Votes	2
FWD 1.5 Advertising (on TV, in store)	
Initial discussion comments	N/A
PostIt note comments	Support: Yes, I've attracted by adv.! (AS2) Reject: No! (AS6)
Votes	0

For all students and for each student group, the following calculations were made:

- The number of support comments for each main food waste driver and sub-driver; reject comments were discarded (see Appendix A.1.8, Table A.4 – support comments).

- The number of votes for each main food waste driver and sub-driver (see Appendix A.1.8, Table A.5 - votes).
- The percentages of the total number of support comments for each main food waste driver and for the sub-drivers within each main food waste driver.
- The percentages of votes for each main food waste driver and for the sub-drivers within each main food waste driver (a percentage was used partly due to the error of providing the Chinese students with many more dots for the voting process than the other student groups).

Finally, to indicate the importance of each main food waste driver and sub-driver for all students and for each student group, the following calculations were made:

- For all students and for each group:
  - A ranking of the main drivers according to the percentages of votes
  - A ranking of the main drivers according to the percentages of support comments
  - A ranking of the sub-drivers according to the percentages of votes
  - A ranking of the sub-drivers according to the percentage of support comments, Then, if
    - A food waste main/sub-driver received Rank 1 by either votes or support comments, it was categorised as "High importance" (rank range = 1 – 1.999)
    - A food waste main/sub-driver received Rank 2 by either votes or support comments, it was categorised as "Moderate importance" (rank range = 2 – 2.999)
    - A food waste main/sub-driver received Rank 3 by either votes or support comments, it was categorised as "Low importance" (rank range = 3 – 3.999) (see Appendix A.1.8, Table A.4 and A.5)

3.3 Results

The results include two main sub-sections, which answered RQ1.1. The results from the questionnaire about food practice and waste, and the results of food waste drivers.

3.3.1 Food practices and attitudes to food waste (RQ1.1)

In the general questionnaire (see Appendix A.1.3), Participants were asked a number of questions about their food shopping habits, their cooking practices and what diet they follow. They were also asked about their food waste practices and attitudes to food waste, and about factors influencing them towards reducing food waste.

The key results are summarized in Table 3.5. Only answers with more than 10% of responses from any participant group that are relevant to the design of the Wasteless app (see Chapter 6), are presented (full results can be found in Appendix A.1.9).

Table 3.5 Food shopping and cooking practices (Number and percentage of responses)

	Chinese Students N = 10	British Students N = 5	Arab Students N = 6	All Students N = 21
Who does most of the food shopping for your household? (Q12)				
Myself	10 (100.0)	2 (40.0)	4 (66.7)	15 (71.4)
Shop separately	0 (0.0)	2 (40.0)	2 (33.3)	4 (19.0)
How is the shopping for your household usually done? (Q15) [1]				
In supermarket	10 (100.0)	5 (100.0)	6 (100.00)	21 (100.00)
Online	3 (30.0)	0 (0.0)	2 (33.3)	5 (23.8)
In specific shops and market (e.g., bakery, markets. farm shops)	2 (20.0)	0 (0.0)	0 (0.0)	2 (9.5)
What types of food do you prefer to buy? (Q16) [1]				
Fresh foods	10 (100.0)	5 (100.0)	6 (100.0)	21 (100.0)
Frozen food	3 (30.0)	1 (20.0)	4 (66.7)	8 (38.0)
Canned food	2 (20.0)	3 (60.0)	2 (33.3)	7 (33.3)
Pre-cooked foods (e.g., ready meals)	2 (20.0)	1 (20.0)	1 (16.7)	4 (19.0)
Other (e.g., pasta, rice)	0 (0.0)	1 (20.0)	0 (0.0)	1 (4.7)
Who does most of the food cooking for your household? (Q20) [2]				
Myself	N/A	2 (40.0)	6 (100.0)	8 (72.7)
Other (e.g., cook separately)	N/A	2 (40.0)	0 (0.0)	2 (18.1)
My spouse/partner	N/A	1 (20.0)	0 (0.0)	1 (9.0)
Does the main cook normally use recipes when cooking? (Q22)				
Sometimes	7 (70.0)	1 (20.0)	1 (16.7)	9 (42.8)
Rarely	2 (20.0)	1 (20.0)	2 (33.3)	5 (23.8)
Hardly ever	0 (0.0)	2 (40.0)	2 (33.3)	4 (19.0)
Frequently	1 (10.0)	1 (20.0)	1 (16.7)	3 (14.2)
The cook is a skilled cook (Q30.1) (rating: 1 = strongly disagree to 7 = strongly agree) (Median, Semi-Interquartile Range, SIQR)				
Median (Semi Interquartile range)	4.0 (1.0)	6.0 (0.5)	5.5 (1.5)	5.0 (1.0)

Notes: 1 = multiple answers possible. **2:** This question was accidently omitted in the focus group with Chinese students.

Typically, students do most of the food shopping for the household themselves (Q12), with nearly three-quarters of all students giving this response. This included all the

Chinese students, approximately two-thirds of the Arab students (66.7%) but only one fifth of the British students (20.0%). However, nearly half the British students (40.0%) and a third of the Arab students (33.3%) who were living with other students said they shop separately from their housemates.

All students reported shopping at supermarkets (Q15). However, surprisingly only about a quarter (23.8%) reported online shopping for food, with none of the British students reporting this mode of food shopping. Only the Chinese students reported using specific shops (e.g., bakeries, markets or farm shops) and then only a minority (20.0%).

All students reported buying fresh food (Q16). Next in popularity were frozen and canned foods (reported by 38.0% and 33.3% respectively), with less than a fifth of students reporting buying pre-cooked meals (19.0%). The notable differences between the groups are that the Arab students reported buying frozen foods much more than canned foods (66.7% vs 33.3%) whereas for British students it was the other way round (20.0% vs 60.0%).

In relation to who does most of the food cooking in their household (Q20), most students said themselves (72.7%). This included all the Arab students, but less than half of the British students (40.0%). In addition, nearly half of the British students (40.0%) reported that they usually cook separately and only occasionally together.

Nearly half the students (42.8%) reported the person who mainly does the cooking sometimes uses recipes (Q22). This included almost three-quarters of Chinese students (70.0%), but only about a fifth of British and Arab students (20.0% and 16.7% respectively). Frequent use of recipes was less common, with only 14.2% of students reporting this.

In terms of whether they think that the main cook is a skilled cook (Q30.1), the overall median rating was 5.0 (on a scale from 1 = strongly disagree to 7 = strongly agree), which is significantly above the midpoint of the scale (Wilcoxon One Sample Signed Rank Test, $W = 2.47$, $p = 0.013$). There is no significant difference between student groups (Kruskal-Wallis H Test, $H = 3.25$, n.s.).

In relation to diet type (Q25, see Table 3.6) more than half the students (57.1%) reported no restriction in their diet. This included all the Chinese students and nearly half the British students (40.0%). On the other hand, all the Arab students reported that they follow a Halal diet.

Table 3.6 Participants' diet type (Number of responses, percentage for each group)

	Chinese Students N = 10	British Students N = 5	Arab Students N = 6	All Students N = 21
Are you... (Q25)				
No restriction (eat everything)	10 (100.0)	2 (40.0)	0 (0.0)	12 (57.1)
Halal	0 (0.0)	0 (0.0)	6 (100.0)	6 (28.5)
Vegetarian (or trying/becoming)	0 (0.0)	2 (40.0)	0 (0.0)	2 (9.5)
Vegetarian	0 (0.0)	1 (20.0)	0 (0.0)	1 (4.7)

Participants' food waste practices are summarized in Table 3.7, again with only answers with more than 10% of responses from any group that are relevant to the design of the Wasteless app (full results can be found in Appendix A.1.9).

In relation to how they decide whether food is still good to eat (Q23), slightly more than half of students said they rely on appearance (57.2%). This included all the British students, half the Chinese students, but only a third of Arab students. The notable differences between the groups are that the Chinese students reported using labelling much more than Arab students (70.0% vs 33.3%), British students reported using smell much more than Chinese students (80.0% vs 20.0%), and almost two thirds of British students used taste (60.0%), with none of the Chinse students reported using this method.

In terms of throwing away unopened food (Q24), overall almost half the students reported that they hardly ever did this. This included more than three quarters of British students (80.0%), half of Arab students (50.0%), but only a fifth of the Chinese students (20.0%).

In terms of the most thrown away food items (Q27), vegetables were the most frequently mentioned item, although they only appeared in the top group for British and Arab students. Bread and other baked goods were the most common reported thrown items for Chinese students.

On reasons for reducing food waste (Q26), almost half the students reported that the most important reason would be to reduce the amount of money they spent on food. Nearly two-thirds of Chinese students (60.0%) reported this motivation, compared to less than a fifth of Arab students (16.7%). British students were equally split between reducing the amount spent on food and minimising environmental impact, with almost half of them (40.0%) reporting each reason. In addition, only Arab students (66.7%) mentioned reasons related to their religious beliefs or moral principles.

Table 3.7 Food waste practices and attitudes (Number, percentage of responses)

	Chinese Students N = 10	British Students N = 5	Arab Students N = 6	All Students N = 21
How do you decide whether food is still good to eat? (Q23) *				
Appearance	5 (50.0)	5 (100.0)	2 (33.3)	12 (57.1)
Labelling	7 (70.0)	2 (40.0)	2 (33.3)	10 (47.6)
Smell	2 (20.0)	4 (80.0)	3 (50.0)	9 (42.8)
Taste	0 (0.0)	3 (60.0)	2 (33.3)	5 (23.8)
Do you throw away food which you have not opened the packaging? (Q24) **Answers: hardly ever, rarely, sometimes, frequently, and regularly**				
Hardly ever	2 (20.0)	4 (80.0)	3 (50.0)	9 (42.8)
Rarely	5 (50.0)	0 (0.0)	2 (33.3)	7 (33.3)
Sometimes	3 (30.0)	1 (20.0)	1 (16.7)	5 (23.8)
What are the three most thrown away food items in your household? (Q27)				
Most thrown away	Bread/baked goods 4 (40.0) Meat/fish 2 (20.0)	Vegetables 2 (40.0) Dairy 1 (20.0) Fruit 1 (20.0) Other 1 (20.0)	Vegetables 2 (33.3) Fruit 2 (33.3) Bread/baked goods 1 (16.7) Dairy 1 (16.7)	Vegetables 5 (23.8) Bread/baked goods 5 (23.8) Fruit 4 (19.0) Dairy 3 (14.2)
If you were to try to reduce your food waste, what would be the most important reason? (Q26)				
To reduce the amount spend on food	6 (60.0)	2 (40.0)	1 (16.7)	9 (42.8)
To minimise environmental impact	4 (40.0)	2 (40.0)	1 (16.7)	7 (33.3)
Religious beliefs/moral principles	0 (0.0)	0 (0.0)	4 (66.7)	4 (19.0)
Have you done any positive actions to reduce food waste? (Q28)				
Yes	9 (90.0)	2 (40.0)	5 (83.3)	16 (76.2)
No	1 (10.0)	3 (60.0)	1 (16.7)	5 (23.8)
Do you know of any apps to help with food waste? (Q29)				
No	9 (90.0)	3 (60.0)	6 (100.0)	18 (85.7)
Yes	1 (10.0)	2 (40.0)	0 (0.0)	3 (14.2)
Have you used [these apps]? (Q29)				
No	9 (90.0)	5 (100.0)	6 (100.0)	20 (95.2)

Note: * = more than one response was possible, so numbers and percentages may not add to totals.

In relation to whether they have undertaken any positive actions for food waste reduction (Q28), about three-quarters of students reported they have. This included

most Chinese and Arab students (90.5% and 83.8% respectively), compared to less than half the British students (40.0%). The actions mentioned by students in a follow up open-ended question were:

- Reducing food purchased by purchasing only required items, small packages of food, or versatile ingredients to be used for several meals and not a lot of perishable food items
- Trying to eat food already at home before it expires or before buying new items
- Doing small but frequent food shops
- Doing shopping and meal planning
- Limiting the daily spend on food
- Cooking only the amount of food needed
- Recycling unneeded food.

In terms of whether they know any apps for food waste reduction (Q29), more than three-quarters of students reported they did not and almost none of the students used such apps. "Too Good to Go" (https://toogoodtogo.co.uk/en-gb/) was the only app mentioned, and only by one of the British students. This is an app which allows people to obtain unused food from restaurants, cafes and food shops. However, when asked about their experience in using it, the student said they did not use it as it only included two to three places where one could obtain unused food in York.

Participants were asked to rate their agreement with a number of statements related to food waste issues (see Table 3.8). Overall, students significantly disagreed with the statement that their households waste a lot of food (Q30.2) (median rating: 2.0). There was no significant difference between student groups. However, they also significantly disagreed with the statement that reducing food waste in their households would be difficult (Q30.3) (median: 2.0). So, they presumably think they could reduce food waste further. Again, there was no significant difference between student groups.

Table 3.8 Ratings of food waste attitudes (Median, Semi Interquartile Range) (1 = strongly disagree to 7 = strongly agree) with Wilcoxon One Sample Tests (median compared with midpoint of the scale) and Kruskal-Wallis H Tests (difference between groups)

Chinese Students N = 10	British Students N = 5	Arab Students N = 6	All Students N = 21	Wilcoxon One Sample Test	Kruskal-Wallis H Test
Our household wastes a lot of food (Q30.2)					
2.0 (0.0)	2.0 (1.0)	2.0 (0.5)	2.0 (0.0)	W = -3.77 p < 0.001	H = 0.7.8 n.s.
Reducing the food waste in our household would be difficult (Q30.3)					
2.0 (0.5)	3.0 (1.0)	2.0 (1.5)	2.0 (1.0)	W = -2.99 p = 0.003	H = 3.75 n.s.
Food waste has a significant effect on the environment (Q30.4)					
6.0 (0.5)	6.0 (1.5)	6.0 (1.0)	6.0 (1.0)	W = 3.78 p < 0.001	H = 0.25 n.s.
Food waste has a significant effect on my budget (Q30.5)					
6.0 (1.5)	3.0 (1.5)	6.0 (1.5)	5.0 (2.0)	W = 2.10 p = 0.036	H = 6.91 p < 0.05
I feel guilty when I throw food away (Q30.6)					
7.0 (0.5)	6.0 (0.5)	7.0 (0.5)	7.0 (0.5)	W = 4.030 p < 0.001	H = 3.85 n.s.
I try not to waste food (Q30.7)					
7.0 (0.5)	6.0 (0.5)	7.0 (0.5)	7.0 (0.5)	W = 4.117 p < 0.001	H = 0.51 n.s.

Overall, students significantly agreed that food waste has significant effect on the environment (Q30.4) (median: 6.0). There was no significant difference between student groups. They also significantly agreed that food waste has significant effect on their budget (Q30.5) (median: 5.0). In this case there was a significant difference between the three student groups with British students giving significantly lower ratings than either Chinese or Arab students (3.0 vs 6.0 in both cases; post hoc: British vs Chinese: p = 0.036; British vs Arab: p = 0.011). Overall students also felt guilty to a significant extent when throwing food away (Q30.6) (median: 7.0). There was no significant difference between student groups. Finally, all students significantly agree that they try not to waste food (Q30.7) (median: 7.0). There is no significant difference between student groups.

3.3.2 Food waste drivers (RQ1.1)

A codebook thematic analysis was conducted of the comments made in the initial discussion and on the PostIt exercise. As discussed in Section 3.2.5 and illustrated in Table 3.3, five main food waste drivers and 21 sub-drivers emerged from the thematic analysis.

For all students, Overbuying Food received the most votes (27.2%), and the most comments (27.2%) (see Figures 3.2 and 3.3). The breakdown of the votes and comments for the three different student groups is illustrated in Figure 3.4 and 3.5.

■ %	Overbuying	Planning	Management	Cooking	Eating
%	27.2	9.4	20.9	18.8	23.4
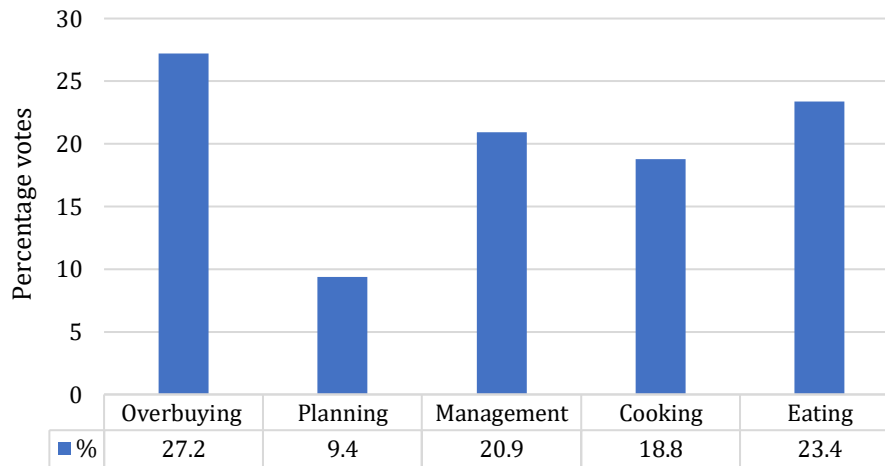
Figure 3.2 Percentage of votes allocated to each main driver for all students

Note: Overbuying refers to Overbuying Food, Planning refers to Shopping and Meal Planning, Management refers to Food Storage and Management, Cooking refers to Food Preparation and Cooking, and Eating refers to Eating and socialising.

■ %	Overbuying	Planning	Management	Cooking	Eating
%	26.9	11.4	25.4	16.1	20.2
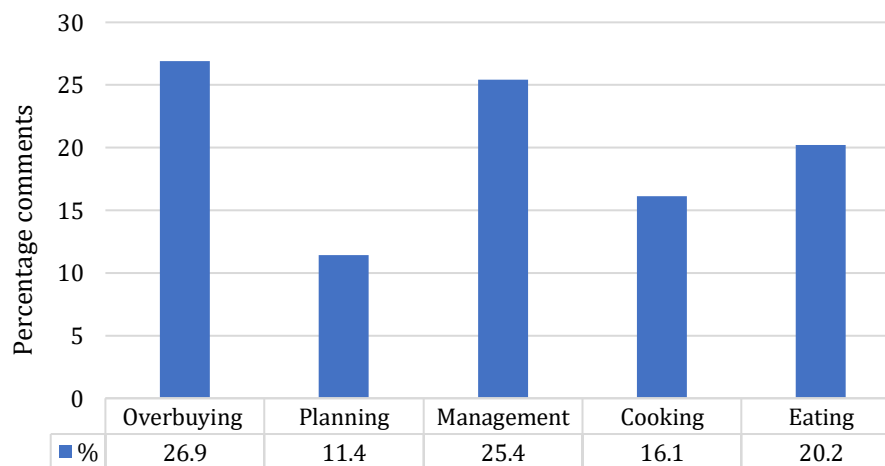
Figure 3.3 Percentage of comments allocated to each main food waste driver by all students

	Overbuying	Planning	Management	Cooking	Eating
Arab students	21.7	1.7	23.3	38.3	15
British students	34.7	26.5	16.3	12.2	10.2
Chinese students	27.2	8.4	21.2	16.6	26.6
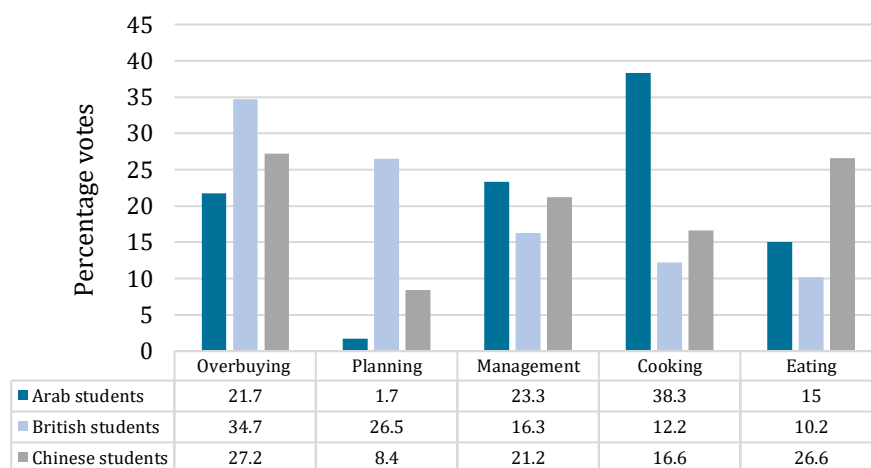
Figure 3.4 Percentage of votes allocated to each main food waste driver for students from different cultures

	Overbuying	Planning	Management	Cooking	Eating
Arab students	22.6	3.8	24.5	18.9	30.2
British students	31.8	16.7	24.2	12.1	15.2
Chinese students	25.3	13.3	26.7	17.3	17.3
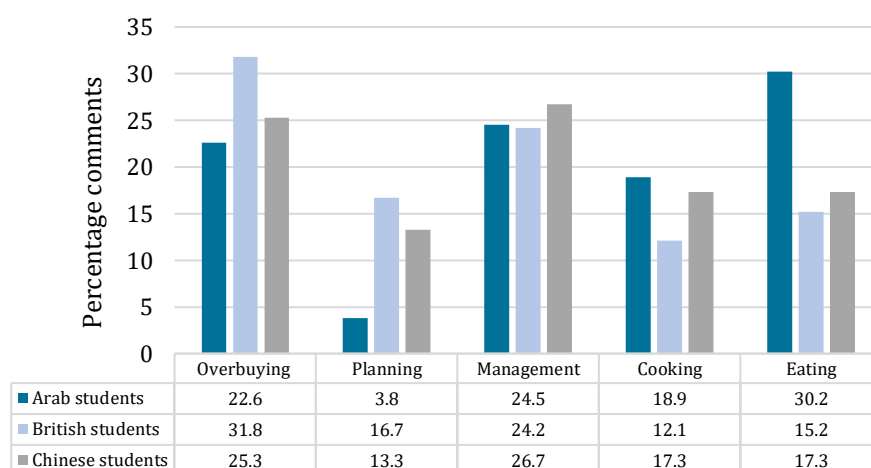
Figure 3.5 Percentage of comments made for each main food waste driver for students from different cultures

Based on the percentage of votes and comments received by each of the main food waste drivers, the level of importance of each main driver was assigned (see Section 3.2.5 for the process) (Table 3.9). For all students, Overbuying Food was the only high importance main food waste driver, and was also a high importance driver for both British and Chinese students (equal with Food Storage and Management for the latter group). However, for Arab students, Food Preparation and Cooking and Eating and Socialising were the high importance main drivers.

Table 3.9 Main food waste drivers of different levels of importance for the three student groups

Chinese students	British students	Arab students	All students
High importance			
FWD1. Overbuying food	FWD1. Overbuying food	FWD 4. Food Preparation and Cooking	FWD1.Overbuying food
FWD 3. Food Storage and Management		FWD 5. Eating and socialising	
Moderate importance			
FWD 5. Eating and socialising	FWD 2. Shopping and meal planning	FWD 3. Food Storage and Management	FWD 3. Food Storage and Management
	FWD 3. Food Storage and Management		FWD 5. Eating and socialising
Low importance			
FWD 4. Food Preparation and Cooking		FWD1. Overbuying food	

Table 3.10 shows the corresponding analysis for food waste sub-drivers. Overall, there were 8 sub-drivers in the high importance level, with all the main drivers represented. All the main drivers were also represented in the high importance category for all three student groups, although there were some differences in which particular sub-drivers were represented.

Figure 3.6 shows the overlap of high importance food waste sub-drivers among the three student groups. Only two sub-drivers (FWD2.1: Failure to make a plan and FWD4.1: Lack of time or motivation to cook) were high importance sub-drivers for all student groups. Four sub-drivers were shared by two student groups (FWD1.1: Packages too big, FWD5.2: Catering for special occasions FWD 3.2: Lack of information about what food is in the fridge or pantry, and FWD 4.4 Belief that leftovers are not healthy). Finally, 7 sub-drivers were high importance for only one group (FWD 1.2: Over optimistic buying, FWD 2.3: Communication about meal/shopping/planning, FWD 3.1: Confusion about food labels, FWD 3.3: Lack of knowledge about storing food, FWD 4.2: Lack of knowledge of how to use leftovers, FWD 5.1: Catering for "picky" eaters, and FWD 5.4: Impulse eating).

Comments illustrating the high importance food waste sub-drivers are provided in Table 3.11.

Table 3.10 Food waste sub-drivers of different levels of importance for the three student groups

Chinese students	British students	Arab students	All students
High importance			
FWD1.1 Packages too big	FWD1.1 Packages too big	FWD 1.2 Over optimistic buying	FWD1.1 Packages too big
FWD 2.1 Failure to make a plan	FWD 2.1 Failure to make a plan	FWD 2.1 Failure to make a plan	FWD 2.1 Failure to make a plan
FWD 3.1 Confusion about food labels	FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 2.3 Communication about meal/shopping/planning	FWD 3.2 Lack of information about what food is in the fridge/pantry
FWD 3.3 Lack of knowledge about storing food	FWD 4.1 Lack of time/motivation to cook	FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 3.3 Lack of knowledge about storing food
FWD 4.1 Lack of time/motivation to cook	FWD 5.1 Catering for "picky" eaters	FWD 4.1 Lack of time/motivation to cook	FWD 4.1 Lack of time/motivation to cook
FWD 4.2 Lack of knowledge of how to use leftovers	FWD 5.2 Catering for special occasions	FWD 4.4 Belief that leftovers are not healthy	FWD 4.2 Lack of knowledge of how to use leftovers
FWD 4.4 Belief that leftovers are not healthy		FWD 5.4 Impulse eating	FWD 5.2 Catering for special occasions
FWD 5.2 Catering for special occasions			FWD 5.4 Impulse eating
Moderate importance			
FWD 1.2 Over optimistic buying	FWD 1.2 Over optimistic buying	FWD 1.4 Impulse buying	FWD 1.2 Over optimistic buying
FWD 1.3 Influenced by offers	FWD 2.2 Failure to stick to a plan	FWD 3.3 Lack of knowledge about storing food	FWD 2.2 Failure to stick to a plan
FWD 2.2 Failure to stick to a plan	FWD 3.3 Lack of knowledge about storing food	FWD 3.4 Lack of space to store food	FWD 4.4 Belief that leftovers are not healthy
FWD 5.1 Catering for "picky" eaters	FWD 3.4 Lack of space to store food	FWD 5.3 Cooking a lot, but not eating it	FWD 5.3 Cooking a lot, but not eating it
FWD 5.3 Cooking a lot, but not eating it	FWD 4.2 Lack of knowledge of how to use leftovers		
	FWD 4.4 Belief that leftovers are not healthy		
	FWD 5.4 Impulse eating		
Low importance			
FWD 1.4 Impulse buying	FWD 1.3 Influenced by offers	FWD 1.3 Influenced by offers	FWD 1.3 Influenced by offers
FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 5.3 Cooking a lot, but not eating it	FWD 1.5 Advertising (on TV, in store)	FWD 2.3 Communication about meal/shopping/planning
FWD 5.4 Impulse eating		FWD 4.2 Lack of knowledge of how to use leftovers	FWD 3.1 Confusion about food labels
		FWD 5.2 Catering for special occasions	
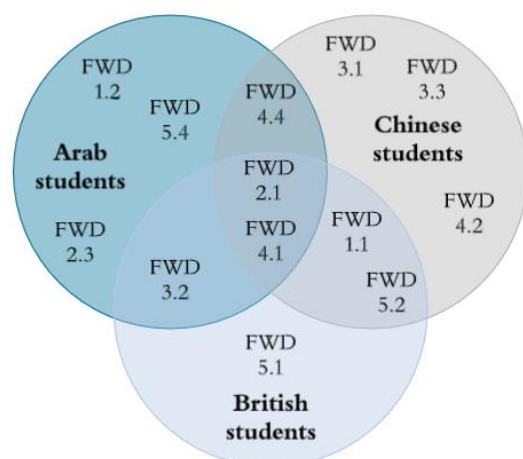
Figure 3.6 *High importance* food waste sub-drivers for
the three student groups

Table 3.11 Participants' comments made about *High importance* food waste sub-drivers

Driver/Sub-Driver	Example comments
FWD1: Overbuying food	
FWD1.1: Packages being too big	I only cook for myself so often have to buy larger packages of vegetables or salad than I want (BS5) Totally agree! Especially for potatoes. So difficult to buy one single potato for me, which is the amount I need (CS3)
FWD1.2: Over-optimistic buying	Yes, when I try to eat more fruit and vegetables to be healthy. I lose enthusiasm easily (AS4)
FWD2: Shopping and meal planning	
FWD 2.1: Failure to make a plan for shopping or meal	I don't put much time aside to think about a meal plan (BS2)
FWD 2.3: Communication about meal, shopping, and planning	Yes, being alone helped me a lot in managing the waste (AS5)
FWD3: Food storage and management	
FWD 3.1: Confusion about food labels	I can't identify the difference between display by and use by (CS8)
FWD 3.2: Lack of information about what food is in the fridge or pantry	I always forget what I have in my fridge! (AS2)
FWD 3.3: Lack of knowledge about storing food	Chicken spread smell in the fridge as the package has been destroyed and then chicken fillet has been spread all the smell in the fridge lead the accommodation to change the fridge (CS8)
FWD4: Preparing and cooking food	
FWD 4.1: Lack of time or motivation to cook	I agree, sometimes I don't have time to cook, so I buy ready meals (AS2)
FWD 4.2: Lack of knowledge of how to use leftovers	Yes, especially for some meat and vegetables (CS5)
FWD 4.4: Belief that leftovers are not healthy	Sometimes I feel it is unhealthy to eat cooked food couple of days ago (AS4)
FWD5: Eating and socializing around food	
FWD 5.1: Catering for "picky" eaters	Yes! (BS1)
FWD 5.2: Catering for special occasions	Yes. Especially Chinese New Year Eve (CS4)
FWD 5.4: Impulse eating	Appetite, I put food in the fridge, but I don't want to eat it again that's why I waste it (AS5)

3.4 Discussion and conclusion

This study aimed to explore postgraduate university students' attitudes and practices in relation to food consumption and waste. It was conducted to answer RQ1.1 in this programme of research (RQ1.1: What are the similarities and differences among postgraduate university students from three different cultures in terms of their practices around food consumption and food waste and the drivers which lead them to waste food?).

In relation to students' practices around food consumption and food waste, the study found both similarities and differences among postgraduate university students from three different cultures in relation to their attitudes and practices around food and food waste. Regardless of culture, students generally believe that their households did not waste much food. In addition, they waste the same food items in their households. However, there were also clear differences between students from different cultures (e.g., different motivating reasons to reduce their food waste).

In relation to the drivers which lead them to waste food, the study found that students from different cultures have different drivers towards food waste, although some drivers were in common between the student groups. "Overbuying food" was the main food waste driver for both Chinese and British students; however, both "Food preparation and cooking" and "Eating and socialising" were the main drivers for Arab students. "Food storage and management" was also the main driver for Chinese students.

3.4.1 Implications for technological interventions to support food waste reduction

The results of students' practices and attitudes around food and food waste (see Section 3.3.1) as well as the results in relation to the food waste drivers (see Section 3.3.2) have implications for the design of interventions to support food waste reduction.

Table 3.12 illustrates how the results of the questionnaire about students' practices might have relevance for the design of interventions and Table 3.13 illustrates of the results on the food waste drivers might have relevance. Both tables include consideration of cultural differences between the students, and whether these differences might need particular support to be given by researchers or designers of

technological interventions for food waste reduction. For example, for Chinese and British students, interventions could provide support for over buying (e.g., discouraging buying packages of food that are bigger than really needed), while for Arab students provide support for eating and socialising (e.g., helping them with the issue of impulse eating by providing easy and delicious recipes to increase their desire to use up their available food).

Table 3.12 Implications of the findings for technological interventions to support food waste reduction (**Note:** if an implication does not mention particular student groups, it would apply to all student groups studied in this chapter)

Finding (for all students)	Cultural differences in finding	Implications for technological interventions
Most students did food shopping by themselves (Q12).	None.	Provide support for the creation of personal shopping lists. Provide support for sharing shopping lists with others in their household.
Shopping in supermarkets was the most popular method for all students (Q15).	Chinese and Arab students shop online. Chinese students shop in specialist shops and markets.	Provide support during supermarket shopping (e.g., checking of household food stock while shopping). Link supermarket loyalty cards/user accounts to other interventions to facilitate food information management. Link to preferred supermarket websites, to allow notification of special offers/promotions. Provide comparative information about preferred supermarkets, based on distance, or prices. For Chinese students, provide information about specialist shops and markets.
Fresh foods are the most preferred type of food purchased by all students (Q16). Fresh foods such as fruit, vegetables and bread and baked food are the most wasted items in student households (Q27).	None.	Provide support to purchase only needed amounts of fresh food. Provide information about how to store fresh food to maximize its shelf-life. Provide information about how to use up leftover fresh food. Provide information about nutritious alternatives to fresh food which last longer (e.g., frozen, canned foods).
Most students cook by themselves in their households, using recipes with different levels of frequency (Q20, Q22).	Chinese students reported using recipes sometimes more than other groups.	Support students who cook for themselves. Provide strategies to increase students' knowledge and skills related to cooking. For example,

		provide recipes to help cook appropriately.
Students has a variety of diets – no restrictions, vegetarian, Halal (Q25).	Arab students were Halal. Chinese students had no dietary restrictions. British students had different diets.	Provide support for different diets, considering in individuals' preferences, health conditions, culture and religion.
Above half of students relied on appearance in checking food edibility (Q23).	Labelling is commonly used by Chinese students. Using food appearance is common by British students. Using smell is common by Arab students.	Provide advice for British and Arab students who use appearance or smell to check food edibility.
Students did not believe their household wasted a lot of food, and also they did not believe that it would be difficult to reduce food waste in their household (Q30.2 and Q30.3).	None.	Support students by enhancing their awareness of their wasted food. For example, provide means to improve the visibility of how much food they wasted.
Students believed that food waste has effect on the environment and on their budget (Q30.4 and Q30.5).	For the effect on budget, British students gave lower ratings than other groups.	Provide support in monitoring the cost of food waste.
Almost half students would reduce food waste to reduce the amount of money spent on food (Q26).	For Chinese students, the motivational reason was to reduce the amount spend on food. For Arab students, reasons related to religious beliefs or moral principles. For British students, to reduce the amount spend on food and to minimise environmental impact.	See previous item about providing support on cost of food waste. In addition, for Arab students, use the link between religious and moral principles and food waste to motivate them.
Students feel guilty when throwing food away (Q30.6).	None.	Support students to reduce the amount of food being thrown away. Provide positive feedback when students conserve food that might otherwise being wasted.

Table 3.13 Implications of food waste drivers for interventions to support food waste reduction
(**Note:** if the implication does not mention a student group, it would apply to all student groups studied
in this chapter)

Finding (for all students)	Cultural differences	Implications
Overbuying food is a High importance main driver for students.	High importance for Chinese and British students. Low importance for Arab students. **Sub-drivers underlying Overbuying food:** For Chinese and British students: Packages too big. For Arab students: Over optimistic buying.	For Chinese and British students, provide information about appropriate packages sizes to buy, facilitate sharing extra food with others, and facilitate finding longer lasting substitutions for foods. For Arab students, provide information about if it is worth to buy food and the sufficient amount to buy.
Food storage and management is a Moderate importance main driver for students.	High importance for Chinese students. Moderate importance for British and Arab students. **Sub-drivers underlying Food storage and management:** For Chinese students: Confusion about food labels and Lack of knowledge about storing food. For British and Arab students: Lack of information about what food is in the fridge/pantry.	For Chinese students, provide information to increase knowledge about food labels and storing food. For British and Arab students, provide information of what food is in the fridge or pantry.
Eating and socialising is a Moderate importance main driver for students.	High importance for Arab students. Moderate importance for Chinese students. No importance for British students. **Sub-drivers underlying Eating and socialising:** For Chinese students: Catering for special occasions. For Arab students: Impulse eating.	For Chinese students, provide support with catering for special occasions. For Arab students, provide easy and delicious recipes to increase their desire to use up available food.
Shopping and meal planning is not perceived as an importance main driver for students.	Moderate importance for British students. No importance for Chinese and Arab students. **Sub-drivers underlying Shopping and meal planning:** For British students: Failure to make a plan.	For British students, provide information about the importance of making shopping and meal plans for reducing food waste. Provide encouragement to make shopping/meal plans.
Food preparation and cooking is not perceived as	High importance for Arab students.	For Chinese and Arab students, provide motivations to cook and to make time for cooking.

an importance main driver for students.	Low importance for Chinese students.	Provide information of food safety including leftovers, and re-heating food.
	No importance for British students.	For Chinese students, provide suggestions to use up particular foods and leftovers.
	Sub-drivers underlying Food preparation and cooking:	
	For Chinese and Arab students: Lack of time/motivation to cook and Belief that leftovers are not healthy.	
	For Chinese students: Lack of knowledge of how to use leftovers.	

3.4.2 Comparison with the previous literature

This study investigated the food and food waste practices of university students from three very different cultures, a Western culture and two non-Western cultures. In comparison, there is only a small body of previous research which has investigated food waste issues with university students (e.g., Clark & Manning, 2018; Ghinea & Ghiuta, 2019; Mondejar-Jimenez et al., 2016; Nikolaus et al., 2018; Tsai et al., 2020; Yagoub et al., 2022). However, these studies were generally conducted with students from single cultures. Clark and Manning investigated students in the UK. Ghinea and Ghiuta studied students in Romania, Nikolaus et al. studied students in the USA, Tsai et al. examined students in China, and Yagoub et al. studied students in the United Arab Emirates (UAE). To the best of my knowledge, only two studies (Bravi et al., 2020; Mondejar-Jimenez et al., 2016) investigated the practices for students or young people in different cultures in order to be able to be investigate cultural differences in young people at the beginning of their adult lives. However, Bravi et al. studied Italian, Spanish, and UK young adults. Whereas Mondéjar-Jiménez et al. studied Italian and Spanish students, who have similar dietary patterns (Bravi et al., 2020). So, the studies did not compare Western and non-Western cultures. In addition, some researchers (e.g., Tsai et al., 2020) conducted their studies based on limited theoretical backgrounds (i.e., TPB). Thus, the outcomes of these studies in relation to food waste drivers were varied, making the possible impact of culture on students' practices around food and food waste unclear.

This study therefore addressed this gap in the research by exploring three cultural groups of students in relation to their practices and drivers to food waste, along with a comparison between the student groups. This contribution can inform researchers in the area of food waste and designers of technological interventions to reduce food

waste (see Section 3.4.1), the use of which can be influenced by culture and thus need to be designed specifically for particular cultures to improve the effectiveness of the proposed interventions.

With respect to the kinds of foods most wasted, this study found that across all three cultural groups, students wasted vegetables, fruit and bread. Several previous studies with students also commented on common foods wasted. Mondejar-Jimenez et al. (2016) found the same food types were commonly wasted by both Italian and Spanish students, although they also found some cultural differences, with Italian students wasting pasta but Spanish students wasting convenience foods. Clark and Manning (2018) found that UK students wasted vegetables, fruit and milk, but not bread, as was found in the current study. Bravi et al (2019) however found that ready meals, sauces, and beverages were the most wasted food for Italian young people.

In relation to belief about the level of food waste, this study found that across all three cultural groups, students did not believe their household wasted a lot of food. Thus, this belief does not seem to be affected by culture. This also agreed with the findings of research conducted with Italian and Spanish students by Mondejar-Jimenez et al. (2016). This could be related to the "unrealistic optimism", when students think that negative events are less likely to occur to them than to others. Research has shown that unrealistic optimism is not affected by variables such as gender or cultural background (O'Sullivan, 2015). Another possible interpretation could be because of the busy lifestyles of students. So, this could make them focus on high priority daily activities they have rather than the issue of food waste. Thus, technological interventions for students (regardless of their cultures) could improve the students' awareness of their wasted food.

In relation to motivation for food waste reduction, this study found that the three student groups had different motivations to reduce their food waste. For British students, the motivation was to both reduce the amount they spend on food and to minimise environmental impact. However, for Chinese students the motivation was only to reduce the amount they spend on food. On the other hand, Arab students were motivated by religious beliefs or moral principles. For Arab students, this could be because the strong belief of Muslims that food should be saved rather than wasted. In addition, as discussed by Yoreh and Scharper (2020) in relation to extravagance in

Islam, providing evidence from the Qur'an ("Good does not like wasteful people", The Qur'an 6:141). However, this was in contrast with the research conducted by Yagoub et al. (2022), where they found that the motivating reason for students in the UAE was concern for the environment. Considering environmental impact as a motivation for food waste might be related to the level of awareness the students have. Clark and Manning (2018) found that UK students were aware of the environmental implications of food waste, especially students who had food topics in their university courses. However, Tsai et al. (2020) noted that China has had a late start in environmental education, and even when it is introduced, if the environmental education course conflicts with other courses, it is usually ignored. So, this results in a lack of awareness of environmental problems.

In relation to the most important food waste drivers, this study found that "Overbuying food" was the High importance main food waste driver for both Chinese and British students, but not for Arab students. This agreed with the findings by Bravi et al. (2020), about British young people's purchasing of excess food. However, this finding was in contrast with the findings by Yagoub et al. (2022), which found that over purchasing is one of the common reasons for students in the UAE. This may be related to the different cost of food in the different countries. In fact, the cost of food in the UK is higher than in the UAE, therefore Arab students who were living in the UK might be more cautious for buying unneeded food. This may also explain the finding of this study in which Arab students in the UK thought that food waste has a significant effect on their budget. "Packages too big" was the sub-driver underlying "Overbuying food" for both Chinese and British students. However, this sub-driver had no importance at all for Arab students. This might be due to the culture of abundance in food buying in Arab countries such as Saudi Arabia, as Baig, Al-Zahrani, et al. (2018) mentioned, Saudi consumers usually purchase food in large packages. This might be related to the culture of hospitality in Saudi Arabia, as they prepare too much food as a gesture of welcome. Baig, Al-Zahrani, et al. (2018) also noted that people who save food are seen as unwelcoming and misers in Arab culture. Another possible reason could be that in Saudi Arabia, the size of families and the number of household members is often bigger compared to the UK. Furthermore, usually food such as fruits and vegetables are sold in Saudi Arabia in bigger quantities compared to the UK.

In relation to the most important food waste sub-drivers, this study found that "Confusion about food labels" and "Lack of knowledge about storing food" were the sub-drivers underlying "Food storage and management" only for Chinese students. Although this is different from the results from the quantitative data, where most Chinese students said they use labelling to decide whether food is still good to eat or not. However, they might use labelling in addition to other methods such as food appearance and/or smell. In addition, the source of the problem for Chinese students might be because Chinese students are less familiar with the food labels used in the UK. Patra et al. (2022) cited a relatively new draft standard for food labels in China (Foreign Agricultural Service, 2020) to have "Best Before" and "Shelf Life ends on". In addition, Y. Chen (personal communication, March 20, 2023) explained that in China fresh food such as vegetables, fruit, and meat have no labels that show the "best by" or "use by" dates, because these are not packaged for sale, these are loose sales. Although packaged vegetables, fruits, and meat have labels that show the "use by" dates, such packaged goods are not mainstream. Further, she mentioned that these labels are less common in China than the UK, as people in China usually judge whether food is edible according to the state of the food, not the date.

However, this study found that "Confusion about food labels" had no importance for British students, which disagrees with Clark and Manning (2018), who found that UK students misunderstand food labels. However, "Lack of time/motivation to cook" and "Belief that leftovers are not healthy" were the sub-drivers underlying "Food preparation and cooking" as well as "Impulse eating" underlying "Eating and socialising" only for Arab students. Although Clark and Manning (2018) found that UK students wanted to eat what they preferred and not what they should eat, such as leftovers, this study found that "Impulse eating" was only of Moderate importance for British students.

Interestingly, the study found that across all three cultural groups, "Failure to make a plan" and "Lack of time or motivation to cook" were the most sub-drivers for students. This could be because of the life stage the participants were at, as they could be busy with their studies and have minimum time for such planning. Bravi et al. (2019) discussed the issue of lack of time to cook food for Italian young people, and Bhatti et al. (2019) studied the association of time pressure and food waste for Pakistani young

people. Another possible reason could be that students at the beginning of their adult lives might lack food management and cooking skills. Tsai et al. (2020) mentioned that young people have little idea about ingredients, older people have more cooking skills and more time to engage in cooking activities. In fact, having little knowledge or experience in planning or cooking could require students to spend more time and effort, and thus may decrease their motivation to do these activities. Hebrok and Boks (2017) reported that younger people seldom make shopping lists compared to older people. This study has provided evidence that regardless of culture, time pressure affects young adults. In addition, this could also be because students have not yet learnt the importance of strategies for shopping and eating in ways that wastes the least food possible. The similarities between student groups in relation to drivers to food waste highlight the importance of life stages as a factor that might impact individuals. Therefore, an investigation of life stages will be conducted in Study 2 of this programme of research (Chapter 4), using another two different life stages.

The study revealed the main food waste drivers and the sub-drivers underlying them for each cultural group of students. In addition, it categorised each of the main and sub-driver for each group to whether they are *High*, *Moderate*, or *Low importance* This helped to reduce the long and complex list of food waste drivers that were discussed in the literature. Thus, future researchers and designers of technological interventions can give more attention to the *High importance* food waste drivers. However, technological interventions which have the potential to be used by students will be investigated in Study 4 of this research (see Chapter 7).

3.4.3 Limitations of the study

The study had some limitations which should be highlighted. The study used an opportunistic sample (Flick, 2018) of postgraduate university students who volunteered to be in a study about waste food and reducing food waste using technology. Such individuals may be particularly interested in being in research, even if they received a small payment for participating as reward. It might also be that people who volunteered to be in the study are more interested in food waste reduction than the overall postgraduate university student population. In addition, all participants were students at the University of York, and were living in York. Therefore, the findings of this study are not necessarily representative of either national or international

students in the UK. Moreover, all students were postgraduate students rather than just young adults. This was because I wished to compare individuals from different cultures, and there is a very large number of international students from different cultures (particularly students from China and the Arab countries) at the University of York, as discussed in Section 3.1.

The study used self-report measures, so the results reflect participants' conscious statements about their attitudes and behaviour food practice and food waste, which may well be susceptible to social desirability bias (Nederhof, 1985). However, some techniques were used in order to mitigate such bias. For example, assuring the anonymousy and confidentiality of the responses to minimise the stress of reporting undesirable behaviours around food waste; informing participants at the beginning of the study that there were no "yes" or "no" answers, just their opinions, in order to make them feel more comfortable in answering the questions and not feeling that they were going to be judged by others. However, particularly in the focus groups discussions, participants may have felt peer pressure and pressure from the researcher to give appropriate answers. Whereas, participants might not have this kind of pressure when doing the questionnaire and the semi-anonymity of the PostIt note comments.

Further, the languages used for different student groups might have impacted on the findings. This is because I used English in the interviews with British students, and Arabic in the focus group with Arab students, their native languages. However, I used English in the focus group with Chinese students. Therefore, both British and Arab might have been more comfortable in participating and explaining their opinions around food waste as they used their native language. However, for Chinese students this might be less comfortable, especially as the study was conducted using a focus group. So, they may have felt peer pressure in discussing topics using another language. In addition, the fact that I, as the researcher, am Arabic, might have influenced the findings by my understanding Arab students more than the other student groups. This might have also made Arab students more comfortable and confident in discussing their practice and culture around food. This might have also affected my interpreting the results.

In addition, although giving the presentation to the student participants before they voted for the statements had some advantages as discussed earlier in this chapter (see

Section 3.2.1), there could be some disadvantages which need to be highlighted. There might have been an increase in the social desirability bias in participants voting behaviour due to them being more aware of the importance of food waste. Thus, they might have felt they should have been doing things about it. Thus, in future research, I would ask people if they are aware of the problems of food waste and ask more questions before introducing the importance of the problems, as well as asking them questions about whether this information would be likely to change their attitudes and behaviour.

The study was unbalanced with respect to gender, 71.4% of participants were women. This has been the case with many previous studies on this topic (e.g., Yagoub et al., 2022 had 71.6% women; Nikolaus et al.,2018 had 63.7% women). Yagoub et al. (2022) reported that some studies such as those by Buzby and Guthrie (2002) and Kijboonchoo et al. (2013) stated that women wasted food more than men, however other studies such as those by Barr (2007) and Li (2017) indicated that women are more likely to reduce food waste than men. Future research should focus on the effect of gender as a factor in different cultures, and whether the differences between men and women is vary among different cultures.

The number of participants in each student group was small (10 Chinese students, 6 Arab students, and 5 British students). This might have had an effect on the results of the study. However, this was an exploratory study, to give ideas about different student groups in relation to food consumption and waste, and the plan was to follow up with studies with larger samples of participants. In the end this was only possible with the UK participants due to the Covid-19 pandemic, but Studies 3 and 4 were conducted with large samples of UK participants. Study 3 recruited 135 UK participants including 19 students, and Study 4 recruited 215 UK participants including 63 students. However, in Study 1, a lot of data, both quantitative and qualitative, was collected from each participant highlighting their practices around food and food waste, as well as drivers in relation to food waste.

Participants in this study also had different living conditions, although more than half of them (57.1%) were living with other students. Approximately a quarter (23.8%) were living alone, and some (only 14.2%) were living with children. Two students were in the Arab group (33.3% of the group), one was in the British group (20%), and one in

the Chinese group (10%). The different living conditions would undoubtedly affect food and food waste practices. For example, catering for "picky" eaters was a High importance sub-driver for British students, which could be due to the participant who living with children in this group. Marriage age and having children might be related to the culture of the student group.

This study highlighted the similarities and difference between participants at the same stage of life (i.e., postgraduate students) from three cultures in terms of food practices and food waste and drivers to food waste. Therefore, next chapter will present the second study which provided further exploration of participants from different life stages (i.e., family members and older people) from two cultures, Arab and the UK.

Chapter 4

Study 2: A study of food consumption and waste related attitudes and practices by family members and older people from two cultures

4.1 Introduction

This chapter presents the second study in my programme of research, which was conducted to achieve the objective of the second phase of the research, understanding and investigation. The study extended the research in Study 1 by investigating the attitudes and practices in relation to food consumption and waste of two groups at different life stages from the students, family members living with children and older people from two different cultures, Arab and UK. The results of Study 1 showed some similarities and some differences between the student groups from the different cultures. Therefore, I wanted to explore whether that pattern of similarities and differences extended to later life stages. Thus, this study was conducted with two different life stages (family members and older people) to further investigate whether *Life stage* has an impact on food-related attitudes and practices and food waste or not. I did not have access to Chinese participants at these two life stages, so the study focused on only two of the cultures from Study 1. In addition, this chapter compares the results from this study with the results from Study 1.

To further investigate the role of *Life stage* and *Culture* on individuals' attitudes, practices, and drivers around food and food waste (see Chapter 1, Section 1.1), this study targeted individuals at two further stages of life and from two different cultures. This study targeted individuals in family situations living with children under the age of 18 living at home; and older people, living alone, with a partner or with adult family members over the age of 18. The rationale for selecting individuals at these different life stages is that these individuals may have different attitudes, problems and behaviours in relation to food waste due to their differing living situations and experience of life. Family members living with children may have pressures of time and

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money, as well as child "pester power" and "picky" eating. On the other hand, older people may have more time, but concerns about money and lack motivation to prepare complex meals if their children have grown up and left home or their partner has died. In terms of the two cultures, Arab and British are very different cultures in terms of religion and cultural traditions which may influence people's attitudes to food consumption and waste, and rituals around food and hospitality (see Chapter 1, Section 1.1; and Chapter 2, Section 2.2).

Thus, this study was conducted to address RQ1.2 in my programme of research:

RQ1.2: What are the similarities and differences among individuals from different cultures living in family situations with children and older people in terms of their practices around food consumption and food waste and drivers that lead them to waste food?

The comparison of the results of this study and Study 1 was conducted to address RQ1.3 in this research:

RQ1.3: What are the similarities and differences among individuals at three different life stages and from two different cultures in terms of their practices and attitudes around food consumption and food waste and drivers that lead them to waste food?

4.2 Method

4.2.1 Design

Face-to-face interviews and questionnaires were conducted with individuals in family members with children under 18 living at home and with older people who were living alone, with a partner or with adult family members (over the age of 18), from both Saudi Arabia and the UK. Due to constraints in the availability of participants, interviews were conducted with British family members, British older people and four Arab family members, and questionnaires were completed by Arab older people and one of the Arab family members. Arab participants in this study were all from Saudi Arabia, although I attempt to recruit participants from other Arab countries. However,

because my contacts were in Saudi Arabia all participants were from Saudi Arabia. The subject matter was kept as close as possible in both methods.

The same design of Study 1 was used in this study. Similar to Study 1, ("I don't have a good communication with partner about what meals will be prepared to know what to buy") was included only for Arab participants. This is because Baig, Gorski, et al. (2018) discussed the culture of separation of responsibility for food shopping and cooking between men and women in Saudi Arabia, which means that a lack of good coordination between them could lead to food waste.

However, there were slight adjustments on the initial set of statements about food-related practices and food waste used in Study 1 (see Chapter 3, Table 3.1). An additional statement was added in Shopping for food for only Arab participants, who were all from Saudi Arabia in this study, ("Food in our country is affordable, so I would not be affected when I buy more food"). This is because as Aljamal and Bagnied (2021) mentioned, even when food prices rise, the Saudi government provides mechanisms involving price caps and subsidies to maintain relatively low prices. However, policies which help maintain food relatively affordable might contribute to high levels of waste through encouraging buying and preparation of extra food than will actually be consumed (UN FAO, 2014) (see Chapter 2, Section 2.2.4). For Arab participants, the statement "I don't know the difference between "sell by"/ "use by"/ "best before" date" was changed to "production" and "expiry" dates, as these are the terms used in Saudi Arabia.

4.2.2 Participants

Participants were recruited via several methods: sending emails to older people in the UK, personal encounters with potential participants who were working at the University of York, and personal contacts with participants in Saudi Arabia. The inclusion criteria for family member participants were to be an individual living in a family situation with children under 18 years of age from one of the two target cultures (Arab or UK) and be between the ages of 30 to 49 years. The inclusion criteria for older participants were to be an individual living alone, with a partner or with adult family members (over the age of 18) from one of the two target cultures (Arab or UK) and be 50 years old or above.

The demographics of the participants are summarized in Table 4.1. 28 individuals participated in the study, 17 women and 11 men, family members aged from 30 to 49 years (mean age 38.7 years), and older people aged from 50 to 78 years (mean age 65.9 years). 16 participants (57.1%) were from the UK, 12 participants (42.9%) all from Saudi Arabia. Detailed demographic information of participants is provided in Appendix B.1.1. Participants were offered an Amazon or Marks and Spencer gift voucher for £10 in thanks for their participation. For participants who completed the questionnaire in Saudi Arabia, as it was difficult to find an appropriate reward and they were happy to do it for free.

Table 4.1 Demographic information for the participants in Study 2 (Number and percentage)

	Arab Family members N=5	British Family members N=6	Arab Older people N=7	British Older people N= 10	All participants N=28
Gender					
Women	5 (100.0)	5 (83.3)	2 (40.0)	5 (50.0)	17 (60.7)
Men	0 (0.0)	1(16.7)	5 (60.0)	5 (50.0)	11 (39.3)
Age					
Range (years)	30-35	32-49	50-65	69-78	30-78
Mean	32.5	42.8	57.6	71.8	55.9
Standard Deviation	2.1	6.6	6.2	2.9	15.6
Country of origin					
N (%)	SA: 5 (100.0)	UK: 6 (100.0)	SA: 7 (100.0)	UK: 10 (100.0)	SA: 12 (42.9) UK: 16 (57.1)
Employment					
Employee	5 (100.0)	6 (100.0)	0 (0.0)	0 (0.0)	11 (39.3)
Housewife	0 (0.0)	0 (0.0)	2 (28.6)	0 (0.0)	2 (7.1)
Retired	0 (0.0)	0 (0.0)	4 (57.1)	10 (100.0)	14 (50.0)

Note: SA means Saudi Arabia.

4.2.3 Equipment and materials

The same equipment was used as in Study 1 (see Chapter 3, Section 3.2.3). Materials were the same as used in Study 1, with slight changes described below.

The demographic and general questionnaire was slightly changed to make it suitable for family members and older people (see Appendix A.1.3). The questionnaire was in English for British participants and was in Arabic for Arab participants.

The set of open-ended questions was the same in Study 1, again in English with British participants and in Arabic with Arabic participants.

Materials for the Comment and voting exercise were mainly the same as in Study 1. They provided the initial set of 33 statements about food-related practices and food waste. However, two additional statements ("I don't have a good communication with partner about what meals will be prepared to know what to buy" and "Food in our country is affordable, so I would not be affected when I buy more food") were included only for Arab participants. In the statement ("I don't know the difference between "sell by"/ "use by"/ "best before" date") was changed to "production" and "expiry" dates for Arab participants in Saudi Arabia. The statements were in English for British participants and were translated into Arabic for Arab participants.

To make them easy to use for older people, a sheet of 10 sticky arrows which were larger than the sticky dots used to "vote" for the statements.

The questionnaire included an information page with the nature of the study, the confidentiality and anonymity of participants' data assured, and a consent box to be checked by participants as agreement to participate in the study. It included demographic and general questions, a question about food waste statements (listed in Chapter 3, Table 3.1, with slight adjustments) to comment on, and a question to vote for the statements. Participants were asked to vote for statements which they thought had the most effect on them by using 10 asterisks (equivalent to the dots in Study 1). Participants could allocate their votes however they wished, putting all the asterisks on one statement, or one asterisk on each of 10 statements or any combination in between. There was no initial discussion and presentation provided for participants who completed the questionnaire.

The questionnaire was developed in Arabic using the Qualtrics online survey system. As some Saudi older participants preferred to answer the questionnaire on paper, the questionnaire was also available as a paper copy.

The interview materials included the same materials for the participants of the focus groups, a consent form, a demographic and general questionnaire. For the researcher, the materials were also the same as in the focus groups, a set of open-ended questions

for the initial discussion, a slide presentation about food waste, and an A4 sheet which included a table of food waste statements for participants to comment and vote on.

4.2.4 Procedure

The study was conducted between October 2019 and February 2020.

4.2.4.1 Procedure for the interviews

The same procedure for the interviews was used as in Study 1 (see Chapter 3, Section 3.2.4.2). The English language was used to interact with British participants in the interviews, Arabic was used with the Arab participants in their interviews.

4.2.4.2 Procedure for the questionnaires

The online survey was distributed via social media (e.g., WhatsApp.com). However, for older individuals, hard copies were sent to their households. Participants were informed about the nature of the study, and the approximate completion time of the questionnaire. In addition, they were informed that all information they provided would be confidential and stored securely. To mitigate the potential social desirability bias, participants were informed that no judgements would be made about their attitudes or behaviour, as we all waste food. However, by conducting this study I was trying to find out what people know about the issues, and how I can use that to help people waste less food.

Data were collected automatically from online participants; however, hard copies were collected manually from each participant.
On average, the questionnaire took between 30 and 45 to complete.

4.2.5 Data analysis

The quantitative data collected from the questionnaire about food practice and attitudes to food shopping habits, cooking and diet, as well as food waste, was analysed using Statistical Package for the Social Sciences (SPSS) version 28. For the qualitative data, the data analysis was conducted manually, without use of any software.

4.2.5.1 Transcription and translation

The following text sources were originally in English, so were transcribed in English:

- Initial verbal discussion in interviews (British family members and British older people)
- Written answers on the sheet about food waste statements (Arab family members and Arab older people)

4.2.5.2 Codebook thematic analysis

The same codebook thematic analysis approach, which is used for Study 1 (see Chapter 3, Section 3.2.5.2) was also used for this study. The codebook was the same as used for Study 1 (see Appendix A.1.7), with an addition of one more code to include a statement that was not included in Study 1 (Food in our country is affordable, so I would not be affected when I buy more food). Thus, the list of food waste drivers and sub-drivers to be used in the thematic analysis is the same as in Chapter 3, Table 3.3, with an addition of one code, which is:

> FWD 1.6 Food is cheap: Food is relatively economic and affordable in the country whether the participant lives which encourages overbuying.

4.2.5.3 Quantitative analysis of votes and comments

This was the same analysis as described in Chapter 3, Section 3.2.5.3.

4.3 Results

The results include two main sections, which answered RQ1.2. The results from the questionnaire about food practices and attitudes and food waste (see Appendix A.1.3), and the results of the codebook thematic analysis of food waste drivers. In addition, it includes the results of the analysis comparing the results from Study 1 and 2, which answered RQ1.3.

4.3.1 Food practices and attitudes to food waste (RQ1.2)

As in Study 1, participants were asked a number of questions about their food shopping habits, their cooking practices and what diet they follow (see general questionnaire,

Appendix A.1.3). They were also asked about their food waste practices and attitudes to food waste, and about factors influencing them towards reducing food waste.

The key results are summarized in Table 4.2. Only answers with more than 10% of responses from any participant group that are relevant to the design of the Wasteless app (see Chapter 6) are presented (full results can be found in Appendix B.1.3).

Participants do most of the food shopping for the household themselves (Q12), with almost two-thirds of participants giving this response. This included about two-thirds of British family members (66.7%), British older people (70.0%), and Arab older people (71.4%). However, almost two-thirds of Arab family members (60.0%) reported their spouses did the shopping for food.

Almost all participants reported shopping at supermarkets (Q15). Only about a tenth of them reported online shopping for food. The notable differences between the groups are that almost half of older people reported shopping in specific shops such as bakeries, open air markets or farm shops compared to less than a fifth of family members.

All participants reported buying fresh food (Q16). Next in popularity were frozen and canned foods (46.4% and 42.9%), with just about a tenth reporting buying pre-cooked meals (10.7%). The notable differences between the groups are that the British older people reported buying frozen foods much more than Arab older people (60.0% vs 28.6%).

Table 4.2 Food shopping and cooking practices (Number and percentage of responses)

	Arab family members N = 5	British family members N = 6	Arab older people N = 7	British older people N = 10	All participants N = 28
Who does most of the food shopping for your household? (Q12)					
Myself	1 (20.0)	4 (66.7)	5 (71.4)	7 (70.0)	17 (60.7)
My spouse/partner	3 (60.0)	0 (0.0)	2 (28.6)	2 (20.0)	7 (25.0)
Shop separately or together	1 (20.0)	2 (33.3)	0 (0.0)	1 (10.0)	4 (14.3)
How is the shopping for your household usually done? (Q15) *					
In supermarket	5 (100.0)	6 (100.0)	5 (71.4)	10 (100.0)	26 (92.9)
In specific shops and market (e.g., bakery, markets. farm shops)	1 (20.0)	1 (16.7)	3 (42.9)	5 (50.0)	10 (35.7)
Online	0 (0.0)	2 (33.3)	1 (14.2)	0 (0.0)	3 (10.7)
What types of food do you prefer to buy? (Q16) *					
Fresh foods	5 (100.0)	6 (100.0)	7 (100.0)	10 (100.0)	28 (100.0)
Frozen food	2 (40.0)	3 (50.0)	2 (28.6)	6 (60.0)	13 (46.4)
Canned food	2 (40.0)	4 (66.7)	2 (28.6)	4 (40.0)	12 (42.9)
Pre-cooked foods (e.g., ready meals)	0 (0.0)	1 (16.7)	1 (14.2)	1 (10.0)	3 (10.7)
Who does most of the food cooking for your household? (Q20)					
Myself	3 (60.0)	5 (83.3)	2 (28.6)	7 (70.0)	17 (60.7)
My spouse/partner	0 (0.0)	1 (16.7)	4 (57.1)	3 (30.0)	8 (28.6)
Housemaid	2 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (7.1)
Other (e.g., cook separately)	0 (0.0)	0 (0.0)	1 (14.2)	0 (0.0)	1 (3.6)
Does the main cook normally use recipes when cooking? (Q22)					
Sometimes	1 (20.0)	4 (66.7)	4 (57.1)	4 (40.0)	13 (46.4)
Rarely	3 (60.0)	0 (0.0)	1 (14.2)	3 (30.0)	7 (25.0)
Frequently	0 (0.0)	2 (33.3)	1 (14.2)	1 (10.0)	4 (14.3)
Hardly ever	0 (0.0)	0 (0.0)	1 (14.2)	2 (20.0)	3 (10.7)
Regularly	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.6)
The cook is a skilled cook (Q30.1) (rating: 1 = strongly disagree to 7 = strongly agree) (Median, Semi-Interquartile Range, SIQR)					
Median (SIQR)	5.0 (1.5)	5.0 (0.0)	6.0 (3.0)	5.0 (1.0)	5.0 (0.0)

Note: * = multiple answers possible.

In relation to who does most of the food cooking for their households (Q20), most participants said themselves, with almost two-thirds of participants giving this response. This was the common answer for all participant groups except Arab older people, of whom only around a quarter (28.6%) reported this. However, around half of the Arab older people (57.1%) reported their spouses as doing the cooking. Nearly half of the Arab family members (40.0%) reported that a housekeeper did the cooking.

Nearly half the participants reported the person who does the cooking sometimes uses recipes (Q22). The notable differences between the groups are that the British family

members reported "sometimes" using recipes more often than "rarely" (66.7% vs 0.0%) whereas for Arab family members it was the other way round (20.0% vs 60.0%).

In terms of whether they think that the main cook is a skilled cook (Q30.1), the median rating of all participants was 5.0 (on a scale from 1 = strongly disagree to 7 = strongly agree), which is significantly above the midpoint of the scale (Wilcoxon One Sample Signed Rank Test, W = 2.96, p = 0.003). There is no significant difference between the participant groups (Kruskal-Wallis H Test, H = 1.24, n.s.).

In relation to diet type (Q25, see Table 4.3) most participants reported no restriction in their diet (i.e., they eat everything). This included all Arab family members and most participants of the other groups (85.0% and above).

Table 4.3 Participants' diet type (Number of responses, percentage for each group)

	Arab family members N = 5	British family members N = 6	Arab older people N = 7	British older people N = 10	All participants N = 28
Are you... (Q25) *					
No restriction (eat everything)	5 (100.0)	5 (83.3)	6 (85.7)	8 (80.0)	24 (85.7)
Vegetarian	0 (0.0)	1 (16.7)	0 (0.0)	1 (10.0)	2 (7.1)
Pescatarian (eat fish but not meat)	0 (0.0)	0 (0.0)	1 (14.2)	0 (0.0)	1 (3.6)

Note: * when Arab participants said no restriction, they mean within the Halal diet.

Participants' food waste practices are summarized in Table 4.4, with only answers with more than 10% of responses from any group that are relevant to the design of the Wasteless app (full results can be found in Appendix B.1.3).

In relation to how they decide whether food is still good to eat (Q23), about two-thirds of participants said they rely on labelling. This included most of Arab older people (85.7%), two-thirds of British family members (66.7%), nearly two-thirds of British older people (60.0%), and almost half of Arab family members (40.0%). The notable difference between the cultural groups is that Arab family members reported using taste much more than British family members (60.0% vs 16.7%), and British older people reported using appearance much more than Arab older people (80.0% vs 0.0%). In terms of different life stages, Arab older people reported using labelling much more than smell (85.7% vs 14.2%) while for Arab family members it was the other way round (40.0% vs 100.0%).

Table 4.4 Responses related to food waste practices and attitudes (Number of responses, percentage of responses for that group)

	Arab family members N = 5	British family members N = 6	Arab older people N = 7	British older people N = 10	All participants N = 28
Do you throw away food which you have not opened the packaging? (Q23) *					
Labelling	2 (40.0)	4 (66.7)	6 (85.7)	6 (60.0)	18 (64.2)
Appearance	3 (60.0)	5 (83.3)	0 (0.0)	8 (80.0)	16 (57.1)
Smell	5 (100.0)	4 (66.7)	1 (14.2)	7 (70.0)	17 (60.7)
Taste	3 (60.0)	1 (16.7)	0 (0.0)	3 (30.0)	7 (25.0)
Do you throw away food which you have not opened the packaging? (Q24) Answers: hardly ever, rarely, sometimes, frequently, and regularly					
Hardly ever	2 (40.0)	2 (33.3)	4 (57.1)	6 (60.0)	14 (50.0)
Sometime	1 (20.0)	4 (66.7)	1 (14.2)	2 (20.0)	8 (28.6)
Rarely	2 (40.0)	0 (0.0)	2 (28.6)	2 (20.0)	6 (21.4)
What are the three most thrown away food items in your household? (Q27)					
Most thrown away	Vegetables 1 (20.0) Dairy 1 (20.0) Fruit 1 (20.0) Bread/baked goods 1 (20.0) Rice, pasta, other starches 1 (20.0)	Fruit 3 (50.0) Vegetables 1 (16.7) Bread/baked goods 1 (16.7) Meat/fish 1 (16.7)	Vegetables 3(42.9) Bread/baked goods 3(42.9) Rice, pasta, other starches 1(14.2)	Vegetables 5(50.0) Dairy 2(20.0) Fruit 2 (20.0)	Vegetables 10(35.7) Fruit 6 (21.4) Bread/baked goods 6 (21.4) Dairy 3 (10.7)
If you were to try to reduce your food waste, what would be the most important reason? (Q26)					
To reduce the amount spend on food	1 (20.0)	2 (33.3)	5 (71.4)	5 (50.0)	13 (46.4)
To minimise environmental impact	1 (20.0)	3 (50.0)	0 (0.0)	5 (50.0)	9 (32.1)
Other[1]	3 (60.0)	0 (0.0)	2 (28.6)	0 (0.0)	5 (17.9)
Both[2]	0 (0.0)	1 (16.7)	0 (0.0)	0 (0.0)	1 (3.6)
Have you done any positive actions to reduce food waste? (Q28)					
Yes	3 (60.0)	3 (50.0)	6 (85.7)	9 (90.0)	21 (75.0)
No	2 (40.0)	3 (50.0)	1 (14.2)	1 (10.0)	7 (25.0)
Do you know of any apps to help with food waste? (Q29)					
No	4 (80.0)	6 (100.0)	7 (100.0)	9 (90.0)	26 (92.9)
Yes	1 (20.0)	0 (0.0)	0 (0.0)	1 (10.0)	2 (7.1)
Have you used [these apps]? (Q29)					
No	4 (80.0)	6 (100.0)	7 (100.0)	10 (100.0)	27 (96.4)
Yes	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.6)

Note: 1: This includes reasons like against their believe, feeling guilty, religious reasons, saving food. **2:** This includes both (reduce the amount spend on food and minimise environmental impact). Although participants were asked to select only one answer, there was one participant selected two answers.

In terms of throwing away unopened food (Q24), half of the participants reported that they hardly ever did this. This included almost two thirds of British older people (60.0%), slightly more than half of Arab older people (57.1%), almost half of Arab family members (40.0%), and a third of the British family members (33.3%). The

notable differences between the groups are that almost half of the Arab family members reported that they rarely throw unopened food while none of British family members did this (40.0% vs 0.0%). However, British family members reported they did this sometimes much more than other groups: from the different culture (i.e., Arab family members), with 66.7% vs 20.0%; at different life stage (i.e., British older people), with only 20.0%, or from different culture and at different life stage (i.e., Arab older people) with only 14.2%.

In terms of the most thrown away food items (Q27), overall, vegetables were the most commonly mentioned item, they appeared in the top group for Arab family members, Arab older people and British older people. Fruits were the most common reported thrown items for British family members. Rice, pasta, other starches were one of the most common reported thrown items for only Arab groups (i.e., Arab family members and Arab older people).

In relation to the reasons for reducing food waste (Q26), almost half of the participants reported that the most important reason would be to reduce the amount of money spent on food. The notable differences are that above half of older people (58.8%, 5 older UK participants plus 5 older Arab participants out of a total of 17 older participants) reported this motivation, compared to only about a quarter of family members (27.3%, 2 UK family members plus 1 Arab family member out of a total of 11 family members). However, British participants (i.e., family members and older people) reported minimising environmental impact as a motivation much more than Arab participants, 50.0% vs 8.3% (3 UK family members plus 5 older UK participants out of a total of 16, is 50%; and 1 Arab family members plus no older Arab participants out of a total of 12, is 8.3%). Almost half of the Arab participants (41.6%, 3 Arab family members plus 2 older Arab participants out of a total of 12 Arab participants) provided reasons related to their religious beliefs or moral principles.

In relation to whether they have undertaken any positive actions for food waste reduction (Q28), three-quarters of participants reported they did. This included most of British older people (90.0%) and Arab older people (85.7%), almost two thirds of Arab family members (60.0%), and half of the British family members (50.0%). The actions mentioned by participants were:

- Reducing food purchases by purchasing only required items;
- Buying small packages of food;
- Not buying much perishable food (such as fresh vegetables);
- Buying locally and more frequently;
- Doing meal planning and paying more attention when shopping;
- Wrapping vegetables with a towel to save them for longer and sorting them from time to time to get rid of spoiled one to avoid damaging the rest;
- Eating or freezing food before it gets to the expiry date;
- Cooking only the appropriate amount of food, and giving leftover to animals.

In terms of whether they know any apps for food waste reduction (Q29), most of participants reported they did not. In addition, almost none of the participants used apps for food waste reduction. "Too Good to Go" (https://toogoodtogo.co.uk/en-gb/) was mentioned by only one participant from the British older people group, however when asked about their experience in using it, they said they did not use it. In addition, an app for charity was mentioned by one Arab family members, and they reported their experience as excellent.

Participants were asked to rate their agreement with a number of statements related to food waste issues (see Table 4.5). Overall, participants significantly disagreed with the statement that their household wastes a lot of food (Q30.2), the median rating was 2.0. There was no significant difference between participant groups. However, they also significantly disagreed with the statement that reducing food waste in their households would be difficult (Q30.3), the median rating was 3.0. Again, there was no significant difference between participant groups.

Table 4.5 Ratings of food waste attitudes (Median, Semi Interquartile Range) (1 = strongly disagree to 7 = strongly agree) with Wilcoxon One Sample Tests (whether the overall median was significantly different from the midpoint of the scale) and Kruskal-Wallis H Tests (whether there was a significant difference between the three groups)

Arab family members N = 5	British family members N = 6	Arab older people N = 7	British older people N = 10	All participants N = 28	Wilcoxon One Sample Test	Kruskal-Wallis H Test
Our household wastes a lot of food (Q30.2)						
4.0 (2.5)	3.0 (1.5)	3.5 (1.25)	1.0 (0.5)	2.0 (1.5)	W = -3.394 p < 0.001	H = 6.028, p = 0.110
Reducing the food waste in our household would be difficult (Q30.3)						
3.0 (1.5)	2.0 (0.0)	3.5 (1.0)	3.0 (1.5)	3.0 (1.0)	W = -2.501 p = 0.012	H = 6.065, p = 0.108
Food waste has a significant effect on the environment (Q30.4)						
5.0 (1.0)	5.5 (0.5)	7.0 (0.62)	7.0 (0.5)	6.0 (1.0)	W = 4.622 p < 0.001	H = 7.091 p = 0.069
Food waste has a significant effect on my budget (Q30.5)						
5.0 (1.5)	4.0 (1.0)	7.0 (0.62)	3.0 (1.5)	4.5 (1.37)	W = 1.312 p = 0.190	H = 17.29 p < 0.001
I feel guilty when I throw food away (Q30.6)						
7.0 (0.0)	6.5 (0.5)	7.0 (0.0)	6.5 (1.0)	7.0 (0.5)	W = 4.839 p < 0.001	H = 7.900 p = 0.048
I try not to waste food (Q30.7)						
7.0 (0.5)	6.0 (1.0)	7.0 (0.25)	7.0 (0.5)	7.0 (0.5)	W = 4.785 p < 0.001	H = 4.307 p = 0.230

Overall participants significantly agreed that food waste has significant effect on the environment (Q30.4), the median rating was 6.0. There was no significant difference between participant groups. They agreed that food waste has significant effect on their budget (Q30.5), the median rating was 4.5. In this case there was a significant difference between the participant groups, with British older people giving significantly lower ratings (3.0) than either Arab older people (7.0), Arab family members (5.0), and British family members (4.0) (post-hoc: British older people and Arab older people p < 0.001; British older people and Arab family members p = 0.012; British older people and British family members p = 0.347). In addition, British family members gave lower ratings than Arab family members (4.0 vs 5.0) (post-hoc: British family members and Arab family members (p = 0.142)). Arab older people giving significantly higher rating than British family members (7.0 vs 4.0), and higher rating than Arab family members (7.0 vs 5.0) (post-hoc: Arab older people and British family members p=0.010; Arab older people and Arab family members (p = 0.359)). Overall participants also feel significantly guilty when throwing food away (Q30.6), the median rating was 7.0. There was a significant difference between the participant groups, with British older people

giving significantly lower ratings than either Arab older people or Arab family members (6.5 vs 7.0) (post-hoc: British older people and Arab older people p=0.025; British older people and Arab family members p = 0.044). Finally, all participants significantly agree that they try not to waste food (Q30.7), the median of all participants was 7.0. There is no significant difference between participant groups.

4.3.2 Food waste drivers (RQ1.2)

A codebook thematic analysis was conducted of the comments made in the initial discussion and comments provided by participants about the food waste statements. As discussed in Section 4.2.5, there are five main food waste drivers and 22 sub-drivers emerged from the thematic analysis. For all participants, the Eating and socialising received the most votes (with 30.5% of votes), and Overbuying Food received the most comments (with 32.9% of comments) (see Figure 4.1 and Figure 4.2). The breakdown of the votes and comments for the four different participant groups is illustrated in Figure 4.3 and Figure 4.4.

	Overbuying	Planning	Management	Cooking	Eating
■ %	29	12.7	17.4	10.1	30.5
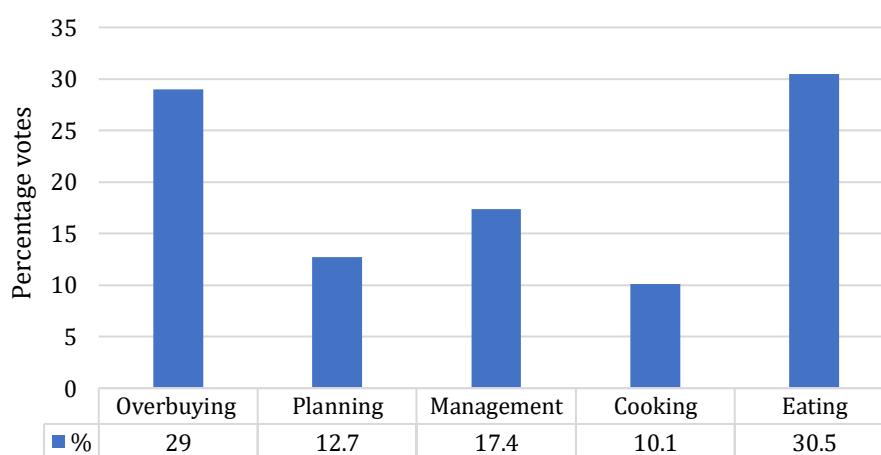
Figure 4.1 Percentage of votes allocated to each main driver for all participants

Note: Overbuying refers to Overbuying Food, Planning refers to Shopping and Meal Planning, Management refers to Food Storage and Management, Cooking refers to Food Preparation and Cooking, and Eating refers to Eating and socialising.
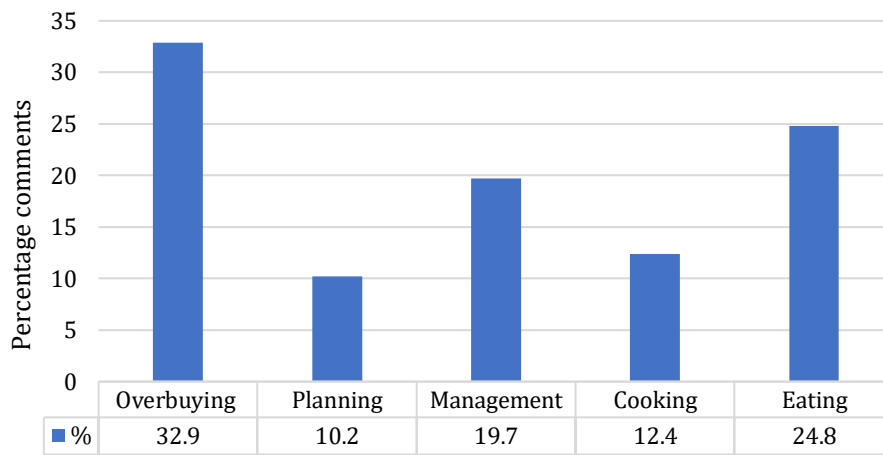
Figure 4.2 Percentage of comments allocated to each main driver for all participants

	Overbuying	Planning	Management	Cooking	Eating
%	32.9	10.2	19.7	12.4	24.8

	Overbuying	Planning	Management	Cooking	Eating
British family members	6.65	21.66	11.66	13.32	46.64
Arab family members	28.27	13.2	18.86	11.31	28.28
British older people	35	7	22	7	29
Arab older people	41.91	12.89	14.49	11.27	19.33
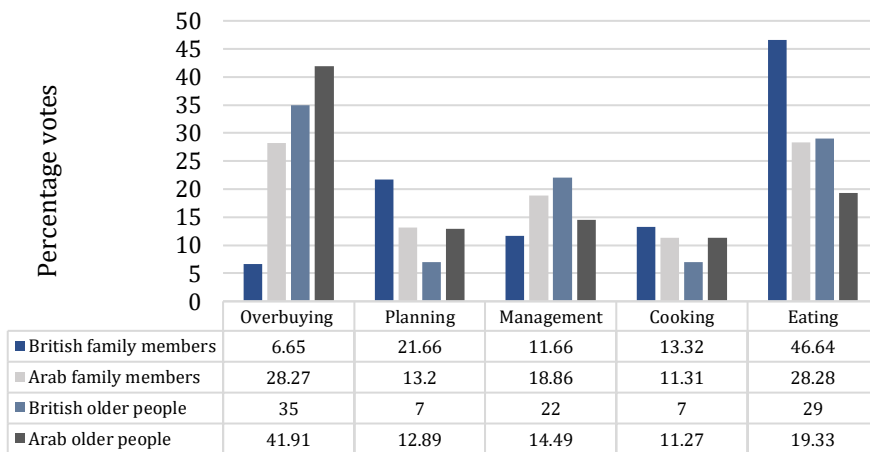
Figure 4.3 Percentage of votes allocated to each driver for people at different life stages and from different cultures

	Overbuying	Planning	Management	Cooking	Eating
British family members	31.91	19.15	17.02	10.64	21.28
Arab family members	25.53	12.77	12.77	19.15	29.79
British older people	48.21	3.57	23.21	3.57	21.43
Arab older people	27.38	8.33	22.62	15.48	26.19
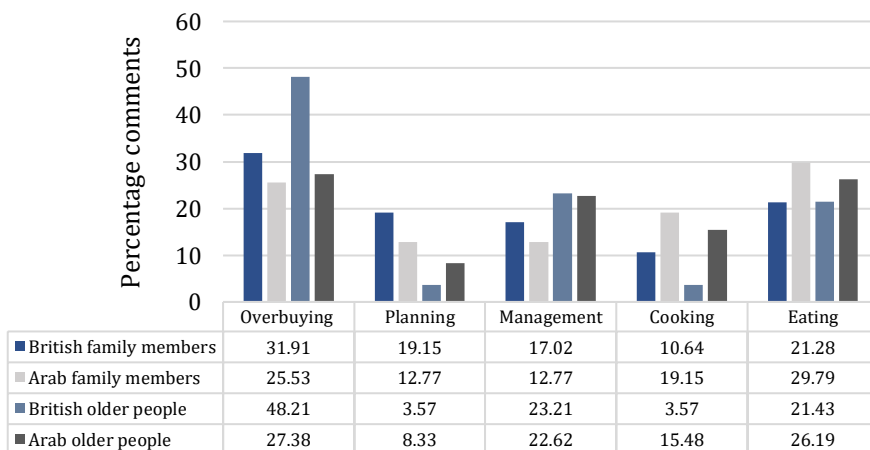
Figure 4.4 Percentage of comments made for each driver for participants from different groups

Based on the percentages of votes and comments received by each of the main food waste driver, the level of importance of each main driver was assigned (see Chapter 3, Section 3.2.5 for the process) (Table 4.6). For all participants, Overbuying Food and Eating and socialising were the *High importance* food waste main drivers. In addition, Overbuying Food was the *High importance* driver for each individual participant group (equally important with Eating and socialising for Arab family members and British family members).

Table 4.6 Main food waste drivers of different levels of importance for the four participant groups

Arab family members	British family members	Arab older people	British older people	All participants
High importance				
FWD1.Overbuying food	FWD1.Overbuying food	FWD1.Overbuying food	FWD1.Overbuying food	FWD1.Overbuying food
FWD 5. Eating and socialising	FWD 5. Eating and socialising			FWD 5. Eating and socialising
Moderate importance				
	FWD 2. Shopping and meal planning	FWD 5.Eating and socialising	FWD 3. Food Storage and Management	
			FWD 5. Eating and socialising	
Low importance				
FWD 3. Food Storage and Management	FWD 4. Food Preparation and Cooking	FWD 3. Food Storage and Management		FWD 3. Food Storage and Management
FWD 4. Food Preparation and Cooking				

Table 4.7 shows the corresponding analysis for food waste sub-drivers. Overall, there were 7 sub-drivers in the *High importance* level, with all the main drivers represented. All the main drivers were also represented in the *High importance* category for all four participant groups, although there were some differences in which particular sub-drivers were represented.

Figure 4.5 shows the intersection of *High importance* food waste sub-drivers among the four participant groups. Only one sub-driver (FWD 3.2: Lack of information about what food is in the fridge or pantry) was *High importance* sub-drivers for all participant groups. Three sub-drivers were shared by three participant groups (FWD 1.2: Over optimistic buying, FWD5.2: Catering for special occasions, and FWD2.1: Failure to make a plan). Four sub-drivers were shared by two participant groups (FWD 1.3: Influenced

by offers, FWD 2.2: Failure to stick to a plan, FWD 2.3: Communication about meal/shopping/planning, and FWD 4.4 Belief that leftovers are not healthy). Finally, 6 sub-drivers were *High importance* for only one group (FWD1.1: Packages too big, FWD 3.3: Lack of knowledge about storing food, FWD4.1: Lack of time or motivation to cook, FWD 4.2: Lack of knowledge of how to use leftovers, FWD 4.5: Lack of cooking skills, and FWD 5.1: Catering for "picky" eaters).

Table 4.7 Food waste sub-drivers of different levels of importance for the four participant groups

Arab family members	British family members	Arab older people	British older people	All participants
High importance				
FWD 1.2 Over optimistic buying	FWD1.3 Influenced by offers	FWD 1.2 Over optimistic buying	FWD1.1Packages too big	FWD 1.2 Over optimistic buying
FWD 2.1 Failure to make a plan	FWD 2.1 Failure to make a plan	FWD 1.3 Influenced by offers	FWD 1.2 Over optimistic buying	FWD 1.3 Influenced by offers
FWD 2.3 Communication about meal/shopping/ planning	FWD 2.2 Failure to stick to a plan	FWD 2.1 Failure to make a plan	FWD 2.2 Failure to stick to a plan	FWD 2.1 Failure to make a plan
FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 2.3 Communication about meal/shopping/ planning	FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 3.2 Lack of information about what food is in the fridge/pantry
FWD 4.2 Lack of knowledge of how to use leftovers	FWD 4.1 Lack of time/motivation to cook	FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 4.4 Belief that leftovers are not healthy	FWD 4.1 Lack of time/motivation to cook
FWD 5.2 Catering for special occasions	FWD 5.1 Catering for "picky" eaters	FWD 3.3 Lack of knowledge about storing food	FWD 4.5 Lack of cooking skills	FWD 4.2 Lack of knowledge of how to use leftovers
		FWD 4.4 Belief that leftovers are not healthy	FWD 5.2 Catering for special occasions	FWD 5.2 Catering for special occasions
		FWD 5.2 Catering for special occasions		
Moderate importance				
FWD1.1 Packages too big	FWD1.1 Packages too big	FWD1.1 Packages too big	FWD1.3 Influenced by offers	FWD1.1 Packages too big
FWD 1.3 Influenced by offers	FWD 1.2 Over optimistic buying	FWD 1.6 Food is cheap	FWD 2.1 Failure to make a plan	FWD 2.2 Failure to stick to a plan
FWD 3.3 Lack of knowledge about storing food	FWD 3.4 Lack of space to store food	FWD 2.2 Failure to stick to a plan	FWD 3.3 Lack of knowledge	FWD 3.3 Lack of knowledge about storing food

			about storing food	
FWD 4.1 Lack of time/motivation to cook	FWD 4.2 Lack of knowledge of how to use leftovers	FWD 4.2 Lack of knowledge of how to use leftovers	FWD 3.4 Lack of space to store food	FWD 4.4 Belief that leftovers are not healthy
FWD 5.4 Impulse eating	FWD 5.4 Impulse eating	FWD 4.3 Using leftover food is too much effort	FWD 4.2 Lack of knowledge of how to use leftovers	FWD 5.1 Catering for "picky" eaters
		FWD 5.1 Catering for "picky" eaters	FWD 5.4 Impulse eating	FWD 5.4 Impulse eating
		FWD 5.4 Impulse eating		
Low importance				
FWD 1.6 Food is cheap	FWD 1.5 Advertising (on TV, in store)	FWD 3.4 Lack of space to store food	FWD 1.4 Impulse buying	FWD 2.3 Communication about meal/shopping/ planning
FWD 2.2 Failure to stick to a plan	FWD 5.2 Catering for special occasions	FWD 4.1 Lack of time/motivation to cook	FWD 3.1 Confusion about food labels	FWD 3.4 Lack of space to store food
FWD 4.4 Belief that leftovers are not healthy		FWD 4.5 Lack of cooking skills	FWD 5.1 Catering for "picky" eaters	
FWD 4.5 Lack of cooking skills		FWD 5.3 Cooking a lot, but not eating it	FWD 5.3 Cooking a lot, but not eating it	
FWD 5.1 Catering for "picky" eaters				
FWD 5.3 Cooking a lot, but not eating it				
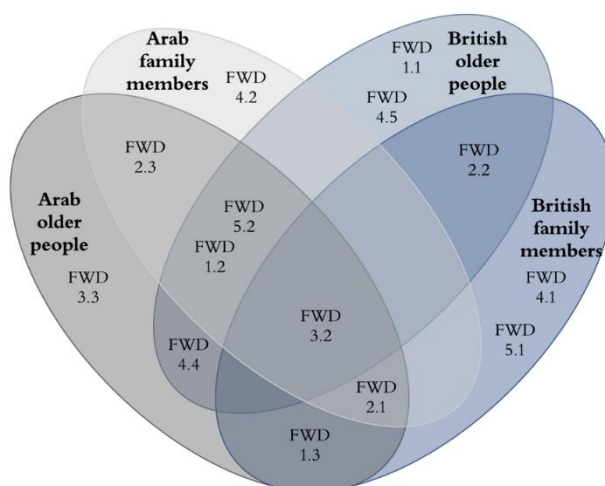
Figure 4.5 *High importance* food waste sub-drivers for the four participant groups

Comments illustrating the *High importance* food waste sub-drivers are provided below (see Table 4.8).

Table 4.8 Participants' comments made about *High importance* food waste sub-drivers

Driver/Sub-Driver	Example comments
FWD1: Overbuying food	
FWD1.1: Packages being too big	The yogurt that we like it only comes in big pot (in a kilo pot). They don't have smaller one (BO2)
FWD 1.2: Over optimistic buying	Sometimes I am optimistic (AO6)
FWD 1.3: Influenced by offers	This is a big reason to waste food on the occasion of the offer I bought many quantities and do not use them, which leads to expiration (AO5)
FWD2: Shopping and meal planning	
FWD 2.1: Failure to make a plan for shopping or meal	This often happens, if family members weekly commitments change (BF5)
FWD 2.2: Failure to stick to a plan	Plans changed, my husband comes back late from work and does not want to eat so ending having toast (BF1)
FWD 2.3: Communication about meal, shopping, and planning	My husband may have eaten some simple things before eating before attending the meal (AF3)
FWD3: Food storage and management	
FWD 3.2: Lack of information about what food is in the fridge or pantry	Sometimes, I buy potatoes and then I don't have them for a while, and then I think oh there is potato in the fridge and then [it has] gone off (BO4)
FWD 3.3: Lack of knowledge about storing food	Some foods have a strong smell like fish and shrimp …. and we throw away (AO6)
FWD4: Preparing and cooking food	
FWD 4.1: Lack of time or motivation to cook	I work m-f then run around with after school clubs. I cook more at the weekend (BF1)
FWD 4.2: Lack of knowledge of how to use leftovers	I am confused which may lead to store it for a period and then throwing after expiration (AF5)
FWD 4.4: Belief that leftovers are not healthy	Sometimes I leave in fridge too long so throw away (BO4)
FWD 4.5: Lacking cooking skills	I burn food (BO3)
FWD5: Eating and socializing around food	
FWD 5.1: Catering for "picky" eaters	My children often refuse to eat healthier options especially if they see onion! (BF1)
FWD 5.2: Catering for special occasions	Sometimes I made a mistake in estimating the quantity (AF4)
	This happens occasionally when family stay but for example decide to eat out (BO2)

4.3.3 Comparison of results from Study 1 and Study 2

This section compares the results from Study 1 and Study 2 in order to investigate results at the three life stages (i.e., students, family members, and older people) and from two cultures, Arab and UK. Because it was not possible to recruit family members and older people from China, the results about Chinese students obtained from Study 1 was excluded from this comparison. Therefore, the comparison of individuals'

practice around food and food waste, as well as the comparison of food waste drivers only included Arab and UK cultures at the three stages of life.

4.3.3.1 The role of *Culture* and *Life stage* might play on individuals' practice around food and waste (RQ1.3)

The results from participants at different life stages (students, family members, and older people), and from different cultures (UK and Arab), in relation to food shopping habits, their cooking practices and what diet they follow are provided in Table 4.9 and 4.10 (this includes only answers with more than 10% of responses from any group).

Table 4.9 Food shopping and cooking practices for participants at three life stages (Number and percentage of responses)

	Students N = 11	Family members N = 11	Older people N = 17
Who does most of the food shopping for your household? (Q12)			
Myself	6 (54.5)	5 (45.4)	12 (70.5)
My spouse/partner	1 (9.0)	3 (27.2)	4 (23.5)
Shop separately or together	4 (36.3)	3 (27.2)	1 (5.8)
How is the shopping for your household usually done? (Q15) *			
In supermarket	11 (100.0)	11 (100.0)	15 (88.2)
In specific shops and market (e.g., bakery, markets. farm shops)	0 (0.0)	2 (18.1)	8 (47.0)
Online	2 (18.1)	2 (18.1)	1 (5.8)
What types of food do you prefer to buy(Q16) *			
Fresh foods	11 (100.0)	11 (100.0)	17 (100.0)
Frozen food	5 (45.4)	5 (45.4)	8 (47.0)
Canned food	5 (45.4)	6 (54.5)	6 (35.2)
Pre-cooked foods (e.g., ready meals)	2 (18.1)	1 (9.0)	2 (11.7)
Who does most of the food cooking for your household? (Q20)			
Myself	8 (72.7)	8 (72.7)	9 (52.9)
My spouse/partner	1 (9.0)	1 (9.0)	7 (41.1)
Other (e.g., cook separately)	2 (18.1)	0 (0.0)	1 (5.8)
Housemaid	0 (0.0)	2 (18.1)	0 (0.0)
Does the main cook normally use recipes when cooking? (Q22)			
Sometimes	2 (18.1)	5 (45.4)	8 (47.0)
Rarely	3 (27.2)	3 (27.2)	4 (23.5)
Hardly ever	4 (36.3)	0 (0.0)	3 (17.6)
Frequently	2 (18.1)	2 (18.1)	2 (11.7)
Regularly	0 (0.0)	1 (9.0)	0 (0.0)
The cook is a skilled cook (Q30.1) (rating: 1 = strongly disagree to 7 = strongly agree) (Median, Semi-Interquartile Range, SIQR)			
Median (SIQR)	6.0 (0.5)	5.0 (0.5)	5.5 (1.5)

Note: * = multiple answers possible.

As Table 4.9 illustrates, the key similarities and differences due to *Life stage* were participants do most of the food shopping for the household themselves, in supermarkets. However, almost half of older people (47.0%) reported shopping in

specific shops and market like bakery, in open air markets or farm shops compared to none of the students. Although all participants at different life stages reported buying fresh food, family members reporting buying canned food more than older people (54.5% vs. 35.2%). For who does most of the food cooking for their households, most participants said themselves. Nevertheless, older people reporting their spouses were cooking for food more than family members or students (41.1% vs. 9.0%). In terms of using recipes, older people and family members reported sometimes using recipes (47.0% and 45.4%, respectively) much more than students (18.1%). Further, around a third of students (36.3%) reported hardly ever using recipes, compared to none of the family members. In terms of whether they think that the main cook is a skilled cook, there is no significant difference between participants at different life stage (Kruskal-Wallis H Test, H = 2.103, n.s.).

Table 4.10 Food shopping and cooking practices for participants from two cultures (Number and percentage of responses)

	Arab N = 18	British N = 21
Who does most of the food shopping for your household? (Q12)		
Myself	10 (55.5)	13 (61.9)
My spouse/partner	5 (27.7)	3 (14.2)
Shop separately or together	3 (16.6)	5 (23.8)
How is the shopping for your household usually done? (Q15) *		
In supermarket	16 (88.8)	21 (100.0)
In specific shops and market (e.g., bakery, markets. farm shops)	4 (22.2)	6 (28.5)
Online	3 (16.6)	2 (9.5)
What types of food do you prefer to buy(Q16) *		
Fresh foods	18 (100.0)	21 (100.0)
Frozen food	8 (44.4)	10 (47.6)
Canned food	6 (33.3)	11 (52.3)
Pre-cooked foods (e.g., ready meals)	2 (11.1)	3 (14.2)
Who does most of the food cooking for your household? (Q20)		
Myself	11 (61.1)	14 (66.6)
My spouse/partner	4 (22.2)	5 (23.8)
Other (e.g., cook separately)	1 (5.5)	2 (9.5)
Housemaid	2 (11.1)	0 (0.0)
Does the main cook normally use recipes when cooking? (Q22)		
Sometimes	6 (33.3)	9 (42.8)
Rarely	6 (33.3)	4 (19.0)
Hardly ever	3 (16.6)	4 (19.0)
Frequently	2 (11.1)	4 (19.0)
Regularly	1 (5.5)	0 (0.0)
The cook is a skilled cook (Q30.1) (rating: 1 = strongly disagree to 7 = strongly agree) (Median, Semi-Interquartile Range, SIQR)		
Median (SIQR)	6.0 (1.5)	5.0 (0.5)

Note: * = multiple answers possible.

As Table 4.10 illustrates, the key similarities and differences due to *Culture* were participants do the food shopping for the household themselves in supermarkets. Although all participants from the two cultures reported buying fresh food, British people reporting buying canned food more than Arab people (52.3% vs. 33.3%). For who does most of the food cooking for their households, most participants said themselves. However, some Arab people (11.1%) reported that housemaid was cooking for food compared to none of the British people. In terms of using recipes, both cultural groups were similar in sometime using recipes (for Arab, rarely using recipes was equal to sometime). In terms of whether they think that the main cook is a skilled cook, there is no significant difference between participants from different cultures (Kruskal-Wallis H Test, H = 0.123, n.s.).

Participants' food waste practices are summarized in Table 4.11 and 4.12.

As Table 4.11 illustrates, the key similarities and differences due to *Life stage* were most of family members (81.8%) and around two-thirds of students (63.6%) relied on smell in deciding whether food is still good to eat, compared to less than half of older people (47.0%). In addition, older people reported using labelling much more than students (70.5% vs. 36.3%). In addition, students using taste much more than older people (45.4% vs 17.6%). For throwing away unopened food, family members reported they did sometimes throw unopened food much more than students and older people (family members = 45.4% vs. students = 18.1%, older people = 17.6%). Vegetables were the most commonly mentioned item, although they only appeared in the top group for students and older people. Fruits were the most common reported thrown items for family members. In relation to the reasons for reducing food waste, older people reported reduce amount spent on food as motivation much more than students and family members (58.8% vs. 27.2%). For whether they have undertaken any positive actions for food waste reduction, older people reported doing positive actions more than family members and students (older people = 88.2% vs. family members = 54.5% and students = 63.6%). The details of actions mentioned by participants provided in Section 3.3.1, Chapter 3 for students, and in Section 4.3.1, Chapter 4 for family members and older people.

Table 4.11 Responses related to food waste practices and attitudes for participants at three life stages
(Number and percentage of responses)

	Students N = 11	Family members N = 11	Older people N = 17
Do you throw away food which you have not opened the packaging? (Q23) *			
Smell	7 (63.6)	9 (81.8)	8 (47.0)
Appearance	7 (63.6)	8 (72.7)	8 (47.0)
Labelling	4 (36.3)	6 (54.5)	12 (70.5)
Taste	5 (45.4)	4 (36.3)	3 (17.6)
Do you throw away food which you have not opened the packaging? (Q24) Answers: hardly ever, rarely, sometimes, frequently, and regularly			
Hardly ever	7 (63.6)	4 (36.3)	10 (58.8)
Sometime	2 (18.1)	5 (45.4)	3 (17.6)
Rarely	2 (18.1)	2 (18.1)	4 (23.5)
What are the three most thrown away food items in your household? (Q27)			
Most thrown away	Vegetables 4 (36.3) Fruit 3 (27.2) Dairy 2 (18.1)	Fruit 4 (36.3) Vegetables 2 (18.1) Bread/baked goods 2 (18.1)	Vegetables 8 (47.1) Bread/baked goods 4 (23.5) Fruit 2 (11.8) Dairy 2 (11.8)
If you were to try to reduce your food waste, what would be the most important reason? (Q26)			
To reduce the amount spend on food	3 (27.2)	3 (27.2)	10 (58.8)
To minimise environmental impact	3 (27.2)	4 (36.3)	5 (29.4)
Other[1]	4 (36.3)	3 (27.2)	2 (11.7)
Both[2]	1 (9.0)	1 (9.0)	0 (0.0)
Have you done any positive actions to reduce food waste? (Q28)			
Yes	7 (63.6)	6 (54.5)	15 (88.2)
No	4 (36.3)	5 (45.4)	2 (11.7)
Do you know of any apps to help with food waste? (Q29)			
Yes	2 (18.1)	1 (9.0)	1 (5.8)
No	9 (81.8)	10 (90.0)	16 (94.1)
Have you used [these apps]? (Q29)			
Yes	0 (0.0)	1 (9.0)	0 (0.0)
No	11 (100.0)	10 (90.0)	17 (100.0)

Note: 1= This includes reasons like against their believe, feeling guilty, religious reasons, saving food. **2:** This includes both (reduce the amount spend on food and minimise environmental impact). Although participants were asked to select only one answer, there was one participant selected two answers.

As Table 4.12 illustrates, the key similarities and differences due to *Culture* were almost three-quarters of British people (71.4%) reported using smell in deciding whether food is still good to eat, compared to half of Arab people (50.0%). In addition, British people using appearance much more than Arab people (85.7% vs. 27.7%). For throwing away unopened food, slightly more than half of British people (57.1%) and half of Arab people (50.0%). Further, Arab people reported they did rarely throw unopened food much more than British people (33.3% vs 9.5%). Vegetables were the most commonly mentioned item for both cultural groups. However, rice, pasta, other starches were one of the most common reported thrown items for only Arab people. In relation to the

reasons for reducing food waste, British people reported minimise environmental impact as a motivation much more than Arab people (47.6% vs 11.1%). While half of Arab people (50.0%) provided reasons related to their religious beliefs or moral principles, compared to none of the British people. In relation to whether they have undertaken any positive actions for food waste reduction, there is no differences between the two cultural groups. Further, and most of participants reported they did not know any apps for food waste reduction.

Table 4.12 Responses related to food waste practices and attitudes for participants from two cultures (Number and percentage of responses)

	Arab N = 18	British N = 21
Do you throw away food which you have not opened the packaging? (Q23) *		
Smell	9 (50.0)	15 (71.4)
Appearance	5 (27.7)	18 (85.7)
Labelling	10 (55.5)	12 (57.1)
Taste	5 (27.7)	7 (33.3)
Do you throw away food which you have not opened the packaging? (Q24) Answers: hardly ever, rarely, sometimes, frequently, and regularly		
Hardly ever	9 (50.0)	12 (57.1)
Sometime	3 (16.6)	7 (33.3)
Rarely	6 (33.3)	2 (9.5)
What are the three most thrown away food items in your household? (Q27)		
Most thrown away	Vegetables 6 (33.3) Bread/baked goods 5 (27.7) Fruit 3 (16.6) Dairy 2 (11.1) Rice, pasta, other starches 2 (11.1)	Vegetables 8 (38.0) Fruit 6 (28.5) Dairy 3 (14.2)
If you were to try to reduce your food waste, what would be the most important reason? (Q26)		
To reduce the amount spend on food	7 (38.8)	9 (42.8)
To minimise environmental impact	2 (11.1)	10 (47.6)
Other[1]	9 (50.0)	0 (0.0)
Both[2]	0 (0.0)	2 (9.5)
Have you done any positive actions to reduce food waste? (Q28)		
Yes	14 (77.7)	14 (66.6)
No	4 (22.2)	7 (33.3)
Do you know of any apps to help with food waste? (Q29)		
Yes	1 (5.5)	3 (14.2)
No	17 (94.4)	18 (85.7)
Have you used [these apps]? (Q29)		
Yes	1 (5.5)	0 (0.0)
No	17 (94.4)	21 (100.0)

Note: 1= This includes reasons like against their believe, feeling guilty, religious reasons, saving food. **2:** This includes both (reduce the amount spend on food and minimise environmental impact). Although participants were asked to select only one answer, there was one participant selected two answers.

Participants were asked to rate their agreement with a number of statements related to food waste issues (see Table 4.13 and 4.14).

As Table 4.13 illustrates, the key similarities and differences due to *Life stage* were that participants at different life stages significantly disagreed with that their households waste a lot of food as well as reducing food waste in their households would be difficult, with no significant difference between them. However, they agreed that food waste has significant effect on their budget as well as they feel significantly guilty when throwing food away and they significantly agree that they try not to waste food, with no significant difference between participants at different life stages. But there is a significant difference between participants at different life stages in terms of whether food waste has significant effect on the environment, with older people giving significantly higher ratings (7.0) than family members (5.0) (post-hoc = older people and family members (p = 0.015)).

Table 4.13 Ratings of food waste attitudes (Median, Semi Interquartile Range) (1 = strongly disagree to 7 = strongly agree) with Kruskal-Wallis H Tests (whether there was a significant difference between different life stage groups groups)

Students N = 11	Family members N = 11	Older people N = 17	Kruskal-Wallis H Test
Our household wastes a lot of food (Q30.2)			
2.0 (0.0)	3.0 (1.0)	2.0 (1.5)	H = 0.851 n.s.
Reducing the food waste in our household would be difficult (Q30.3)			
3.0 (1.0)	2.0 (0.5)	1.5 (1.5)	H = 5.481 n.s.
Food waste has a significant effect on the environment (Q30.4)			
6.0 (1.0)	5.0 (0.5)	7.0 (0.5)	H = 6.436 p =0.040
Food waste has a significant effect on my budget (Q30.5)			
4.5 (2.0)	5.0 (0.5)	4.0 (2.5)	H = 0.115 n.s.
I feel guilty when I throw food away (Q30.6)			
6.5 (0.5)	7.0 (0.5)	7.0 (0.5)	H = 0.736 n.s.
I try not to waste food (Q30.7)			
6.5 (0.5)	6.0 (0.5)	7.0 (0.5)	H = 3.556 n.s.

As Table 4.14 illustrates, the key similarities and differences due to *Culture* were that participants from different cultures significantly disagreed with that their households waste a lot of food as well as reducing food waste in their households would be difficult, with no significant difference between them. However, they agreed that food waste has significant effect on environment as well as they try not to waste food, with no significant difference between Arab and British people. However, there is a significant difference between the two cultural groups in term of food waste has significant effect

on their budget, with Arab people giving significantly higher ratings (6.5) than British people (4.0). Further, there is a significant difference between the two cultural groups in term of they feel significantly guilty when throwing food away, with Arab people giving significantly higher ratings (7.0) than British people (6.0).

Table 4.14 Ratings of food waste attitudes (Median, Semi Interquartile Range) (1 = strongly disagree to 7 = strongly agree) with Kruskal-Wallis H Tests (whether there was a significant difference between different cultural groups groups)

Arab N = 18	British N = 21	Kruskal-Wallis H Test
Our household wastes a lot of food (Q30.2)		
2.5 (1.5)	2.0 (1.0)	H = 0.743 n.s.
Reducing the food waste in our household would be difficult (Q30.3)		
3.0 (1.5)	3.0 (1.5)	H = 1.084 n.s.
Food waste has a significant effect on the environment (Q30.4)		
6.5 (1.0)	6.0 (1.0)	H = 0.515 n.s.
Food waste has a significant effect on my budget (Q30.5)		
6.5 (1.0)	4.0 (1.0)	H = 20.605 $p < 0.001$
I feel guilty when I throw food away (Q30.6)		
7.0 (0.0)	6.0 (1.0)	H = 11.429 $p < 0.001$
I try not to waste food (Q30.7)		
7.0 (0.5)	7.0 (0.5)	H = 0.549 n.s.

4.3.3.2 *Culture* and *Life stage* effect on food waste drivers (RQ1.3)

For all participants[5], the Overbuying Food received the most votes (with 28.6% of votes), and the most comments (with 31.2% of comments) (see Figure 4.6 and Figure 4.7).

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[5] This includes all participants except Chinese students.
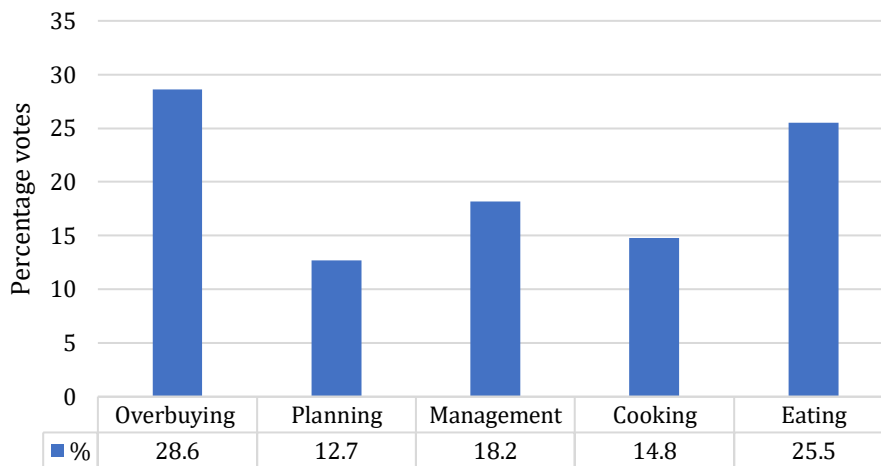
Figure 4.6 Percentage of votes allocated to each main driver for all participants in Study 1 and Study 2

	Overbuying	Planning	Management	Cooking	Eating
%	28.6	12.7	18.2	14.8	25.5

Note: Overbuying refers to Overbuying Food, Planning refers to Shopping and Meal Planning, Management refers to Food Storage and Management, Cooking refers to Food Preparation and Cooking, and Eating refers to Eating and socialising.

	Overbuying	Planning	Management	Cooking	Eating
%	31.2	10.2	21.3	13.3	23.8
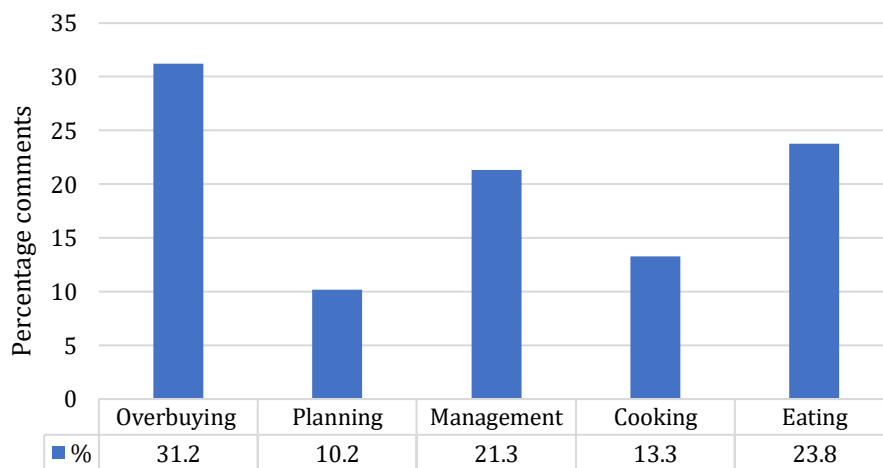
Figure 4.7 Percentage of comments allocated to each main driver for all participants in Study 1 and Study 2

To further investigate the patterns in the voting on the importance of the main drivers, a mixed analysis of variance was conducted. The independent variables were Culture (Arab versus British) and Life Stage (Students vs Family members vs Older people). The dependent variable was the percentage of votes allocated to each main food waste driver. The ANOVA showed that there was a significant main effect for Driver, $F_{(2, 128)}$ = 3.20, $p < 0.05$, ηp^2 = .09. Figure 4.6 shows the percentage of votes given to each of the main food waste drivers by all participants in Study 1 and Study 2 (i.e., students, family members, and older people; from Arab and UK). The driver which received the most

votes was Overbuying Food (with 28.65% of votes), followed by Eating and Socializing (25.52%).

There were no main effects for Culture or Life Stage, but there was a significant interaction between Driver and Life Stage, $F_{8, 128} = 2.68$, $p < 0.01$, $\eta p2 = .14$. Figure 4.8 shows that Overbuying Food and Eating and Socializing produced the most votes, with 37.65% of votes from older people for Overbuying Food and 38.05% of votes from family members for Eating and Socializing.

	Overbuying	Planning	Management	Cooking	Eating
Students	27.52	12.84	20.18	26.61	12.84
Family members	16.81	17.7	15.04	12.39	38.05
Older people	37.65	9.26	19.14	8.64	25.31
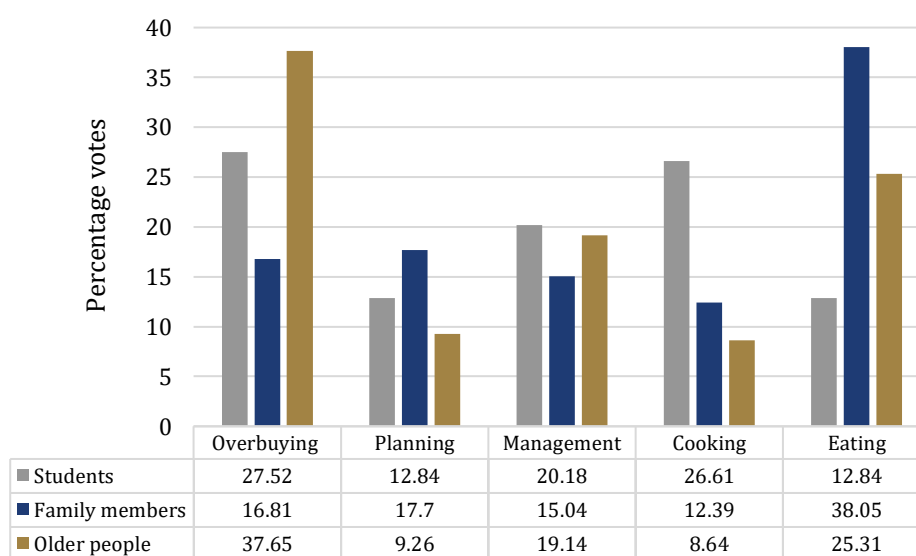
Figure 4.8 Percentage of votes allocated to each main driver for people at different life stages

4.3.3.3 Food waste drivers for individuals at different life stages and from different cultures (RQ1.3)

In relation to different life stages, Overbuying Food was the *High importance* main food waste driver for individuals at all life stages, while Eating and Socialising was also *High importance* for only family members (see Table 4.15). However, Overbuying Food and Eating and Socialising were the *High importance* main food waste driver for individuals from the two culture (see Table 4.16).

Table 4.15 Food waste main drivers of different levels of importance for individuals at different life stages

Students	Family members	Older people
High importance		
FWD1.Overbuying food	FWD1.Overbuying food	FWD1.Overbuying food
	FWD 5. Eating and socialising	
Moderate importance		
FWD 3. Food Storage and Management	FWD 2. Shopping and meal planning	FWD 5. Eating and socialising
FWD 4. Food Preparation and Cooking		
Low importance		
FWD 5. Eating and socialising		FWD 3. Food Storage and Management

Table 4.16 Food waste main drivers of different levels of importance for individuals from different cultures

British	Arab
High importance	
FWD1. Overbuying food	FWD1. Overbuying food
FWD 5. Eating and socialising	FWD 5. Eating and socialising
Moderate importance	
FWD 3. Food Storage and Management	FWD 4. Food Preparation and Cooking
Low importance	
	FWD 3. Food Storage and Management

In relation to the sub-driver food waste drivers for individuals at different life stages, Over Optimistic Buying, Failure to Make a Plan, and Lack of Information about What Food is in the Fridge/Pantry were the *High importance* sub-drivers for participants at all life stages (see Table 4.17, and Figure 4.9).
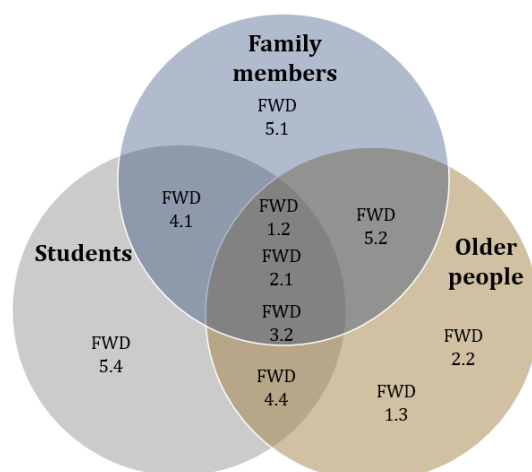
Figure 4.9 *High importance* food waste sub-drivers for participants at different life stages

Table 4.17 Food waste drivers of different levels of importance for participants at different life stages

Students	Family members	Older people
High importance		
FWD 1.2 Over optimistic buying	FWD 1.2 Over optimistic buying	FWD 1.2 Over optimistic buying
FWD 2.1 Failure to make a plan	FWD 2.1 Failure to make a plan	FWD 1.3 Influenced by offers
FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 2.1 Failure to make a plan
FWD 4.1 Lack of time/motivation to cook	FWD 4.1 Lack of time/motivation to cook	FWD 2.2 Failure to stick to a plan
FWD 4.4 Belief that leftovers are not healthy	FWD 5.1 Catering for "picky" eaters	FWD 3.2 Lack of information about what food is in the fridge/pantry
FWD 5.4 Impulse eating	FWD 5.2 Catering for special occasions	FWD 4.4 Belief that leftovers are not healthy
		FWD 5.2 Catering for special occasions
Moderate importance		
FWD1.1 Packages too big	FWD 1.3 Influenced by offers	FWD1.1 Packages too big
FWD 2.2 Failure to stick to a plan	FWD 2.2 Failure to stick to a plan	FWD 2.3 Communication about meal/shopping/planning
FWD 3.3 Lack of knowledge about storing food	FWD 3.3 Lack of knowledge about storing food	FWD 3.3 Lack of knowledge about storing food
FWD 3.4 Lack of space to store food	FWD 3.4 Lack of space to store food	FWD 4.2 Lack of knowledge of how to use leftovers
FWD 5.1 Catering for "picky" eaters	FWD 4.2 Lack of knowledge of how to use leftovers	FWD 4.3 Using leftover food is too much effort
FWD 5.2 Catering for special occasions	FWD 5.4 Impulse eating	FWD 5.4 Impulse eating
FWD 5.3 Cooking a lot, but not eating it		
Low importance		
FWD 1.3 Influenced by offers	FWD1.1 Packages too big	FWD 3.4 Lack of space to store food
FWD 2.3 Communication about meal/shopping/planning	FWD 2.3 Communication about meal/shopping/planning	FWD 4.5 Lack of cooking skills
FWD 4.2 Lack of knowledge of how to use leftovers		FWD 5.1 Catering for "picky" eaters
		FWD 5.3 Cooking a lot, but not eating it

In relation to the sub-driver food waste drivers for individuals from different cultures, Failure to Make a Plan, Lack of Information about What Food is in the Fridge/Pantry, and Catering for Special Occasions were the *High importance* sub-drivers for participants from the two cultures (see Table 4.18, and Figure 4.10).

Table 4.18 Food waste drivers of different levels of importance for participants from different cultures

Arab participants	British participants
High importance	
FWD 1.2 Over optimistic buying	FWD1.1 Packages too big
FWD 2.1 Failure to make a plan	FWD 2.1 Failure to make a plan
FWD 2.3 Communication about meal/shopping/planning	FWD 2.2 Failure to stick to a plan
FWD 3.2 Lack of information about what food is in the fridge/pantry	FWD 3.2 Lack of information about what food is in the fridge/pantry
FWD 4.4 Belief that leftovers are not healthy	FWD 4.1 Lack of time/motivation to cook
FWD 5.2 Catering for special occasions	FWD 5.2 Catering for special occasions
Moderate importance	
FWD 1.3 Influenced by offers	FWD 1.2 Over optimistic buying
FWD 3.3 Lack of knowledge about storing food	FWD 1.3 Influenced by offers
FWD 4.2 Lack of knowledge of how to use leftovers	FWD 3.3 Lack of knowledge about storing food
FWD 5.4 Impulse eating	FWD 3.4 Lack of space to store food
	FWD 4.2 Lack of knowledge of how to use leftovers
	FWD 4.4 Belief that leftovers are not healthy
	FWD 5.1 Catering for "picky" eaters
	FWD 5.4 Impulse eating
Low importance	
FWD1.1 Packages too big	
FWD 2.2 Failure to stick to a plan	
FWD 3.4 Lack of space to store food	
FWD 4.1 Lack of time/motivation to cook	
FWD 5.3 Cooking a lot, but not eating it	
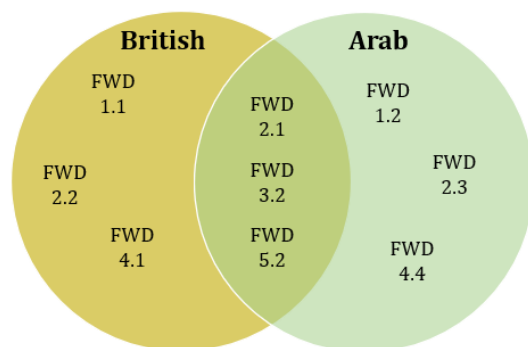
Figure 4.10 *High importance* food waste sub-drivers for
participants from two cultures

Figure 4.11 shows the *High importance* food waste sub-drivers for the culture and life stage groups, highlighting the food waste sub-drivers shared and not shared between groups. As Figure 4.11 illustrates, the food waste sub-drivers which were *High importance* for Arab participants, regardless of the different life stage, were FWD1.2 ("Over optimistic buying"), FWD2.1 ("Failure to make a plan"), and FWD5.4 ("Impulse eating"). However, the only food waste sub-driver which appeared to be *High importance* for British participants regardless of life stage was FWD3.2 ("Lack of information about what food is in the fridge/pantry"). This food waste sub-driver was in fact *High importance* for all participant groups except Arab students.

On the other hand, the food waste sub-drivers which were *High importance* for students regardless of their different cultures were FWD2.1 ("Failure to make a plan") and FWD4.1 ("Lack of time/motivation to cook"). This might be because students are busy with their studies and have less time for planning or cooking food and little experience of these activities. Similarly, these two sub-drivers (FWD2.1 and FWD4.1) as well as FWD3.2 ("Lack of information about what food is in the fridge/pantry") were *High importance* for family members regardless of their culture. However, the food waste sub-drivers which were *High importance* for older people regardless of their culture were FWD 5.2 ("Catering for special occasions"), FWD 4.4 ("Belief that leftovers are not healthy"), as well as FWD 3.2 ("Lack of information about what food is in the fridge/pantry").
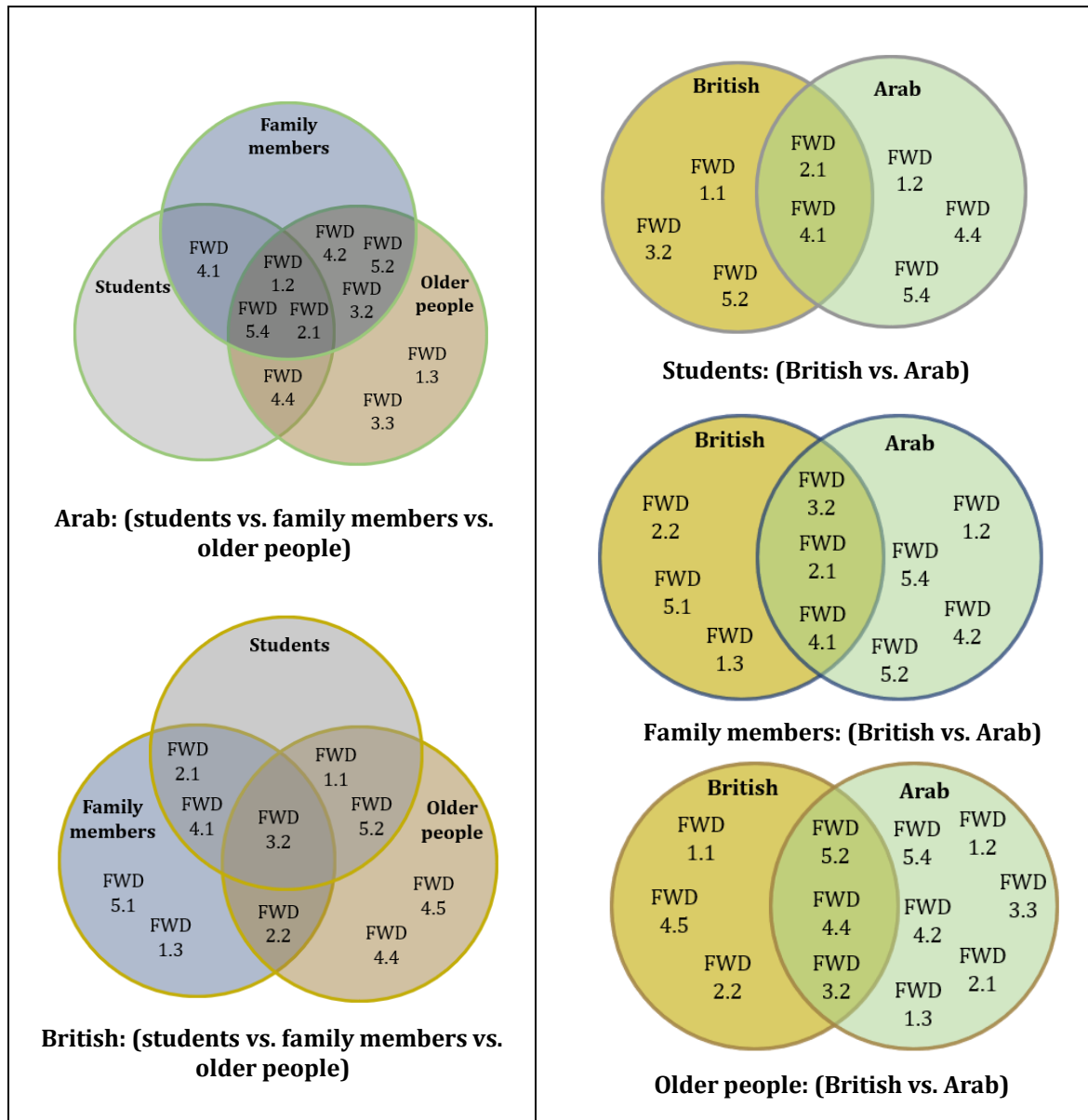
Figure 4.11 Food waste sub-drivers for participants from two cultures and three life stages

4.4 Discussion and conclusion

This section includes discussion and conclusions of Study 2, and discussion and conclusion of Study 1 and Study 2.

4.4.1 Discussion and conclusions of Study 2

This study extended the research in Study 1, by exploring family members living with children and older people's attitudes and practices in relation to food consumption and waste. It was conducted to answer RQ1.2 in this programme of research (RQ1.2: What are the similarities and differences among individuals from different cultures living in

family situations with children and older people in terms of their practices around food consumption and food waste and drivers that lead them to waste food?).

In relation to individuals' practices around food consumption and food waste, the study found both similarities and differences among individuals living in family situations with children and older people from two different cultures in relation to their attitudes and practices around food and food waste. Regardless of cultures and life stages, fresh foods were the most wasted food in individuals' households. In addition, individuals generally believe that their households did not waste much food. However, individuals at different life stages and from different cultures had different motivating reasons to reduce their food waste.

In relation to drivers that lead them to waste food, the study found that "Overbuying food" was the main food waste driver for individual groups at different life stages and from different cultures. However, "Eating and socialising" was the main food waste driver for only family members.

4.4.1.1 Implications for technological interventions to support food waste reduction

The results of participants' practices and attitudes around food and food waste (see Section 4.3.1) as well as the results of food waste drivers (see Section 4.3.2) have implications for the design of interventions to support food waste reduction.

Table 4.19 illustrates how the results of the questionnaire about participants' practices might have relevance for the design of interventions and Table 4.20 illustrates of the results on the food waste drivers might have relevance. Both tables include consideration of life stage and cultural differences between the participants, and whether these differences might need particular support to be given by researchers or designers of technological interventions for food waste reduction. For example, for all individual groups, interventions could provide support for over buying. However, they might need specific support (e.g., for British family members, help with influencing by offers via providing information about whether it is worth to buy food and the sufficient amount to buy; while for British older people, discouraging buying packages of food that are bigger than really needed).

Table 4.19 Implications of the findings for technological interventions to support food waste reduction (**Note:** if the implication does not mention a participant group, it would apply to all participant groups studied in this chapter)

Finding (for all participants)	Cultural and Life stage differences in finding	Implications for technological interventions
Most participants did food shopping by themselves (Q12).	Arab family members, their spouses were shopping for food.	Provide support for the creation of personal shopping lists. Provide support for sharing shopping lists with others in their household.
Shopping in supermarkets was the most popular method for all participants(Q15).	British family members shop online. Older people shop in specialist shops and markets.	Provide support during supermarket shopping (e.g., checking of household food stock while shopping). Link supermarket loyalty cards/user accounts to other interventions to facilitate food information management. Link to preferred supermarket websites, to allow notification of special offers/promotions. Provide comparative information about preferred supermarkets, based on distance, or prices. For British family members, provide support for online shopping. For older people, provide information about specialist shops and markets.
Fresh foods are the most preferred type of food purchased by all participants (Q16). Fresh food such as fruits, vegetables and bread and baked food, and dairy are the most wasted items in participant households (Q27).	Arab participants wasted Rice, pasta, other starches.	Provide support to purchase only needed amounts of fresh food. Provide information about how to store fresh food to maximize its shelf-life. Provide information about how to use up leftover fresh food. Provide information about nutritious alternatives to fresh food which last longer (e.g., frozen, canned foods). For Arab, provide support to conserve as rice, pasta and other starches.
Most participants cook by themselves in their households, using recipes at different levels of frequency (Q20, Q22).	Arab family members relied on housemaids for cooking. Arab older people, their spouses were cooking food. British family members and Arab older people reported using recipes sometimes more than other groups.	Support individuals who cook for themselves. Provide strategies to increase individuals' knowledge and skills related to cooking. For example, provide recipes to help cook appropriately. For Arab family members, provide recipes in different language which can be understood and used by housemaids from different countries.

Most participants relied on labelling in checking food edibility (Q23).	Appearance is commonly used by British family members and British older people. Smell is commonly used by Arab family members. Labelling is commonly used by Arab older people.	Provide advice for British family members and British older people who use appearance to check food edibility. Provide advice for Arab family members who use smell to check food edibility.
Participants did not believe their household wasted a lot of food, and also they did not believe that it would be difficult to reduce food waste in their households (Q30.2 and Q30.3).	None.	Support individuals by enhancing their awareness of their wasted food. For example, providing means to improve the visibility of how much food they wasted.
Participants believed that food waste has effect on the environment and on their budget (Q30.4 and Q30.5).	For the effect on budget, British older people gave lower rating than other participant groups. British family members gave lower rating than Arab family members.	Provide support in monitoring the cost of food waste.
Almost half participants would reduce food waste to reduce the amount of money spent on food (Q26).	For Arab older people, the motivational reason was to reduce the amount spend on food. For British older people, to reduce the amount spend on food and to minimise environmental impact. For British family members, to minimise environmental impact. For Arab family members, reasons related to religious beliefs or moral principles.	See previous item about providing support on cost of food waste. In addition, for Arab participants, link between religious and moral principles and food waste to motivate them.
Participants feel guilty when throwing food away (Q30.6).	None.	Support individuals to reduce the amount of food being thrown away. Provide positive feedback when participants conserve food that might otherwise being wasted.

Table 4.20 Implications of food waste drivers for interventions to support food waste reduction (**Note:** if the implication does not mention a participant group, it would apply to all participant groups studied in this chapter)

Finding (For all participants)	Cultural and Life stage differences	Implications
Overbuying Food is a High importance main driver for participants.	High importance for all individual groups. **Sub-drivers underlying Overbuying food:** For Arab family members, Arab older people, and British older people: Over optimistic buying. For British family members and Arab older people: Influenced by offers. For British older people: Packages too big.	Provide information about if it is worth to buy food and the sufficient amount to buy. For British older people, provide information about appropriate packages sizes to buy, facilitate sharing extra food with others, and facilitate finding longer lasting substitutions for foods.
Eating and Socialising is High importance main driver for participants.	High importance for Arab family members and British family members. Moderate importance for Arab older people and British older people. **Sub-drivers underlying Eating and socialising:** For Arab family members, Arab older people, and British older people: Catering for special occasions. For British family members: Catering for "picky" eaters.	For Arab family members, Arab older people, and British older people, provide support with catering for special occasions. For British family members, provide recipes and suggestions to help serving "picky" eaters.
Food storage and management is Low importance main driver for participants.	Moderate importance for British older people. Low importance for Arab family members and Arab older people. No importance for British family members. **Sub-drivers underlying Food storage and management:** For Arab family members, Arab older people and British older people: Lack of information about what food is in the fridge/pantry. For Arab older people: Lack of knowledge about storing food.	For Arab family members, Arab older people and British older people, provide information of what food is in the fridge or pantry. For Arab older people, provide information to increase knowledge about storing food.
Shopping and meal Planning is not perceived as an importance main driver for participants.	Moderate importance for British family members. No importance for Arab family members, Arab older people, and British older people.	For British family members, provide information about the importance of making shopping and meal plans for reducing food waste.

	Sub-drivers underlying Shopping and meal planning: For British family members: Failure to make a plan and Failure to stick to a plan.	provide encouragement to stick to shopping/meal plans.
Food preparation and cooking is not perceived as an importance main driver for participants.	Low importance for Arab family members and British family members. No importance for Arab older people and British older people. **Sub-drivers underlying Food preparation and cooking:** For Arab family members: Lack of knowledge of how to use leftovers. For British family members: Lack of time/motivation to cook.	For Arab family members, provide suggestions to use up particular foods and leftovers. For British family members, provide motivations to cook and to make time for cooking.

4.4.1.2 Comparison with the previous literature

This study investigated the food and food waste practices of family members and older people from two very different cultures, a Western culture and a non-Western culture. In comparison, the majority of the previous research conducted for a particular culture with very wide range of individual age (e.g., Stancu et al., 2016; Visschers et al., 2016; Russell et al., 2017; Aktas et al., 2018). Stancu et al. investigated people in Denmark, aged between (less than) 35 and (over) 50; Visschers et al. studied people in Switzerland, with mean age of 57; Russell et al. investigated people in the UK, aged between 50 and 59; Aktas et al. investigated people in Qatar, aged between 18-74. There is a small body of previous research considered either individuals cultures or life stage in studying food waste. For example, Heng and House (2022) considered a range of western cultures: USA, Canada, UK, and France. Kansal et al. (2022) also considered the cultures: Anglo, Sri Lankan, Bangladeshi, Greek, and Indian. However, both Heng and House & Kansal et al. had a very wide sample with about 19 to above 60. At the same time, there were some research more focused on specific individuals' life stage. For example, Teng et al. (2021) studied food waste for family members living with children (aged between 30 and 50) in Taiwan. McAdams et al. (2019) focused on retired people (aged between 72 and 98) in Canada. Both studies Teng et al. and McAdams et al. were conducted in single countries. However, the possible impact of both *Culture*

and *Life stage* on individuals' attitudes and practices to food waste still remained a gap in the current literature.

This study therefore addressed this gap in the research by exploring two life stage groups and two cultural groups of individuals in relation to their practices and drivers to food waste, along with a comparison between the groups. This contribution can be useful for researchers in the area of food waste and designers of technological interventions to reduce food waste, the use of which can be influenced by culture and/ or life stage and thus need to be designed specifically for particular life stages and cultures to improve the effectiveness of the proposed interventions. In addition, the possible interaction effect between the two variables (*Life stage* and *Culture*) on individuals food waste practice is presented in Section 4.3.3.

With respect to the kinds of foods most wasted, this study found that across all groups, wasted vegetables, fruit and bread, and dairy products. Except dairy product, this was similar to our finding in Study 1, and in the literature (e.g., Herzberg et al., 2020). However, rice, pasta, other starches appeared to be one of the most wasted foods for only Arab participants. This was also found by Alshabanat et al. (2021) who noted that rice was the most wasted food in Saudi Arabia. Al-Buainain (2015) noted that generally Saudis are very generous in hospitality and when they have special occasions or events such as Eid[6] or a wedding, they prepare too much food as a gesture of welcome, and from my experience, usually in Saudi Arabia main dishes on occasions such as Eid or a wedding do include rice.

In relation to cooking food in households, this study found that Arab family members relied on housemaids. This was also found by Al-Matary and AlJohani (2021) although their study was conducted with students.

In relation to belief about level of food waste, this study found that across all life stages and cultural groups, individuals did not believe their household wasted a lot of food. This believe did not seem to be affected by life stage or culture. This is in line with the

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[6] In Islam, there are two Eid's (*Eid-al-Fitr* and *Eid-al-Adha*), which are special occasions for Muslims to celebrate with their families and friends. *Eid-al-Fitr* marks the end of Holy Month of Ramadan; and *Eid-al-Adha* coincides with the completion of Hajj.

findings of first study in this programme of research, where such belief investigated with students from three three cultures.

In relation to motivation for food waste reduction, this study found that individuals from different cultures would be motivated differently for food waste reduction. For British individuals, to minimize environmental impact more than Arab individuals, while Arab individuals had reasons related to their religious beliefs or moral principles. This could confirm what Elshaer et al. (2021) argued about the role that religiosity could play in influencing intentions in the context of food waste. Nevertheless, many Arab older people would reduce food waste to reduce the amount spent on food. This in fact could be due to the design of this question, where reasons related to religious beliefs and moral principles were not provided as an option, however some participants provided it in the "other" option and explained it in the accompanying text box. Thus, a question which includes religious beliefs and moral principles as an option might have provided different results from Arab older people.

In relation to the most important food waste drivers, this study found that "Overbuying food" was the *High importance* main food waste driver for all individual groups from different cultures and at different life stages. The issue of overbuying food seems to be significant for food waste. Heng and House (2022) also found that for other cultures, where US and Canadian people agreed buying too much is one of the reasons, they that threw away fresh fruit and vegetables. For all individual groups except British family members, "Over optimistic buying" was the sub-driver underlying "Overbuying food". This driver did not get too much attention in the current literature; although it was somewhat raised for French people in the study conducted by Heng and House (2022) reporting the issue of fresh fruits and vegetables to be spoiled more quickly than expected. In addition, it was discussed by Block et al. (2016) as a psychological cause for food waste behaviour.

In addition, for British family members and Arab older people, "Influenced by offers" was the sub-driver underlying "Overbuying food". This driver was discussed by Schneider (2008) along with other psychological traps. Our study findings confirmed the strong effect that psychological drivers could have on these specific individual groups. Among the variety of drivers our study involved, some of which were related to

individual knowledge, skills, and preferences; psychological or emotional drivers appeared to be important drivers to food waste. However, "Packages too big" was the sub-driver underlying "Overbuying food" for only British older people. This can be explained by Herzberg et al. (2020), as this issue could be due to small households.

In relation to "Eating and socialising", this study found that for Arab family members, "Catering for special occasions" was the sub-driver underlying it. This finding might be explained by Baig, Al-Zahrani, et al. (2018), as in Arab culture, people who save food are seen as unwelcoming and misers. In addition, Khan and Kaneesamkandi (2013) discussed the significant increase of food waste during special seasons such as Ramadan. Nevertheless, for only British family members, "Catering for "picky" eaters" was the sub-driver underlying "Eating and socialising". This could be because they were living with children. The pressure children might put on their parents was studied by Kansal et al. (2022), explaining how fussy the children are about what they want to eat could affect food preparation. Living with children as a factor was also discussed by Hebrok and Boks (2017) including possible influence on shopping and meal planning.

4.4.1.3 Limitations of the study

The study had some limitations which should be highlighted. The study used an opportunistic sample (Flick, 2018), individuals who are interested in participating in research about a study on helping consumers waste less food using technology (this was how it was described in the information provided to participants at the beginning of the study), who received a small payment for participating as reward. This might mean that participants who participated are more interested in food waste reduction that the total population of family members living with children and older people.

Recruitment was particularly difficult for participants in Saudi Arabia. So, for older people, I could only recruit participants aged from 50 to 65 years old; and for family members, three of the participants were studying at the University of York and living in the UK but they grew up in Saudi. However, they were asked about their practices when they were in Saudi Arabia.

The study was a self-report, so the results illustrated participants' perception about their attitudes and behaviour around food practice and food waste, which can be

subject to social desirability bias (Nederhof, 1985). Similar to Study 1, some techniques were used in order to mitigate such bias. For example, assuring the anonymously and confidentiality of the responses to minimise the stress of reporting undesirable behaviours around food waste, and informing participants at the beginning of the study that there were no "yes" or "no" answers, and it is just their opinions, in order to make them feel more comfortable in answering the questions and not feeling that they were going to be judged by others.

The study was gender unbalanced, with a total of 60.7% female. For each group, 100% of Arab family members were female, 83.3% of British family members, while only 50% of British older people and 40% of Arab older people. However, this was the case with many studies being the female more than male in their sample (e.g., Visschers et al. (2015) had 59% women; Teng et al. (2021) had 92.5% women).

The number of participants in each individual group were vary. This might have effect when comparison made between individual groups. For example, 50% of British older people is five participants, whereas it is three participants for British family members.

Some statements about food waste drivers were included only for Arab individuals (e.g., "I don't have a good communication with partner about what meals will be prepared to know what to buy"; "Food in our country is affordable, so I would not be affected when I buy more food"). This is because these two ideas were mentioned in the literature on research specifically about Saudi Arabia (Aljamal & Bagnied, 2021; Baig, Gorski, et al., 2018) (as discussed in more detail in Section 4.2.1). However, as this is an exploratory study it might have been useful of considering these statements for all groups to investigate its potential to food waste for other cultural groups. Thus, in future research I would make such considerations into account.

To conclude, the study highlighted the practice and drivers around food waste for participants at different stages of life (i.e., family members and older people) from two cultures (i.e., Arab and UK). A discussion of the results of this study about individuals from the two stages of life (i.e., family members and older people), along with the results of Study 1 of one stage of life (i.e., postgraduate students) from the two cultures Arab and UK will be presented in the next section.

4.4.2 Discussion and conclusions of comparison of Study 1 and Study 2

The results of Studies 1 and 2 aimed to explore students, family members living with children and older people's attitudes and practices in relation to food consumption and waste. The comparison was conducted to answer RQ1.3 in this programme of research (RQ1.3: What are the similarities and differences among individuals at three different life stages and from two different cultures in terms of their practices and attitudes around food consumption and food waste and drivers that lead them to waste food?).

In relation to individuals' practices around food consumption and food waste, the results showed that like Study 2, fresh foods were the most wasted food in individuals' households. In addition, individuals generally believe that their households did not waste much food. However, there are some differences between individuals at different life stages and from different cultures in relation to attitudes and practices around food shopping, food waste, and even how they are motivated to reduce their food waste.

In relation to the nature of any interaction between *Culture* and *Life stage* on individual attitudes and behaviour in relation to food waste drivers, the results showed that there were no main effects for *Culture* or *Life stage*, but there was a significant interaction between *Driver* and *Life stage*. The most votes go to "Overbuying Food" and "Eating and Socializing", with most votes produced by older people for Overbuying Food and by family members for "Eating and Socializing".

In relation to the drivers which lead them to waste food, the results showed that "Overbuying food" was the main food waste driver for individual groups at all life stages and from all cultures. However, in relation to life stage, "Eating and socialising" was also the main food waste driver for only family members. While for culture, "Eating and socialising" was also the main food waste driver for both Arab and British people.

4.4.2.1 Implications for technological interventions to support food waste reduction

The results of participants' practices and attitudes around food and food waste (see Section 4.3.3.1) as well as the results of food waste drivers (see Section 4.3.3.2) have implications for the design of interventions to support food waste reduction.

Table 4.21 illustrates how the results of the questionnaire about participants' practices might have relevance for the design of interventions (based on the results presented in

Table 4.9- 4.14). Table 4.22 illustrates of the results on the food waste drivers might have relevance ("For all participants" column is based on the results presented in Figure 4.6 and 4.7; "Cultural and Life stage differences" based on the results presented in Table 4.15- 4.18). Both tables include consideration of life stage and cultural differences between the participants, and whether these differences might need particular support to be given by researchers or designers of technological interventions for food waste reduction. For example, interventions could provide support for over buying for all groups. Although interventions could provide different support for different groups (e.g., for older people, help with influencing by offers via providing information about if it is worth to buy food and the sufficient amount to buy; while for British people, discouraging buying packages of food that are bigger than really needed). However, for family members interventions could also provide support for eating and socialising (e.g., providing recipes and suggestions to help serving "picky" eaters).

Table 4.21 Integration of the results and implications of Studies 1 and 2 for interventions to support food waste reduction

Finding (For all participants)	Cultural and Life stage differences	Implications
Most participants did food shopping by themselves (Q12).	None.	Provide support for the creation of personal shopping lists.
		Provide support for sharing shopping lists with others in their household.
Shopping in supermarkets is the most popular method for all participants (Q15).	**Life stage:** Older people shop in specialist shops and markets.	Provide support during supermarket shopping (e.g., checking of household food stock while shopping).
		Link supermarket loyalty cards/user accounts to other interventions to facilitate food information management.
		Link to preferred supermarket websites, to allow notification of special offers/promotions.
		Provide comparative information about preferred supermarkets, based on distance, or prices.
		For older people, provide information about specialist shops and markets.
Fresh foods are the most preferred type of food purchased by all participants (Q16).	**Life stage:** Vegetable was in the top group of wasted food for students and older people.	Provide support to purchase only needed amounts of fresh food.

Fresh food such as fruits, vegetables and bread and baked food, and dairy were the most wasted items in participants' households (Q27).	Fruit was in the top group of wasted food for family members. **Culture:** Rice, pasta, other starches were wasted by only Arab people.	Provide information about how to store fresh food to maximize its shelf-life. Provide information about how to use up leftover fresh food. Provide information about nutritious alternatives to fresh food which last longer (e.g., frozen, canned foods). For Arab, provide support to conserve as rice, pasta and other starches.
Most participants cook by themselves in their households, using recipes at different frequency levels (Q20, Q22).	**Life stage:** Older people, their spouses were cooking food. Family members and older people reported using recipes sometimes more than students. **Culture:** Arab people relied on housemaids for cooking.	Support individuals who cook for themselves. Provide strategies to increase individuals' knowledge and skills related to cooking. For example, provide recipes to help cook appropriately. For Arab people, in, provide recipes in different language which can be understood and used by housemaids from different countries.
Most participants relied on smell in checking food edibility (Q23).	**Life stage:** Either smell or appearance is commonly used by students and family members. Labelling is commonly used by older people. **Culture:** Appearance is commonly used by British people.	Provide advice for students and family members who use smell or appearance to check food edibility. Provide advice for British people who use appearance to check food edibility.
Participants did not believe their household wasted a lot of food, and also they did not believe that it would be difficult to reduce food waste in their households (Q30.2 and Q30.3).	None.	Support individuals by enhancing their awareness of their wasted food. For example, providing means to improve the visibility of how much food they wasted.
Participants believed that food waste has effect on the environment and on their budget (Q30.4 and Q30.5).	**Life stage:** For the effect on environment, Older people gave higher ratings than family members. **Culture:** For the effect on budget, Arab people gave higher rating than British people.	Provide support in monitoring the cost of food waste.
Almost half participants would reduce food waste to reduce the amount of money spent on food(Q26).	**Life stage:** For older people, the motivational reason was to reduce the amount spend on food.	See previous item about providing support on cost of food waste. In addition, for Arab participants, link between religious and moral principles and food waste to motivate them.

	Culture: For British people, the motivational reason was to minimise environmental impact. For Arab people, reasons related to religious beliefs or moral principles.	
Participants feel guilty when throwing food away (Q30.6).	**Culture:** Arab people gave higher ratings than British people.	Support individuals to reduce the amount of food being thrown away. Provide positive feedback when participants conserve food that might otherwise being wasted. For Arab individuals, this can be linked to Islamic principles related to food waste.

Table 4.22 Implications of results of food waste drivers for different life stages and cultures for interventions to support food waste reduction

Finding (For all participants)	Cultural and Life stage differences	Implications
Overbuying Food is the High importance main driver for all participants.	High importance for individuals at different life stages and from different cultures. **Sub-drivers underlying Overbuying food:** **Life stage:** For all life stages: Over optimistic buying. Only for older people: Influenced by offers. **Culture:** Arab people: Over optimistic buying. British people: Packages too big.	Provide information about if it is worth to buy food and the sufficient amount to buy. For British people, provide information about appropriate packages sizes to buy, facilitate sharing extra food with others, and facilitate finding longer lasting substitutions for foods.
Eating and socialising is Moderate importance main driver for all participants.	**Life stage:** High importance for family members. Moderate importance for older people. Low importance for students. **Culture:** High importance for the two cultures. **Sub-drivers underlying Eating and socialising:** **Life stage:** For students: Impulse eating. For family members and older people: Catering for special occasions. For family members: also, Catering for "picky" eaters.	For both cultures, as well as for family members and older people, provide support with catering for special occasions. For family members, provide recipes and suggestions to help serving "picky" eaters. For students: provide easy and delicious recipes to increase their desire to use up available food.

	Culture: For Arab and British people: Catering for special occasions.	
Food Storage and Management is Low importance main driver for all participants.	**Life stage:** Moderate importance for students. Low importance for older people. Not importance for family members. **Culture:** Moderate importance for British people. Low importance for Arab people. **Sub-drivers underlying Food storage and management:** **Life stage:** For all life stages: Lack of information about what food is in the fridge/pantry. **Culture:** For both cultures: Lack of information about what food is in the fridge/pantry.	Provide information of what food is in the fridge or pantry.
Shopping and meal Planning is not perceived as an importance main driver for participants.	**Life stage:** Moderate importance for family members. Not importance for students and older people. **Culture:** No importance for Arab and British people. **Sub-drivers underlying Shopping and meal planning:** For family members: Failure to make a plan.	For family members, provide information about the importance of making shopping and meal plans for reducing food waste.
Food preparation and cooking is not perceived as an importance main driver for participants.	**Life stage:** Moderate importance for: students No importance for family members and older people. **Culture:** No importance for Arab and British people. **Sub-drivers underlying Food preparation and cooking:** For students: Lack of time/motivation to cook and Belief that leftovers are not healthy.	For students, provide motivations to cook and to make time for cooking. Provide information of food safety including leftovers, and re-heating food.

4.4.2.2 Comparison of results of Studies 1 and 2 with the previous literature

The results of Studies 1 and 2 investigated the food and food waste practices of students, family members and older people from two very different cultures, a Western culture and a non-Western culture. In comparison, there is no previous research could be found which addressed both culture and life stage in relation to food waste (see Chapter 2, Section 2.2). The results of Study 1 and 2 therefore addressed this gap by exploring the differences and similarities between the three life stage groups and two cultural groups of individuals in relation to their practices and drivers to food waste, along with a comparison between the groups. This contribution can inform the researchers in the area of food waste and designers of technological interventions to reduce food waste, of which practice that can be influenced by either *Life stage*, *Culture*, or both and thus need to be designed specifically for particular group towards improving the effectiveness of the proposed interventions.

In relation to the various practices and attitudes discussed, particularly for food shopping, older people regardless of their cultures do food shopping in specific shops and markets more than family members and students. This might be due to the past experience of older people of doing food shopping. McAdams et al. (2019) discussed how past behaviour of older people could shape their current food habits.

For food waste regardless of either culture or life stage, overall fresh food such as vegetables, fruits, bread and baked goods, as well as dairy were the most wasted. This finding is similar to the findings of Study 2. In addition, except dairy products, this is similar to the findings of Study 1 and previous studies (e.g., Herzberg et al., 2020; Mondejar-Jimenez et al., 2016). However, what is interesting is that vegetables in particular appeared in the most wasted group for the two cultures (Arab and British), and for two life stage groups (students and older people). However, fruits appeared in the most wasted group for family members. Nevertheless, rice, pasta, other starches were reported as one of the most wasted items for only Arab people. As discussed in Study 2, this was also found by previous researchers (e.g., Alshabanat et al., 2021), which can be due to the culture of food consumption in Saudi Arabia.

In addition, for checking food edibility, the findings are in line with the research conducted by Van Boxstael et al. (2014), where younger people use smelling and tasting for checking food edibility more than older people. At the same time, older people use

food labelling for checking food more than younger people. This might be due to that older people are more careful about their health compared with younger people.

Further, on whether participants think that food waste has effect on the environment and on their budget. For environmental effect, older people gave higher ratings than family members. This might be due to the experience older people have, compared to younger people. My findings revealed that Arab people gave higher ratings than British people for the effect of food waste on their budgets. For the Arab student group, who were living in the UK, they may find the cost of food in the UK much higher compared to their own countries. In addition, for the Arab older people group, who were retired, may therefore be financially restricted and concern about cost.

Moreover, for motivations for food waste reduction, older people regardless of their cultures were motivated by reducing the amount of money spent on food more than students and family members. However, British people were motivated by minimising environmental impact more than Arab people. This finding can be influenced by the level of awareness people have in relation to food waste and its possible environmental consequences. In relation to Saudi Arabia, Baig, Al-Zahrani, et al. (2018) recommended increasing public awareness about food waste and the related impact on sustainability in order to reduce food waste. At the same time, Arab people were motivated by reasons related to their religious beliefs or moral principles. As discussed in relation to Study 2 (Section 4.4.1.2).

Finally, for feeling guilty when throwing food away, Arab people gave higher ratings than British people. This might be also related to Islamic beliefs, as Islam emphasize that food should not be wasted, and it should be appreciated. "God does not like wasteful people" (The Qur'an 6:141).

The pattern of *High importance* food waste drivers found for different groups showed interesting results. The ANOVA showed there were no differences just due to *Culture* or *Life stage*, but there was a significant difference between the drivers. Nor was there the predicted interaction between *Culture* and *Life stage.* However, there was an interaction between *Life stage* and *Driver*.

In relation to the differences between the drivers, "Overbuying Food" and "Eating and Socializing" were the most voted drivers (see Figure 4.6). Generally, the issue of overbuying has been extensively discussed and highlighted in previous research (e.g.,

Block et al., 2016; Ganglbauer et al., 2013; Heng & House, 2022; Yagoub et al., 2022). This finding therefore confirmed the importance of such an issue. In addition, issues around eating and socializing are important for both cultures, although Arab and British cultures may have different traditions and practices around food.

In relation to the interaction between *Life stage* and *Drivers*, for "Overbuying food", most votes were produced by older people compared to either family members or students. This could be because of that older people being retired and financially restricted, as mentioned by Schneider (2008). So, they could be influenced easily to buying food on offers, as they think it could help to reduce cost.

While for "Eating and Socializing", most votes were produced by family members in comparison to students and older people. This could be because of that family members were living with children, which sometime being fussy and picky eaters. This confirmed the effect of living with children, that discussed by previous researchers (e.g., Hebrok & Boks, 2017; Kansal et al., 2022).

The limitations of both studies discussed before, for Study 1 (Section 3.4.2, Chapter 3), and for Study 2 (Section 4.4.1.2, Chapter 4).

The result of this phase, understanding and investigation, is a list of *High importance* food waste drivers, which resulted from Study 1 and Study 2 (see Table 4.23). The list includes all food waste drivers, except FWD1.4, FWD1.5, FWD1.6, FWD3.4, FWD4.3, and FWD5.3. This list of food waste drivers will be further used in third phase, validation, and fourth phase, design, in this programme of research. In the third phase, a validation of the this set of food waste drivers will be conducted with British individuals. While the fourth and fifth phases, will use this set of drivers as a foundation in the development of the app to support individuals in food waste reduction to investigate the potential support and approach for individuals at different life stages toward food waste reduction.

Table 4.23 Food waste drivers found as *High importance* in Studies 1 and 2 is indicated with an x

Food waste driver	Resulted in	
	Study 1	Study 2
FWD1. Overbuying food		
FWD1.1 Packages too big	x	x
FWD 1.2 Over optimistic buying	x	x
FWD 1.3 Influenced by offers		x
FWD 2. Shopping and meal planning		
FWD 2.1 Failure to make a plan	x	x
FWD 2.2 Failure to stick to a plan		x
FWD 2.3 Communication about meal/shopping/planning	x	x
FWD 3. Food storage and management		
FWD 3.1 Confusion about food labels	x	
FWD 3.2 Lack of information about what food is in the fridge/pantry	x	x
FWD 3.3 Lack of knowledge about storing food	x	x
FWD 4. Food preparation and cooking		
FWD 4.1 Lack of time/motivation to cook	x	x
FWD 4.2 Lack of knowledge of how to use leftovers	x	x
FWD 4.4 Belief that leftovers are not healthy	x	x
FWD 4.5 Lack of cooking skills		x
FWD 5. Eating and socialising		
FWD 5.1 Catering for "picky" eaters	x	x
FWD 5.2 Catering for special occasions	x	x
FWD 5.4 Impulse eating	x	

Chapter 5

Study 3: Validation of food waste drivers with British individuals

5.1 Introduction

This chapter presents the third study in my programme of research, which was conducted to achieve the objective of the third phase, validation, in the research. The study was conducted to validate the food waste drivers that appeared to be of *High importance* in Study 1 or Study 2 (see Chapter 4, Table 4.23). In those two studies, data were collected from 49 participants, including 10 Chinese students, 18 Arab individuals and 21 British individuals at three different *Life stages*. Therefore, it was important to validate the findings with a larger sample size to investigate whether these drivers are truly key drivers for these individuals' groups or not. However, it was not possible to access a larger sample size of Chinese and Arab individuals, and it was only possible with British individuals.

The study initially targeted British individuals at a number of different stages of life: students, adults living with children, and retired people. These were the same stages of life as sampled in Study 1 and Study 2. However, a large number of respondents (69) to the survey in the current study were actually adults living without children, so this group was added. I think it was worth to add this group and investigate it in this study.

Thus, this study addressed RQ2 in my programme of research:

RQ2: What are the similarities and differences among British individuals at different *Life stages* in terms of food shopping and waste and important food waste drivers?

RQ2.1: What are the similarities and differences among British individuals at different *Life stages* in terms of food shopping and waste?

RQ2.2: What are the underlying and important food waste drivers for British people?

5.2 Method

5.2.1 Design

An online study was conducted using the Qualtrics online survey system (www.qualtrics.com) and distributed via the Prolific participant recruitment website (prolific.co). Prolific is an online platform specifically for recruiting research participants, unlike platforms such as Mechanical Turk (MTurk) which is a more general online outsourcing task platform. It is argued that Prolific provides higher quality research data compared to sites such as MTurk (Douglas et al., 2023) because the participants have expressed a specific interest in helping with research projects.

In the questionnaire, participants were asked general questions around food shopping and food waste practices as well as demographic information. In addition, participants were asked questions about their attitudes towards food waste issue.

The study was conducted with British individuals at different *Life stages*. These were:

- Students, who were studying for undergraduate or postgraduate university degree.
- Adults living with children, either with their spouse/partner, parents, or other relatives, but with children under the age of 18.
- Adults living without children, who are either employed or unemployed, living either alone, with spouse/partner, parents, or relatives but without children under the age of 18.
- Retired people, living either alone, or with their spouse/partner.

To measure the self-reported importance of different food waste drivers to participants, 24 Likert item statements was presented. These statements were based on the *High importance* food waste sub-drivers in Study 1 or in Study 2 (see Chapter 4, Table 23).

5.2.2 Participants

Participants were recruited via the Prolific participant recruitment website (prolific.co), with the inclusion criteria: current country of residence to be United

Kingdom and nationality to be British and to be over the age of 18 (all participants in Prolific should be 18 or over, but participants were asked their age to ensure this).

Based on the answers to the demographic questions, participants were categorised according to different *Life stage* groups: university students (all student participants stated they were studying at university), adults living with children, adults living without children, and retired people.

140 participants completed the study. However, five were omitted for one of two reasons: their age was under 18, or response time less than three minutes, which was considered too short to have been able to answer the questionnaire meaningfully. Therefore, only the data of 135 participants were analysed in this study. The demographics of the sample are summarized in Table 5.1.

Table 5.1 Demographic information for the participants in Study 3 (Number and percentage)

Participant Groups	Students N = 19	Adults living with children N = 36	Adults living without children N = 69	Retired people N = 11	All N = 135
Gender					
Women	12 (63.2)	23 (63.9)	27 (39.1)	2 (18.2)	64 (47.4)
Men	7 (36.8)	12 (33.3)	39 (56.5)	9 (81.8)	67 (49.6)
Non-binary	0 (0.0)	1 (2.8)	3 (4.3)	0 (0.0)	4 (3.0)
Age range					
18-29	19 (100.0)	6 (16.7)	28 (40.6)	0 (0.0)	53 (39.3)
30-39	0 (0.0)	11 (30.6)	18 (26.1)	0 (0.0)	29 (21.5)
40-49	0 (0.0)	13 (36.1)	12 (17.4)	0 (0.0)	25 (18.5)
50-59	0 (0.0)	6 (16.7)	11 (15.9)	0 (0.0)	17 (12.6)
60-69	0 (0.0)	0 (0.0)	0 (0.0)	8 (72.7)	8 (5.9)
70+	0 (0.0)	0 (0.0)	0 (0.0)	3 (27.3)	3 (2.2)
Education					
High school	13 (68.4)	11 (30.6)	21 (30.4)	3 (27.3)	48 (35.6)
Bachelor's degree	4 (21.1)	16 (44.4)	32 (46.4)	5 (45.5)	57 (42.2)
Master's degree	1 (5.3)	6 (16.7)	8 (11.6)	2 (18.2)	17 (12.6)
PhD	0 (0.0)	1 (2.8)	4 (5.8)	1 (9.1)	6 (4.4)
Other	1 (5.3)	2 (5.6)	4 (5.8)	0 (0.0)	7 (5.2)

This sample was close to gender balanced, with 47.4% female, and 49.6% male participants, with four participants (3.0%) identifying as non-binary. Students were aged from 18 to 29, adults living with/or without children aged from 18 to 59, retired people aged from 60 and over. There was a wide range of educational levels. Detailed

demographic information of participants is provided in Appendix C.1.1. Each participant who completed the survey received a reward of GBP 1.25 via Prolific.

5.2.3 Equipment and materials

The study was deployed online via the Qualtrics Survey system, and participants were recruited via an invitation published on the Prolific participant recruitment website.

A questionnaire was developed to collect information about food shopping and food waste attitudes and practice, as well as validating the food waste drivers. It comprised closed questions to collect demographic and general information around food shopping and food waste practice. Two open-ended questions gathered more information from participants about the types and reasons of food waste in their households.

The main part of the questionnaire, used to validate the food waste drivers, consisted of 24 Likert item statements of food waste drivers, which participants rated their agreement about whether they lead to them wasting food in their households on a 7 level scale from 1, "strongly disagree" to 7, "strongly agree". Table 5.2 lists the food waste drivers with the corresponding 24 statements included in the questionnaire. The 24 statements were based on the *High importance* food waste drivers in Study 1 and Study 2.

As illustrated in Table 5.2, there were 16 food waste drivers in the study, however some of the drivers were rather abstract. Therefore, I broke down abstract drivers into more specific statements in order to be more easily assessed by participants. Some of the statements came from the original set of statements used in Study 1 and Study 2, and some were adapted from the original statements.

In addition, six items assessed participants' attitudes to food waste were also included:
- I am concerned about food waste in my household;
- My household wastes too much food;
- I am concerned about food waste in our society;
- I try to minimise the amount of food waste in my household;
- I intend to waste less food in the future;
- I feel guilty when I throw food away.

The two open-ended questions asked about the types of food wasted in participants' households, and the main reasons for the food waste. These questions were used to gather more information about types of food waste and attitudes to food waste not covered by the rating statements.

Table 5.2 List of food waste drivers and corresponding statements Study 3

Food waste driver	Statement in the questionnaire
FWD1. Overbuying food	
FWD1.1 Packages too big	I often buy food in packages that contain more than I need because big packages seem better value
	I often buy food in packages that contain more than I need because smaller packages are not available
FWD 1.2 Over optimistic buying	I am often overly optimistic that I will consume all the food I buy (e.g., I buy fresh food but then don't eat it)
FWD 1.3 Influenced by offers	I am often influenced by offers in the shops (e.g., buy one get one free)
FWD 2. Shopping and meal planning	
FWD 2.1 Failure to make a plan	I often do not make a shopping list
	I rarely make a meal/cooking plan
FWD 2.2 Failure to stick to a plan	I often make a shopping list, but don't stick to it
	I often make a meal/cooking plan, but don't stick to
FWD 2.3 Communication about meal/shopping/planning	There is often not enough communication between household members about what food needs to be bought (If you live alone, rate as "strongly disagree")
FWD 3. Food storage and management	
FWD 3.1 Confusion about food labels	I am often confused about the meanings of food labels such as "use by", "best before", "sell by" "expiry date"
FWD 3.2 Lack of information about what food is in the fridge/pantry	I often forget about what is in the fridge and/or pantry, so items become too old to eat
	I often forget about what is in the fridge and/or pantry, and buy more of the same items
FWD 3.3 Lack of knowledge about storing food	I do not know about storing food so it will last as long as possible
	I do not know what food is better kept in the fridge and what food is better not kept there
	I do not know about freezing food (e.g., what can be frozen, how long things can be kept)
FWD 4. Food preparation and cooking	
FWD 4.1 Lack of time/motivation to cook	I often do not have time to cook
	I am often not motivated to cook
FWD 4.2 Lack of knowledge of how to use leftovers	I do not know how to use up leftover food
FWD 4.4 Belief that leftovers are not healthy	Eating leftovers is not healthy
FWD 4.5 Lack of cooking skills	I am not a good cook, the things I cook do not taste good, which leads to waste
FWD 5. Eating and socialising	
FWD 5.1 Catering for "picky" eaters	In my household I need to prepare different meals for different people, which leads to waste
FWD 5.2 Catering for special occasions	I often prepare too much food when I have guests, which leads to waste
	I often prepare too much food on special occasions, which leads to waste
FWD 5.4 Impulse eating	I often eat what I feel like, not what needs using up

The questionnaire is provided in Appendix C.1.2.

A pilot questionnaire was conducted with three participants to check if the questions were understandable and appropriate, as well as how long participants could take to answer the questionnaire.

For the analysis, the Statistical Package for the Social Sciences (SPSS) was used to analyse the quantitative, in particular to conduct the principal components analysis (PCA), and the Analysis of a Moment Structures (Amos) software (version 28) was used to conduct the confirmatory factor analysis (CFA).

5.2.4 Procedure

The survey was advertised on Prolific for eight days, between 19 December 2020 and 26 December 2020.

Potential participants first saw an introduction page with information about the study. After clicking on the link, respondents were redirected to the Qualtrics website. Participants needed to give their consent and provide their Prolific ID before completing the questionnaire (Appendix C.1.2). After finishing the questionnaire, participants were directed back to Prolific to receive their reward.

The questionnaire started with agreement page including the nature of the study which was explained to the participants, the confidentiality and anonymity of their data assured, and they were asked to check the consent box as agreeing to participate in the study and start the questionnaire. Then, participants were asked to answer general questions about food shopping and waste practice, followed by the open-ended questions about the types and reasons of food waste. After that, Likert scale statements about food waste drivers, and six rating items about participants' attitudes to food waste. Finally, participants were thanked for their participation in the study. The survey required approximately 10 minutes to be complete.

5.2.5 Data analysis

Quantitative data about demographics, and participants practice around food shopping and waste, were analysed using Statistical Package for the Social Sciences (SPSS) program. The data from all participants were analysed as well as for each *Life stage* group separately.

A quantitative content analysis (Krippendorff, 2013) was conducted to analyse one of the open-ended questions (What kinds of food tend to get wasted in your household, Q18).

The codebook (see Appendix A.1.7) used in Study 1 and Study 2, was used in this study to analyse the other open-ended question (What are the main reasons for food waste in your household, Q19).

A principal components analysis (PCA) was used to find the groupings of the food waste drivers, simplify the data and reduce the number of food waste drivers to a smaller number of dimensions. Confirmatory factor analysis (CFA) was conducted to assess the fit of the resulting model, its validity and reliability.

5.3 Results

5.3.1 Food shopping and waste practice (RQ2.1)

Participants were asked about food related activities, food shopping and food waste practices (see the Questionnaire, Appendix C.1.2).

The key results are summarized in Table 5.3. Only answers with more than 10% of responses from any group are presented (full results can be found in Appendix C.1.3, Table C.5).

Almost all participants reported they were involved in food shopping (Q7). However, only about two thirds of participants reported being involved with food waste reduction, with adults living with children reporting this much more than students (88.9% vs 36.8%).

Table 5.3 Results on question related to participant involvement in food-related activities (Number of responses, percentage of responses for each group and all participants)

	Students N = 19	Adults living with children N = 36	Adults living without children N = 69	Retired people N = 11	All N = 135
Are you involved in any of these food related activities in your household? (Q7) *					
Food shopping	16 (84.2)	35 (97.2)	65 (94.2)	11 (100.0)	127 (94.1)
Food cooking	16 (84.2)	35 (97.2)	57 (82.6)	10 (90.9)	118 (87.4)
Food storing and management	13 (68.4)	33 (91.7)	52 (75.4)	7 (63.6)	105 (77.8)
Food waste reduction	7 (36.8)	32 (88.9)	44 (63.8)	8 (72.7)	91 (67.4)

Note: * = multiple answers possible.

Participants' food shopping practices are summarized in Table 5.4, with only answers with more than 10% of responses from any group are presented (full results can be found in Appendix C.1.3, Table C.6).

Table 5.4 Results on questions related to food shopping practice (Number of responses, percentage of responses for each group and all participants)

	Students N = 19	Adults living with children N = 36	Adults living without children N = 69	Retired people N = 11	All N = 135
Who typically shops for food in your household? (Q14)					
Myself	3 (15.8)	19 (52.8)	27 (39.1)	4 (36.4)	53 (39.3)
Myself and spouse/partner	1 (5.3)	11 (30.6)	13 (18.8)	5 (45.5)	30 (22.2)
All members of the household	3 (15.8)	1 (2.8)	15 (21.7)	0 (0.0)	19 (14.1)
My parents or relatives	7 (36.8)	0 (0.0)	10 (14.5)	0 (0.0)	17 (12.6)
Myself and housemate/s	5 (26.3)	1 (2.8)	4 (5.8)	0 (0.0)	10 (7.4)
My spouse/partner	0 (0.0)	2 (5.6)	0 (0.0)	2 (18.2)	4 (3.0)
Where is the shopping for food your household most often done? (Q16) *					
In a supermarket	15 (78.9)	29 (80.6)	59 (85.5)	7 (63.6)	110 (81.5)
Online	4 (21.1)	16 (44.4)	18 (26.1)	5 (45.5)	43 (31.9)
In specific shops and markets (e.g., bakery, in open air markets or farm shops)	0 (0.0)	4 (11.1)	10 (14.5)	2 (18.2)	16 (11.9)
Other	0 (0.0)	1 (2.8)	0 (0.0)	2 (18.2)	3 (2.2)

Note: * = multiple answers possible.

More than a third of participants reported they did the shopping for their household (Q14). This included slightly more than half of adults living with children (52.8%), about a third of adults living without children and retired people (39.1% and 36.4%), but less than a fifth of students (15.8%). The notable differences between the groups are that nearly half of the retired people reported themselves and spouses as doing the shopping compared to less than a tenth of students (45.5% vs 5.3%). About a third of students (36.8%) reported their parents or relatives doing the shopping, compared to none of the adults living with children and retired people.

Most participants reported shopping at supermarkets (Q16). However, about a third (31.9%) reported online shopping, and about a tenth (11.9%) reported using specific shops and markets (e.g., bakeries, open air markets or farm shops), with none of the students reporting this mode of food shopping. Very few participants (2.2%) reported other methods of shopping such as food share services, local shops or food cooperatives.

Participants' opinions about food waste reduction are summarized in Table 5.5, with only answers with more than 10% of responses from any group are presented.

Participants were asked to rate their agreement with a number of statements related to food waste attitudes (see Table 5.5). Overall, participants significantly agreed with the statement about that they are concerned about food waste (Q21.A), the median rating was 5.0. There is no significant difference between participant groups. However, they significantly disagreed with the statement about that think their household wastes too much food (Q21.B), the median rating was 3.0. There is no significant difference between participant groups. They also significantly agreed with the statement about that they concerned about food waste in our society (Q21.C), the median rating was 6.0. There is no significant difference between participant groups. They also significantly agreed with the statement that they try to minimise the amount of food waste (Q21.D), the median rating was 6.0. There is no significant difference between participant groups. They also significantly agreed with the statement that they intend to waste less food in the future (Q21.E), the median rating was 6.0. There is no significant difference between participant groups. They also significantly agreed with the statement that they feel guilty when they throw food away (Q21.F), the median rating was 7.0. There is no significant difference between participant groups.

Table 5.5 Rating of food waste attitudes and intentions (Median, Semi Interquartile Range) (1 = strongly disagree to 7 = strongly agree) with Wilcoxon One Sample Tests (whether the overall median was significantly different from the midpoint of the scale) and Kruskal-Wallis H Tests (whether there was a significant difference between the groups)

	Students N = 19	Adults living with children N = 36	Adults living without children N = 69	Retired people N = 11	All N = 135	Wilcoxon One Sample Test	Kruskal-Wallis H Test
I am concerned about food waste in my household (Q21.A)							
Median (SIQR)	4.0 (1.0)	5.0 (1.0)	4.0 (1.5)	5.0 (1.0)	5.0 (1.5)	W = 2.20 P = 0.03	H = 2.52 n.s.
My household wastes too much food (Q21.B)							
Median (SIQR)	3.0 (1.5)	4.0 (1.5)	3.0 (1.0)	4.0 (2.0)	3.0 (1.5)	W = -3.49 p < 0.001	H = 5.53 n.s.
I am concerned about food waste in our society (Q21.C)							
Median (SIQR)	6.0 (1.0)	6.0 (1.5)	6.0 (1.0)	6.0 (1.0)	6.0 (1.0)	W = 8.39 P < 0.000	H = 0.78 n.s.
I try to minimise the amount of food waste in my household (Q21.D)							
Median (SIQR)	5.0 (0.5)	6.0 (1.5)	6.0 (1.0)	7.0 (1.0)	6.0 (1.0)	W = 8.34 P < 0.000	H = 5.16 n.s.
I intend to waste less food in the future (Q21.E)							
Median (SIQR)	5.0 (1.0)	6.0 (1.0)	6.0 (1.0)	6.0 (1.5)	6.0 (1.0)	W = 7.977 p < 0.001	H = 3.36 n.s.
I feel guilty when I throw food away (Q21.F)							
Median (SIQR)	6.0 (1.5)	7.0 (1.0)	7.0 (1.0)	7.0 (1.0)	7.0 (1.0)	W = 9.14 p < 0.001	H = 2.40 n.s.

Participants were asked an open-ended question about what kinds of foods tend to get wasted in their household (Q18, see Appendix C.1.2). The key results are summarized in Table 5.6 (only answers with more than 10% of responses from any group are presented, full results can be found in Appendix C.1.3, Table C.7).

Table 5.6 Results of content analysis of kinds of foods wasted

	Students N = 19	Adults living with children N = 36	Adults living without children N = 69	Retired people N = 11	All N = 135
What kinds of foods tend to get wasted in your household? (Q18)					
Vegetables	5 (26.3)	19 (52.7)	29 (42.0)	6 (54.5)	59 (43.7)
Bread and baked goods (e.g., Biscuits, crackers, and croissants)	5 (26.3)	11 (30.5)	21 (30.4)	3 (27.2)	40 (29.6)
Fruits	1 (5.2)	9 (25.0)	21 (30.4)	4 (36.3)	35 (25.9)
Dairy products (e.g., such as milk, yogurt and cheese)	1 (5.2)	9 (25.0)	13 (18.84)	2 (18.18)	25 (18.5)
Leftover	2 (10.5)	7 (19.4)	6 (8.7)	1 (9.0)	16 (11.8)
Salads	0 (0.0)	2 (5.5)	8 (11.5)	2 (18.1)	12 (8.8)
Chicken and Meat	2 (10.5)	3 (8.3)	5 (7.2)	1 (9.0)	11 (8.1)
Dips and sauces	0 (0.0)	2 (5.5)	7 (10.1)	0 (0.0)	9 (6.6)
Sausages	0 (0.0)	0 (0.0)	1 (1.4)	2 (18.1)	3 (2.2)

A content analysis of the most wasted items found that vegetables were the most wasted food, followed by bread and baked goods, fruits, as well as dairy products such as milk, yogurt and cheese.

Participants were asked an open-ended question about the main reasons for food waste in their household (Q19). The same codebook as used in Study 1 and Study 2 (see Appendix A.1.7), was used for a thematic analysis of answers. In addition, a quantitative content analysis was conducted. The key results are summarized in Table 5.7 (only answers with more than 10% of responses from any group are presented, full results can be found in Appendix C.1.3, Table C.8).

Table 5.7 Results of quantitative content analysis of main reasons for food waste in the household

	Students N = 19	Adults living with children N = 36	Adults living without children N = 69	Retired people N = 11	All N = 135
What are the main reasons for food waste in their household? (Q19)					
Over optimistic buying	6 (31.5)	8 (22.2)	14 (20.2)	1 (9.0)	29 (21.4)
Lack of information about what food is in the fridge/pantry	6 (31.5)	2 (5.5)	5 (7.2)	2 (18.1)	15 (11.1)
Cooking a lot, but not eating it	1 (5.2)	2 (5.5)	8 (11.5)	1 (9.0)	12 (8.8)
Impulse eating	2 (10.5)	1 (2.7)	4 (5.8)	1 (9.0)	8 (5.9)

The reasons mentioned by participants were related to the following food waste drivers:

Over optimistic buying was the most frequently mentioned. This included estimating more than their need to buy and would consume. If also food reaching its expiry date before it is used, due to the short shelf-life of some foods, which does not give participants enough time to consume them:

> "Short use-by dates, buying more fresh food than we can consume before it goes off" (ALW47) [7]

Lack of information about what food is in the fridge/pantry was the second most frequently reason mentioned by participants. This included forgetting what food items

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[7] ALWOC is used for Adults Living without Children, ALC for Adults Living with Children, S for students, and RP for retired people.

they have at home, and information such as how long they have had an item and when it will be past its expiry date:

> "Forgetting about something in the back of the fridge/pantry" (S18)
>
> "Forgetting the use by dates until it is too late" (ALW56)

Cooking a lot, but not eating it was the third most frequently reason mentioned. This included cooked too much, resulting in having leftovers or excess food that would then go to waste:

> "Making too much for dinner, not finishing dinner" (ALW43)

Impulse eating was also a frequently mentioned reason. This included lack of appetite and not wanting to eat leftovers, depression and irritable bowel syndrome (IBS) which changes eating habits:

> "I have depression and IBS, both of which means I sometimes have periods where I eat little to no freshly prepared food. When this is bad I will often get to 4pm and only then realise I haven't eaten anything yet. Quick meals or delivery then get priority over anything needing any effort" (ALW28)

5.3.2 Food waste drivers

5.3.2.1 Grouping of the importance of the food waste drivers (RQ2.2)

To investigate the groupings in the ratings of importance of the food waste drivers, a principal components analysis (PCA) was conducted on the ratings of 24 statements of food waste drivers. The results of the medians (and semi-interquartile ranges) of the 24 statements of food waste drivers for all and each participant group can be found in Appendix C.1.4. As illustrated in Table 5.8, the analysis yielded five components which explain a total of 54.45% of the variance. Statements with factor loadings higher than 0.400 were considered to contribute to a component. This resulted in 20 out of the 24 statements of food waste drivers being loaded onto these five components.

Table 5.8 Component loadings of the food waste drivers in the principal components analysis

Statement	Component loading				
	Comp 1 Lack of knowledge of food management issues	**Comp 2** Preparing too much food	**Comp 3** Negative attitudes towards cooking	**Comp 4** Lack of planning	**Comp 5** Over shopping
% of variance	21.12	8.93	7.62	6.96	5.80
I do not know what food is better kept in the fridge and what food is better not kept there	.833	.004	.030	.057	-.083
I do not know about freezing food (e.g., what can be frozen, how long things can be kept)	.792	-.008	.044	.024	.074
I do not know about storing food so it will last as long as possible	.767	-.057	-.068	.164	.066
I am often confused about the meanings of food labels such as "use by", "best before", "sell by" "expiry date"	.499	.104	.157	.040	.249
I do not know how to use up leftover food	.422	-.262	.395	-.002	-.016
Eating leftovers is not healthy	.481	-.492	.165	-.147	-.160
I often prepare too much food on special occasions, which leads to waste	-.055	-.928	-.083	.043	.111
I often prepare too much food when I have guests, which leads to waste	.100	-.880	-.146	-.058	.080
I am often not motivated to cook	.036	.105	.804	.035	.032
I often do not have time to cook	-.059	.092	.782	-.145	.023
I am not a good cook, the things I cook do not taste good, which leads to waste	.156	-.038	.552	-.106	-.320
I often eat what I feel like, not what needs using up	.213	-.067	.457	.202	.225
There is often not enough communication between household members about what food needs to be bought	-.118	-.172	.414	.280	.164
I often do not make a shopping list	.168	-.119	-.191	.799	-.047
I rarely make a meal/cooking plan	.123	.271	.075	.723	.127
I often buy food in packages that contain more than I need because big packages seem better value	.040	-.162	-.041	-.005	.738
I often buy food in packages that contain more than I need because smaller packages are not available	.084	-.054	-.046	-.018	.467
I am often influenced by offers in the shops (e.g., buy one get one free)	-.094	-.115	.086	.107	.686
I often make a shopping list, but don't stick to it	.340	.279	-.052	-.231	.525
I often forget about what is in the fridge and/or pantry, so items become too old to eat	.018	-.011	.378	.233	.422
I am often overly optimistic that I will consume all the food I buy (e.g., I buy fresh food but then don't eat it) *	.186	-.303	.380	.227	.086
I often make a meal/cooking plan, but don't stick to *	.295	-.028	-.056	-.376	.262
I often forget about what is in the fridge and/or pantry, and buy more of the same items *	.188	-.243	.151	.114	.323
In my household I need to prepare different meals for different people, which leads to waste *	-.191	-.391	.236	-.170	.321

Note: * No loading over .400, so not included on any factor.

To assess the goodness of fit of the resulting model, its construct validity and reliability, a confirmatory factor analysis (CFA) was conducted (Brown, 2006). CFA is a statistical method, which can be used to assess the model resulting from the PCA. It statistically verifies the relationships between components (latent constructs) and items (observed variables) in the model. The CFA conducted on the five-factor model with 20 items of food waste drivers (i.e., Model A), resulting from the PCA.
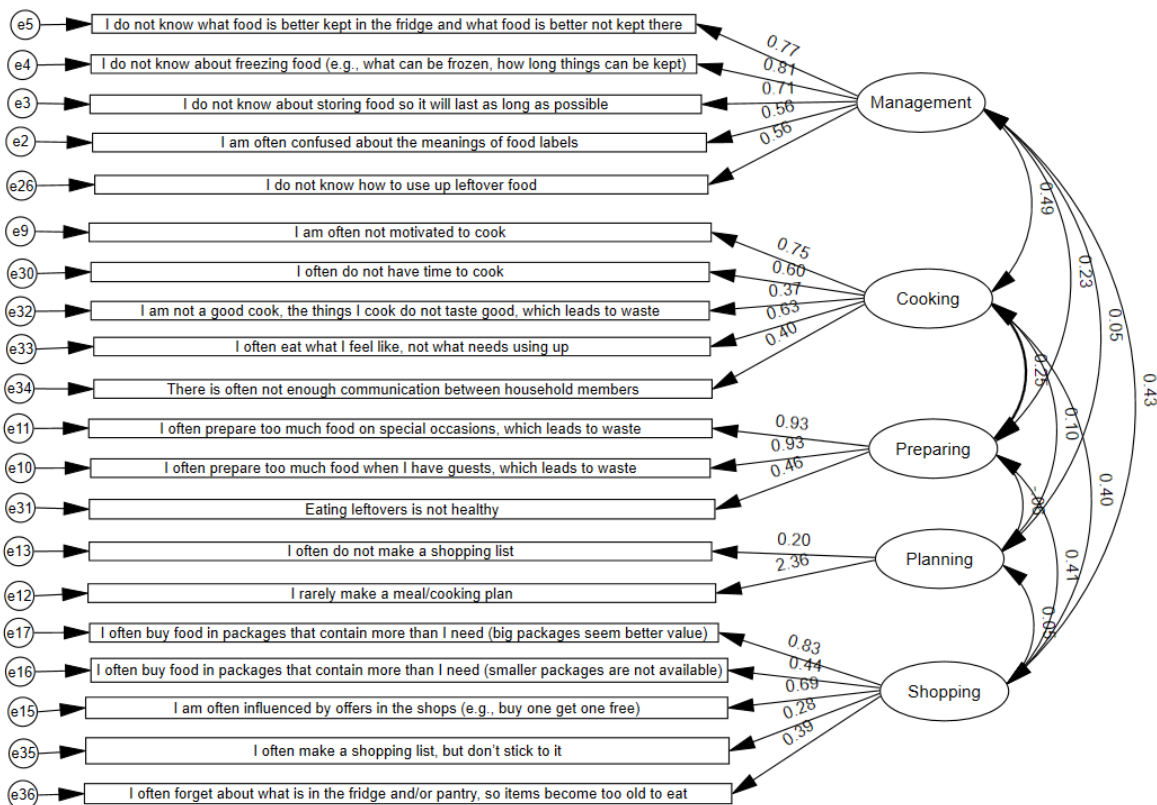
Figure 5.1 Five-factor model of food waste drivers (Model A)

Note: Factor loading displayed in the figure are standardized estimates. **Management** refers to "lack of knowledge of food management issues", **Preparing** refers to "preparing too much food", **Cooking** refers to "negative attitudes towards cooking", **Planning** refers to "lack of planning", and **Shopping** refers to "over shopping".

A good model fit is indicated by the following cut-off levels for the indices:

- Chi-square (x^2), p-value should be greater than 0.05 (Brown, 2006). (x^2/df) value should be less than 2.00 to indicate a very good model fit, and between 2.00 and 5.00 to indicate acceptable model fit (Hair et al., 2010).
- Comparative Fit index (CFI) and Tucker Lewis index (TLI) should be close to 0.95 or greater (Hu & Bentler, 1999); however other writers such as Bentler

(1990) argued that CFI and TLI values between 0.90 and 0.95 indicated acceptable model fit (not below 0.90).

- Root mean square error of approximation (RMSEA) value should be close to 0.06 or below (Hu & Bentler, 1999). However, Browne and Cudek (1993) argued that RMSEA value less than 0.05 indicated a good model fit, and RMSEA value less than 0.08 indicated adequate model fit (not greater than 0.1).

- PCLOSE should be greater than 0.05 (Brown, 2006).

The results of the CFA showed that Model A did not have a good fit (see Figure 5.1), as indicated by the following fit indices (x^2 = 325.274, with p-value = 0.000; x^2/df = 2.033; CFI = 0.815; TLI = 0.781; RMSEA = 0.087; and PCLOSE = 0.000).

Therefore, Model A was revised iteratively to see if I could improve the goodness of fit while maintaining conceptually sensible groups. This required several iterations. Although Hair et al. (2010) recommended a cut-off of factor loading of 0.500, I used a cut-off of 0.400 due to the desire of retaining a factor has at least three items as recommended by Hair et al. (2010).

Iteration 1: two items ("I am not a good cook, the things I cook do not taste good, which leads to waste", "there is often not enough communication between household members about what food needs to be bought") with factor loadings of 0.400 or less were removed from the "negative attitude towards cooking" Component (see Figure 5.1). The removal of these statements made conceptual sense.

Iteration 2: two additional statements ("I often make a shopping list, but don't stick to it" and "I often forget about what is in the fridge and/or pantry, so items become too old to eat") from the "Over Shopping" Component with factor loadings of less than 0.400 were removed. These also made conceptual sense.

Iteration 3: drivers which had relatively high standardized residuals (SRs), were removed. According to Brown (2006), items with standardized residuals greater than 2.58 were considered problematic items. Therefore, two more statements were removed, "eating leftovers is not healthy" (SR = 5.009) and "I often eat what I feel like, not what needs using up" (SR = 2.839). Although, the removal of Statement "eating leftovers is not healthy" would result in the "preparing too much food" component

having only two items, Statement "eating leftovers is not healthy" does not conceptually fit particularly well in "preparing too much food" component.

Iteration 4: modification indices (MIs) were also used to improve the model by making two correlations between unobserved variables (e3 - e5; and e4 - e5) (see Figure 5.1).

These modifications resulted in a revised model, Model B (see Figure 5.2), which was further assessed in terms of the goodness of model fit. Model B has a good model fit, as indicated by the fit indices (x^2 = 75.822, with p-value = 0.169; x^2/df = 1.166; CFI = 0.983; TLI = 0.976; RMSEA = 0.035; and PCLOSE = 0.777). As illustrated in Figure 5.2, Model B is a five-factor model with 14 items.
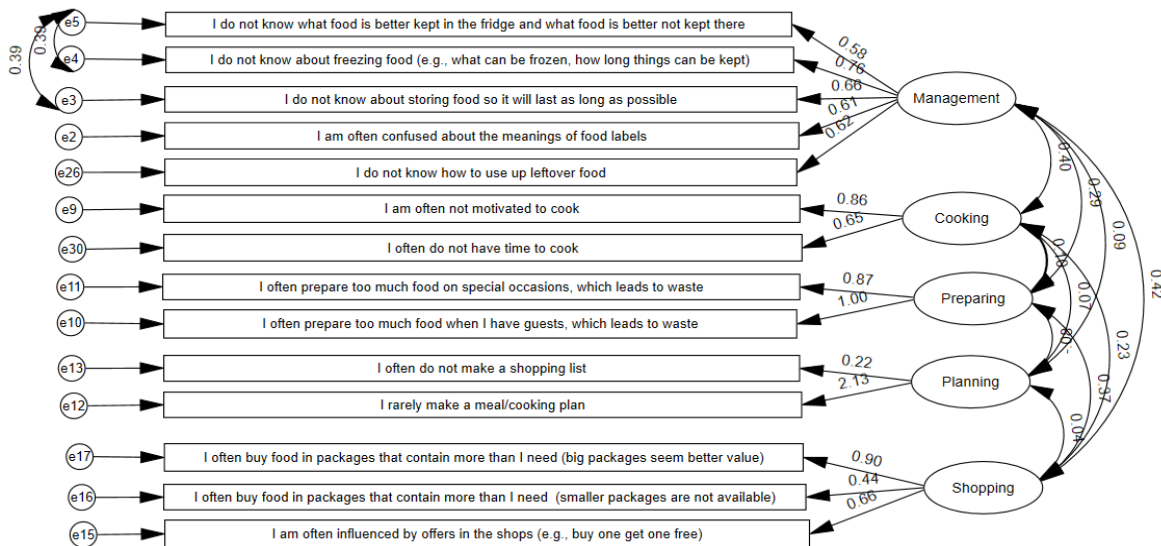
Figure 5.2 Five-factor model of food waste drivers (Model B)

Assessment of the validity and reliability of the constructs of Model B was conducted. Convergent validity and discriminant validity were conducted to assess the construct validity of the model, whereas composite reliability was conducted to assess the construct reliability. Convergent validity means that items within a construct should share a high percentage of variance in common, this measured by considering factor loading of the items, the average variance extracted (AVE) and composite reliability (CR) (Hair et al., 2010). As illustrated in Figure 5.2, all factor loadings of all statements were more than 0.5, which is the acceptable value according to Hair et al. (2010), except two statements: ("I often do not make a shopping list") which was kept for the reason mentioned above, and ("I often buy food in packages that contain more than I need because smaller packages are not available") which had factor loading of only 0.44. This

statement was retained in the model because although it falls slightly below 0.5, and it conceptually makes sense in terms of supporting the main idea of the construct. The AVE was calculated for each component using the following equation (Fornell & Larcker, 1981):

$$AvE = \frac{\sum_{i=1}^{n} \lambda^2}{\sum_{i=1}^{n} \lambda^2 + \sum_{i=1}^{n} \varepsilon}$$

where λ is the factor loading, n is the number of items, and ε is the error variance

The results of the AVE showed that three components (Component 2, 3, and 4) achieved the convergent validity (see Table 5.9). Because, according to Fornell and Larcker (1981), an AVE equal or more than 0.5 indicates a good convergent validity. However, the AVE of Component 5 was slightly below 0.5 (0.477), and the AVE of Component 1 was also less (but not significantly) than 0.5 (0.419). The composite reliability (CR) was calculated for each component according to the following equation (Fornell & Larcker, 1981):

$$CR = \frac{(\sum_{i=1}^{n} \lambda)^2}{(\sum_{i=1}^{n} \lambda)^2 + \sum_{i=1}^{n} \varepsilon}$$

where λ is the factor loading, and ε is the error variance.

Table 5.9 Results of convergent validity of the five components

Component	Average variance extracted (AVE)	Composite reliability (CR)	Cronbach's Alpha
Management	0.419	0.781	0.806
Preparing	0.869	0.930	0.925
Cooking	0.579	0.730	0.714
Planning	0.828	0.853	0.640
Shopping	0.477	0.717	0.678

The results showed that the composite reliability was achieved for all groups. This is because the value of composite reliability (CR) for all groups were more than 0.7 (Fornell & Larcker, 1981) (see Table 5.9). Although the AVE values of some constructs were slightly below the acceptable level. According to Fornell and Larcker (1981); AVE is a conservative measure, and according to the result of CR alone, the researcher might conclude that the convergent validity of the construct is adequate.

Furthermore, discriminant validity (DV) means that the extent to which a component is discernibly different from other component (Hair et al., 2010). In this study, the

discernment validity is measured using Fornell-Lacker criterion. To illustrate, discernment validity is calculated using the square root of the AVE, and then compared with the correlation of the latent constructs. The results showed that the discriminant validity was achieved for all components. This is because the value of discriminant validity (DV) for each component was more than the correlation with other components (see Table 5.10).

Table 5.10 Results of discriminant validity against correlations of the five component

Component	Discriminant validity (DV)				
	Management	Preparing	Cooking	Planning	Shopping
Management	0.647				
Preparing	0.293	0.932		-0.078	0.37
Cooking	0.400	0.099	0.761		
Planning	0.094		0.069	0.910	0.041
Shopping	0.421		0.227		0.690

For construct reliability, the composite reliability (CR) was used as indicator. Further Cronbach's alpha was also calculated for each component in Model B. As mentioned above and illustrated in Table 5.9, composite reliability was achieved; and the values of Cronbach's alphas for all components were not below 0.6, which is the minimum acceptable value according to Griethuijsen et al. (2014).

These analyses showed that Model B has a good level of construct validity and reliability.

Figure 5.3 summarises the model of food waste drivers, developed in this study. The model involves five components and 14 food waste statements. Each component depicted in a different colour. The large hexagons are the components, and the small hexagons are the individual items within the component. The colours are used to distinguish between the different components.

Figure 5.3 Model of food waste drivers

5.3.2.2 Importance of food waste components for British individuals (RQ2.2)

To investigate the importance of the five components of food waste drivers in Model B for the participants, the median score (and semi-interquartile range) of each component was calculated. This was based on the median of each statement loaded in a component. For all the British participants (Figure 5.4), the components with the highest median score were "Negative attitudes towards cooking", "Lack of planning" and "Over shopping", with 4.0 on the 7-level scale; while "Lack of knowledge of food management issues" and "Preparing too much food" had the lowest median score of only 2.0.

	Lack of knowledge of food management issues	Preparing too much food	Negative attitudes towards cooking	Lack of planning	Over shopping
■ Median	2	2	4	4	4
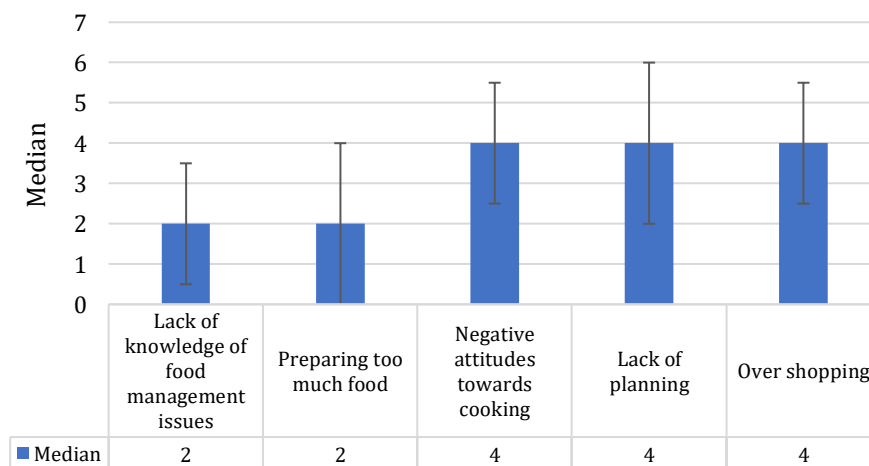
Figure 5.4 Median scores (with semi-interquartile ranges) on food waste drivers component for all participants

Figure 5.5 shows the median scores on the components for the four participant groups. The component which showed the most difference between participant groups was "Lack of knowledge of food management issues", with a median by students over twice that of retired people. The component "Negative attitudes towards cooking" also produced a difference with median of students' rate of this component was over two times compared to retired people. "Preparing too much food" produced a difference as well, with median of students' rate of this component was two times compared to adults living without children.

	Lack of knowledge of food management issues	Preparing too much food	Negative attitudes towards cooking	Lack of planning	Over shopping
Students	2.5	4.0	5.0	3.5	5.0
Adults living with children	2.0	3.0	4.0	4.0	5.0
Adults living without children	2.0	2.0	3.0	4.0	4.0
Retired people	1.0	2.5	2.0	4.0	4.5
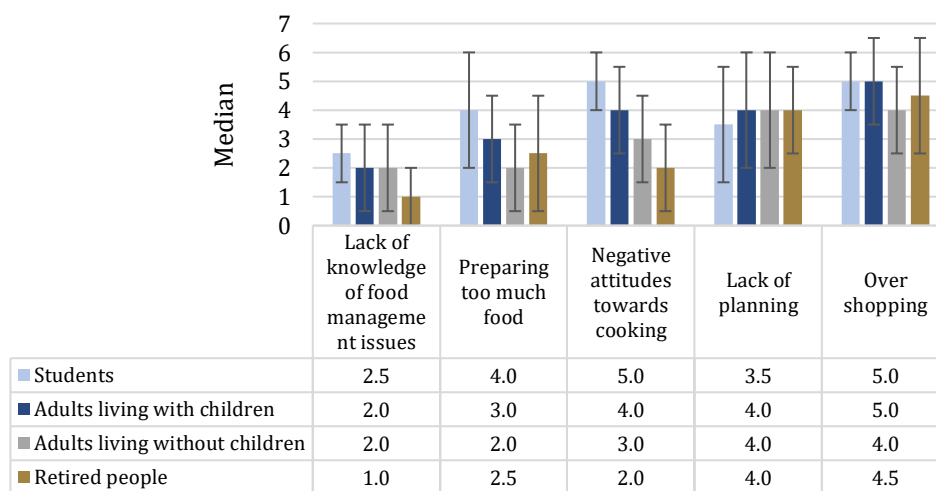
Figure 5.5 Median of food waste drivers' groups for different participants groups

Figure 5.6 summarises the key components of food waste issues for British individuals at different *Life stages*. This was based on the highest rating received by each participant group for each component. "Over shopping" appeared to be key issue for all life stages, However, "Negative attitudes towards cooking" was a key issue for only students, and "Lack of planning" was a key issue for only adults living with children.
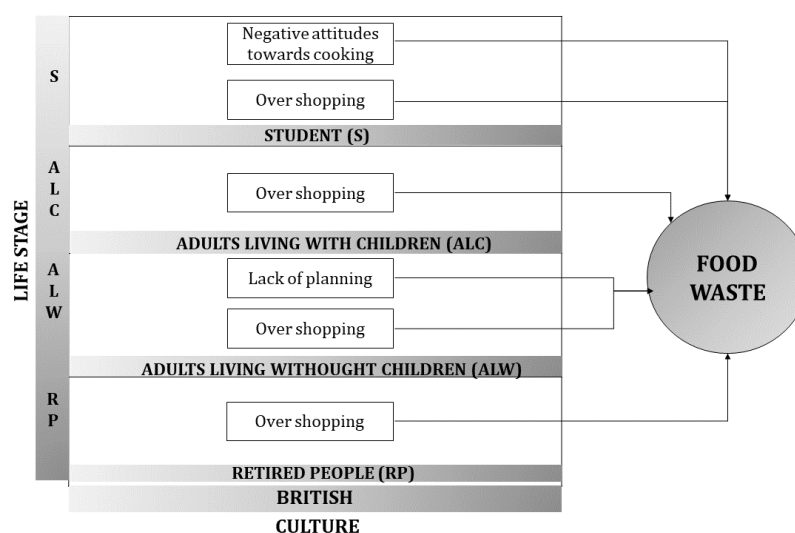
Figure 5.6 Key components of food waste issues for British individuals at
different life stages

5.4 Discussion and conclusions

The study validated the food waste drivers elicited earlier in this programme of
research with larger sample size of British individuals. It was conducted to answer RQ2
in this programme of research (RQ2: What are the similarities and differences among
British individuals at different *Life stages* in terms of food shopping and waste and
important food waste drivers?)

The RQ2 was addressed by answering two sub-RQs. In relation to food shopping and
waste (RQ2.1: What are the similarities and differences among British individuals at
different *Life stages* in terms of food shopping and waste?), the results showed that
some similarities and differences among British individuals at different *Life stages*. For
example, in terms of food waste, there was no difference between participants'
attitudes (e.g., concerning about food waste in household and society). For food
shopping, supermarket was the most preferred place for all individual groups.
However, there were some differences among the individual groups in terms of who is
doing food shopping.

The study found that British individuals at different *Life stages* were similar in terms of
concerns about food waste both in their households and in society. Such concern was
also found for Saudi people, for example Baig, Gorski et al. (2018) reported that 60% of
Saudi participants stated that they were concerned about food waste. These responses

might be affected by social desirability, as individuals may feel they should be concerned about food waste.

In relation to food shopping, this study confirmed the findings of Studies 1 and 2 supermarkets were the most preferred place for all groups. Therefore, technological interventions should focus on providing support during supermarket shopping such as help individuals to check their household food stock while shopping.

The study found that British individuals at different *Life stages* were different in terms of who is doing food shopping. Retired people reported doing shopping themselves and spouses/partners much more than students. However, students reported their parents or relatives doing the shopping, compared to none of the adults living with children and retired people. This finding is different than that found in Study 1, where almost half of the British students reported doing shopping themselves. This might be because all participants in Study 1 were postgraduate students (aged from 25- 33 years old) with most of them were living with other students, while most of participants in this study were undergraduate students (aged from 18 - 29 years old) with many of them were living with their parents and/or relatives. However, this finding was in line with Study 2 in this research, where most British older people do food shopping themselves.

In relation to the food waste drivers (RQ2.2: What are the underlying and important food waste drivers for British people?), the study developed a valid and reliable five-component statistical model of food waste drivers for British individuals. This was based on the food waste drivers identified as *High importance* in Study 1 and Study 2 of the programme of research (Figure 5.3).

A number of previous studies have also produced and discussed models for food waste (e.g., Aktas et al., 2018; Bravi et al., 2019; Grasso et al., 2019; Mondejar-Jimenez et al., 2016; Stancu & Lähteenmäki, 2022; Stancu et al., 2016; Tsai et al., 2020). However, as discussed in Chapter 2 (Section 2.2) most of these models were mainly based on limited theory such as the Theory of Planned Behaviour and collected data from very specific individual groups (Aktas et al., 2018; Mondejar-Jimenez et al., 2016; Stancu et al., 2016; Tsai et al., 2020). While other researchers did not use TPB, they were still limited in terms of the areas of variables used (Bravi et al., 2019).

This study therefore addressed the gap in the research by developing a comprehensive model of food waste drivers that is reliable and valid, based on a long list of food waste drivers investigated and discussed in the literature, as well as those identified as *High importance* in Study 1 and Study 2 (see Chapter 3 and 4) in this programme of research. In addition, the data was collected from British individuals at different *Life stages*. The proposed model used a statistical scale development process (DeVellis, 2003) to provide a valid and reliable model of high-level constructs of food waste drivers, which enabled me to explore the relationships between them. For example, in this model (Figure 5.3), the item "I do not know about freezing food" is related to the underlying latent variable "lack of knowledge of food management issues".

The proposed model can contribute to the area of sustainable HCI, by providing researchers and developers with groupings of food drivers to study food waste issues more easily for particular user groups, and to allow researchers to devote more attention to the areas of concern in developing their interventions. This can facilitate the exploration of the main issues around food waste at early stages of development for food waste reduction interventions. In addition, the statements used in this model can be used by future researchers to investigate the main areas of food waste issue for other user groups considering some factors such as such as social, cultural, or material situations. This can eventually facilitate the task for researchers to compare between different user groups and highlight the impact of particular factors on food waste issues. In this way, researchers and developers of food waste reduction interventions can investigate which kinds of supports are needed to effectively help individuals to reduce their food waste.

According to Bederson and Shneiderman (2003) cited in Rogers (2012), the kind of the proposed model for using in HCI is *descriptive*, as it provides concepts, clarifying terminology around food wastes issue which could be used as a guidance for future inquiry. However, according to Rogers (2004) cited in Rogers (2012), the model is *conceptual*. This is because the model is high level dimensions which can inform the design of prototype to support food waste reduction. It is also important that the model is a statistically based one, rather than one created from other methods such as grounded theory.

In relation to the important food waste drivers, the study found that that the most important components for all British participants, regardless of *Life stage*, were "Negative attitudes towards cooking", "Lack of planning" and "Over shopping".

With respect to the "Over shopping" component in the proposed model, it covers items related to buying bigger packages of food than their need and influenced by offers. This was similar to the "Shopping routine" component in the model discussed by Grasso et al. (2019) and Stancu et al. (2016). In addition, my study found that "Over shopping" was the most important group of food waste drivers for all individual groups. This reflects the importance of this issue regardless of different *Life stages*.

This study found that "Lack of knowledge of food management issues" and "Negative attitudes towards cooking", were more important for students, compared to retired people. This confirms earlier findings about the issue of lack of management for individuals at early stages. Previous research (e.g., Visschers et al., 2015) discussed about the younger individuals usually do not have the skills and experience that older individuals have, in terms of using leftovers or consuming available food before it becomes inedible. In addition, "Negative attitudes towards cooking" can be compared with Tsai et al. (2020), as they found that young people spend less time on cooking food and prefer fast food, as well as they have little idea about ingredients, but older people have more cooking skills and more time to engage in cooking activities. The interesting finding is that the proposed model provides valid and reliable measures to be used for these components.

The main limitation of this study is that it is a self-report study, so the results reflect participants' self-reported views of the most important groups of food waste drivers for them. This in fact reflect what participants think the important drivers which lead them to food waste, and does not necessary explain their actual drivers to food waste. In addition, this might also be affected by social desirability bias (Nederhof, 1985). For example, participants may feel embarrassed to report that they are wasting food because they are not motivated to cook, while they know they should do save food and protect the environment. In addition, self-reported online study hinders collection data about whether participants feel uncomfortable when answering particular questions (e.g., I feel guilty when I throw food away). In fact, such feeling might make them answer the question in the way they should rather than providing truthful answers.

Further, the study was conducted with only British individuals because it was during the Covid-19 pandemic. I would have liked to also conduct the study with Saudi participants to validate the drivers I identified as important for them in Studies 1 and 2, but it was very difficult to recruit participants from Saudi Arabia. Therefore, future research to conduct such a study with Arab participants in Saudi Arabia would be helpful.

In addition, the study was running over the Christmas holiday, and this could have both advantages and disadvantages. The main advantage might be that people during this season are more relaxed and have more time to participate in research. However, Christmas is a special time of the year in the UK where people have more celebrations (Aktas et al., 2018). People gathering and celebration usually involve food preparations and consumption, which therefore could result in more food waste. In addition, Bernstad (2014) also mentioned that major holidays such as Christmas tend to change food preparation routines.

In addition, the data collected via Prolific so that the participants may be motivated to answer quickly to get the reward, and not particularly interested in food issues.

This study developed a model of food waste drivers for British individuals and highlighted the key groups of food waste drivers for British individuals at different *Life stages*. The results of this study achieved the objective of third phase of this programme of research, validation. The results of this study can be used as input of fourth phase, design, as a foundation for developing the technological intervention proposed in this research in the next chapter (Chapter 6). However, due to the time restrictions, this study was conducted in parallel with developing the technological intervention. Therefore, the development of the technological intervention mainly used the results of understanding and investigation phase (Studies 1 and 2) in this programme of research.

To conclude, this study developed a *descriptive* and *conceptual* model which incorporates valid and reliable measures of high-level constructs of food waste drivers. In addition, the study began investigating the important issues of food waste for British individuals at different stages of life. The next chapter will present the design of the technological intervention, WasteLess, proposed to support food waste reduction.

Chapter 6

Design of the WasteLess mobile application to support food waste reduction

6.1 Introduction

This chapter presents the design of the low fidelity prototype WasteLess mobile app for use in the rest of my programme of research. This was conducted to achieve the objective of the fourth phase, design, in this research. It provides a brief introduction to the WasteLess app including the main aim and objectives of the app. It presents the user requirements for the Wasteless app, and the use of the Behaviour Change Wheel (BCW) theory (Michie et al., 2011) in its design. In addition, it illustrates the WasteLess functions, which are organised into four sections: food shopping, food management, cooking, and food waste. Each section has a number of different functions (see Section 6.2.3.1). Then it illustrates the user interface for the WasteLess functions (see Section 6.3.4), and describes an expert evaluation of the WasteLess app which used the Collaborative Heuristic Evaluation (CHE) method (Petrie & Buykx, 2010). This chapter was conducted to address RQ3 in this research:

RQ3: To what extent can the design of a mobile app (WasteLess) provide comprehensive support for food-related practices and techniques for behaviour change?

RQ3.1: To what extent can the design of a mobile app (WasteLess) provide comprehensive support for food-related practices?

RQ3.2: To what extent can a mobile app (WasteLess) incorporate the full set of food waste drivers elicited in Studies 1 and 2 of this programme of research?

RQ3.3: To what extent can a mobile app (WasteLess) incorporate theory-based techniques for behaviour change (i.e., the BCW and persuasive technology techniques)?

6.2 Introduction to the WasteLess app

This section covers the main aim and objectives of the WasteLess app an overview of its functionality, as well as the nature of the interaction between the app and users.

6.2.1 Aim and objectives

The aim of WasteLess app is to help users manage food-related practices in their household and reduce their household food waste. The objectives of the app are as follows:

> Objective 1: Incorporate the food waste drivers identified earlier in this research in the design of a mobile app to support users in reducing food waste (see Chapter 4, Table 4.23).
>
> Objective 2: Incorporate support in the design of a mobile app to support users in a wide variety of food-related practices: food shopping, food management, cooking, and food waste.
>
> Objective 3: Incorporate a variety of BCW intervention and persuasive techniques in the design of a mobile app, which have the potential to change users' behaviour.
>
> Objective 4: Facilitate the evaluation of the potential of the support for different food-related practices and BCW interventions and persuasive techniques in supporting users in reducing their food waste.

6.2.2 Overview of WasteLess app

WasteLess is a mobile app, which can provide support to users via different sections: food shopping, food management, cooking, and food waste. It is assumed that the app would be able to obtain information about food purchased by users from their store loyalty card or (less conveniently) by having them scan the bar codes of food items or by input via a digital voice assistant (see Section 6.2.3 for more detail).

To help users overcome the food waste issues identified in Studies 1 and 2, 18 functions were proposed for the WasteLess app. Furthermore, because food waste issues can occur during any food-related practice, the WasteLess app was designed to provide supports via different sections supporting different food-related practices: food shopping, food management, cooking, and food waste. Functions that

can provide specific motivation and encouragement towards reducing food waste were also incorporated in the food waste reduction group.

Preece et al. (2015) discuss two types of prototypes: low-fidelity and high- fidelity prototyping. According to them, a low- fidelity prototype does not necessarily look the same as the final product, and it does not offer the same functionality as the final product. However, a high-fidelity prototype does look the same as the final product and provides more functionality compared to a low-fidelity prototype. The WasteLess app prototype which I designed for this programme of research is a low-fidelity prototype as it is only presents the functions without performing any of them. In addition, it is not a fully functional app, as it does not provide real interaction with users. This is because the design of the WasteLess app was undertaken in order to able to evaluate the ideas with potential users at early stage of development process.

Lim et al. (2008) proposed a view of prototypes that concentrates on their role in filtering and as manifestations. *Filtering* refers to emphasizing particular aspects of a product to be investigated by a prototype. *Manifestations* refers to tools which can help designers to develop their design ideas via external representations. In their analysis of the anatomy of prototypes, they suggested three main principles:

- The fundamental prototyping principle: focus on that "prototyping is an activity with the purpose of creating a manifestation that, in its simplest form, filters the qualities in which designers are interested, without distorting the understanding of the whole" (p.4).

- The economic principle of prototyping: focus on that "the best prototype is one that, in the simplest and the most efficient way, makes the possibilities and limitations of a design idea visible and measurable" (p.4).

- The anatomy of prototypes principle: focus on the idea that "prototypes are filters that traverse a design space and are manifestations of design ideas that concretize and externalize conceptual ideas" (p.4).

Lim et al. (2008) identified some dimensions of filtering and manifestation. The filtering dimensions are as follows,

- *Appearance* refers to the physical properties of a design (e.g., colours, size, textures, shapes)

- *Data* refers to the information architecture as well as the data model of a design (e.g., size of data, type of data, hierarchy)

- *Functionality* refers to functions to be achieved by the design, which allows designers to determine preferred functionalities and scenarios related to using various functions (e.g., users' functionality needs)

- *Interactivity* refers to how people interact with every part of a system (e.g., feedback, input/output behaviour)

- *Spatial structure* refers to how components of a system are combined together (e.g., arrangement of interface or information elements)

The manifestation dimensions are as follows,

- *Materials* refers to what prototypes should be composed or made out of (e.g., wood, paper)

- *Resolution* refers to the level of fidelity the prototype should be (e.g., real versus fake data, feedback time responding considering paper-based is slower than computer-based)

- *Scope* refers to how complete the prototype should be (e.g., to figure out what colour scheme is the best for their website, designers might use colour scheme without details of icons/texts).

The filtering and manifestation dimensions covered in the prototype for the WasteLess app are illustrated in Table 6.1.

Table 6.1 Filtering and manifestation dimensions covered in the WasteLess app prototype

	Addressed	Not addressed
Filtering	*Appearance*- the appearance of user interface including size, colour and style of font, buttons, and icons.	*Interactivity*- Does not address Interactivity as it just provides some hints as assumption of basic interaction with the app.
	Data- the data structure, including the hierarchy of the data in the app. It also includes the label naming.	
	Functionality- the functions in the design, and functionalities which might satisfy users' needs.	
	Spatial structure- the arrangement of the interfaces of different functions in the app, and how they will be grouped and accessed.	
Manifestation	*Materials*- Computational prototyping tools, using Axure.	
	Resolution- Simplified screens of interfaces (Low-fidelity prototype).	
	Scope- Limited to the specific features and functionalities. Not include data entry and updating.	

6.2.3 Information flow and architecture of WasteLess

Figure 6.1 illustrates the flow of the interaction between the WasteLess app and users in relation to entering their food purchases into the app. It is assumed that to enter data about food bought in a supermarket has been logged on users' supermarket loyalty card, users will just have to transfer data from the card to WasteLess (e.g., with a Wi-Fi connection, this would require them to simply wave their loyalty cards over their smartphone). For food bought in shops without loyalty card schemes, there are several routes which would be available to enter information about food into WasteLess. The easiest would be to use a virtual assistant like Alexa or Siri. They could tell the agent what they have bought, and the virtual assistant would log that information into WasteLess. An alternative would be to use the bar codes on packets. WasteLess would also have a barcode reader to make this easy to do.

A trickier issue is that users would need to keep WasteLess informed about what food they are using and throwing away. A virtual assistant would be the easiest route to do this. For example, they might say "I'm eating one of the apples". The assistant might ask for more information, with a question like "You have gala and golden delicious apples at the moment, which are you eating?". Users would also tell the assistant what food items they are using when they are cooking.
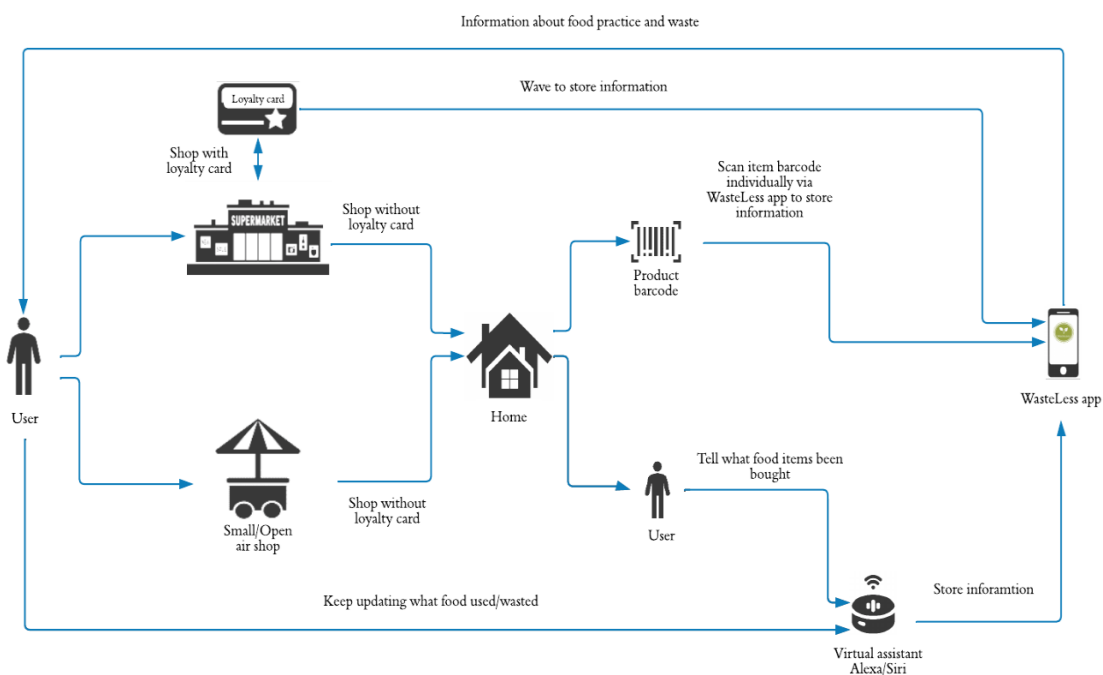
Figure 6.1 Flow of interaction between WasteLess app and user for inputting food purchased and used/wasted

Figure 6.2 provides an overview of the information architecture of the WasteLess app including the main four sections: food shopping, food management, cooking, and food waste.
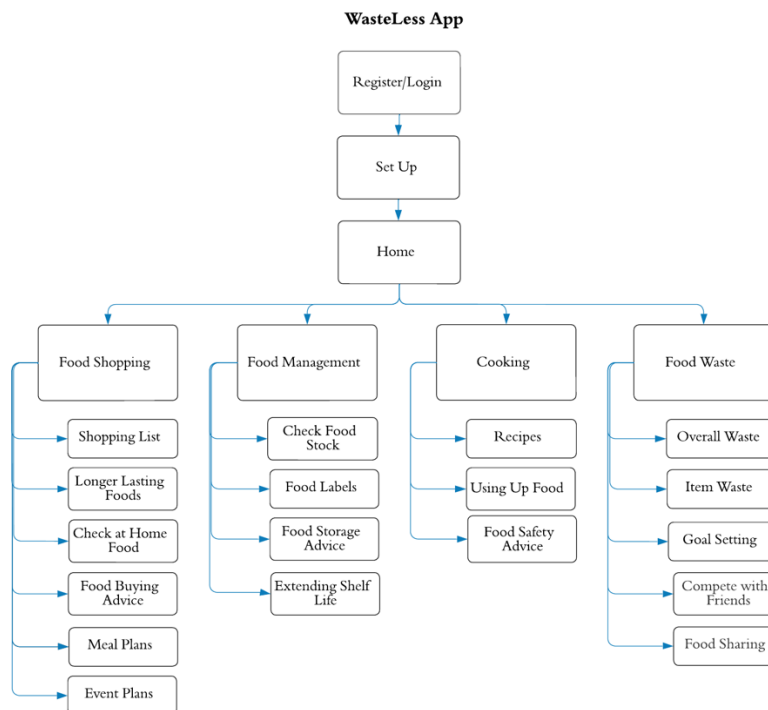
Figure 6.2 Information architecture of the WasteLess app

6.2.3.1 Functions of WasteLess app

Table 6.2 provides a brief explanation of each function the functions it provides in WasteLess. The *Food Shopping* section of the app involves six functions which can support users to plan and shop for food for their household, by providing a shopping list, information about longer lasting food, a check what food is at home function, food buying advice, meal plans and event plans. The Food Management section involves four functions which can support users after purchasing food to help them to properly manage and store food at home, by providing a check of food stock, information about food labels, food storage advice and information about extending food shelf life. The *Cooking* section involves three functions which can support user to cook and prepare food at home, by providing recipes, information about recipes to use up ingredients and food safety advice. The *Food Waste* section involves five functions which can motivate, encourage and help users to monitor and reduce their food waste, by providing information about their overall waste, their waste of

particular items, allowing them to set goal in relation to food waste, allowing them to compare their food waste with friends and food sharing information.

Table 6.2 Brief explanation of WasteLess sections and functions

WasteLess function	Brief explanation
Food shopping	
Shopping list	Create a shopping list, share it, and view it when users are out shopping
Longer lasting foods	Find longer lasting substitutions for foods
Check at home food	Check if users have a particular food item at home while shopping for food
Food buying advice	Find advice on food shelf-life, if it is worth to buy and the sufficient amount to buy
Meal plans	Make a meal plan, share it, and generate its shopping list
Event plans	Plan upcoming event by seeing user past meals and shopping list of similar events
Food management	
Check food stock	Check what food users have at home that stored at different areas
Food labels	Find out the meanings of different food labels
Food storage advice	Find advice on where and how best to store user food
Extending shelf life	Find advice on how to extend food shelf life to last for longer
Cooking	
Recipes	Find different recipes to cook food according to users' preferences
Using up food	Find recipes to use up particular foods and leftovers
Food safety advice	Find out about safety of eating leftover food, re-heating food and other safety advice
Food waste	
Overall waste	Check user overall food waste and for each item
Item waste	Check user waste of a particular food item
Goal setting	Set a goal to reduce user food waste
Compete with friends	Join a competition for food waste reduction with user friends
Food sharing	Share user food with others to reduce food waste

6.3 Design of WasteLess app

6.3.1 User requirements for the Wasteless App

The *High importance* food waste drivers which were identified in Studies 1 and 2 (see Chapter 4, Table 4.23) as well as information gathered in the questionnaire in Study 1 and Study 2 formed the main inputs to designing the WasteLess app. It would have been ideal if I had used the refined list of food waste drivers that resulted from Study 3, however, due to time restrictions, the design of the WasteLess app was conducted in parallel with conducting Study 3, so this was not possible.

A set of requirements was developed from the food waste drivers and information gathered in the questionnaires and utilizing of the Behaviour Change Wheel (BCW) (see Section 6.3.2). The requirements developed include data requirements, functional

requirements, environmental requirements (physical, social, and technical), and security requirements. The requirements of WasteLess app are as follows:

Data requirements (DR)

DR1: Where possible, data about types and quantities of food purchased should be acquired by the system automatically (e.g., from supermarket loyalty schemes);

DR2: If automatic acquisition of types and quantities of food purchased is not possible, data should be entered manually;

DR3: Data about types and quantities of food used should be entered accurately;

DR4: Data about types and quantities of food wasted should be entered accurately;

DR5: Users' personal data should be entered accurately;

DR6: Users' personal data can be updated as needed.

Functional requirements (FR)

FR1: Provide different ways to create shopping lists;

FR2: Allow users from within a household to share shopping lists;

FR3: Provide users with options for substituting longer lasting foods for ones they waste;

FR4: Allow users to check what food they have at home and where these food items are stored;

FR5: Provide advice on food shelf life, including the appropriate amount to buy;

FR6: Allow users to make meal plans, adjust them based on user preferences, and make them editable;

FR7: Allow users within a household to share meal plans;

FR8: Allow users to plan upcoming special events involving food, by providing information of previous events of a similar nature;

FR9: Provide information about food available in the household (e.g., remaining types and quantities, expiry dates);

FR10: Provide recipes appropriate to users' dietary requirements and level of expertise in cooking to use up available food;

FR11: Provide information to enable users to understand the meanings of different food labels;

FR12: Provide advice on where and how to best store food;

FR13: Provide advice on how to extend the shelf life of food;

FR14: Allow users to search recipes, and filter them based on their preferences;

FR15: Provide step-by-step videos of recipes to help users learn cooking skills;

FR16: Provide recipes which allow users to use up remaining quantities of ingredients and leftovers;

FR17: Provide advice on safety of eating and re-heating leftover food;

FR18: Allow users to check their overall household food waste;

FR19: Allow users to check their waste of particular food items;

FR20: Allow users to set and monitor goals for food waste reduction;

FR21: Allow users to participate in competitions for food waste reduction

FR22: Allow users to share their extra food with others;

FR23: Allow users to personalise the app to fit their dietary and other preferences.

Environmental Requirements (ER)

Environmental Requirements_ Physical (ER_Ph)

ER_Ph 1: Allow users to access the app at home via a computer or smartphone;

ER_Ph 2: Allow users to access the app from a smartphone while out shopping.

Environmental Requirements_ Social (ER_So)

ER_So 1: Allow users in the same household to collaborate in using the app.

Environmental Requirements_ Technical (ER_T)

ER_T 1: Users should have an internet connection to enter information, but should be able to view their information when offline;

ER_T 2: Users should have a smartphone with a camera.

Security requirements (SR)

SR1: All data in the system should be stored securely;

SR2: Any data acquired from third parties (e.g., supermarkets) should be confidential and not shared with other third parties.

6.3.2 Utilizing of the Behaviour Change Wheel (BCW)

This section will illustrate the application of the Behaviour Change Wheel (BCW) (Michie et al., 2011; Michie et al., 2014) in the development of the WasteLess app.

I followed the guidance provided by the BCW (Michie et al., 2014) for developing interventions for behaviour change issues (see Chapter 2, Section 2.3.1.2). The BCW

was used due to that it was proposed as a comprehensive framework to provide a systematic method to understand the nature of behaviour, as well as providing intervention functions and policies. Thus, it has the potential to cover the variety of food waste drivers which could affect food waste at household level that were investigated earlier in this research (See Chapter 3 and Chapter 4). Some of the drivers investigated were related to internal factors such as user capability or motivation, however other drivers were related to external factors such as opportunity (further illustration is provided below).

I followed the steps provided by Michie et al. (2014) to apply the BCW, although there were some adjustments in the application of BCW in this programme of research:

- Step 1: Define the problem in behavioural terms;
- Step 2: Select the target behaviour;
- Step 3: Specify the target behaviour;
- Step 4: Identify what needs to change;
- Step 5: Identify intervention functions;
- Step 6: Identify policy categories [not implemented];
- Step 7: Identify behaviour change techniques [not implemented];
- Step 8: Identify mode of delivery.

Step 1 (Define the problem in behavioural terms) has been already conducted by Study 1 and Study 2 in the first phase in this programme of research. This was by providing a list of food waste drivers and information which highlight the attitude and practice of individuals. In addition, identifying the intended audience of the WasteLess app, individuals who are interested in reducing their household food waste. Further, the app targets the same examined individuals' groups in Study 1 and Study 2 of this programme of research. Thus, it targets users from three cultural groups (Chinese, British, and Arab), and at different *Life stages* (students, family members living with children, and older people). However, as the app was designed in English, it targets users who speak English.

Step 2 (Select the target behaviour) was also conducted in the first phase by highlighting the *High importance* food waste drivers resulted in Study 1 and Study 2 (see Chapter 4, Table 4.23).
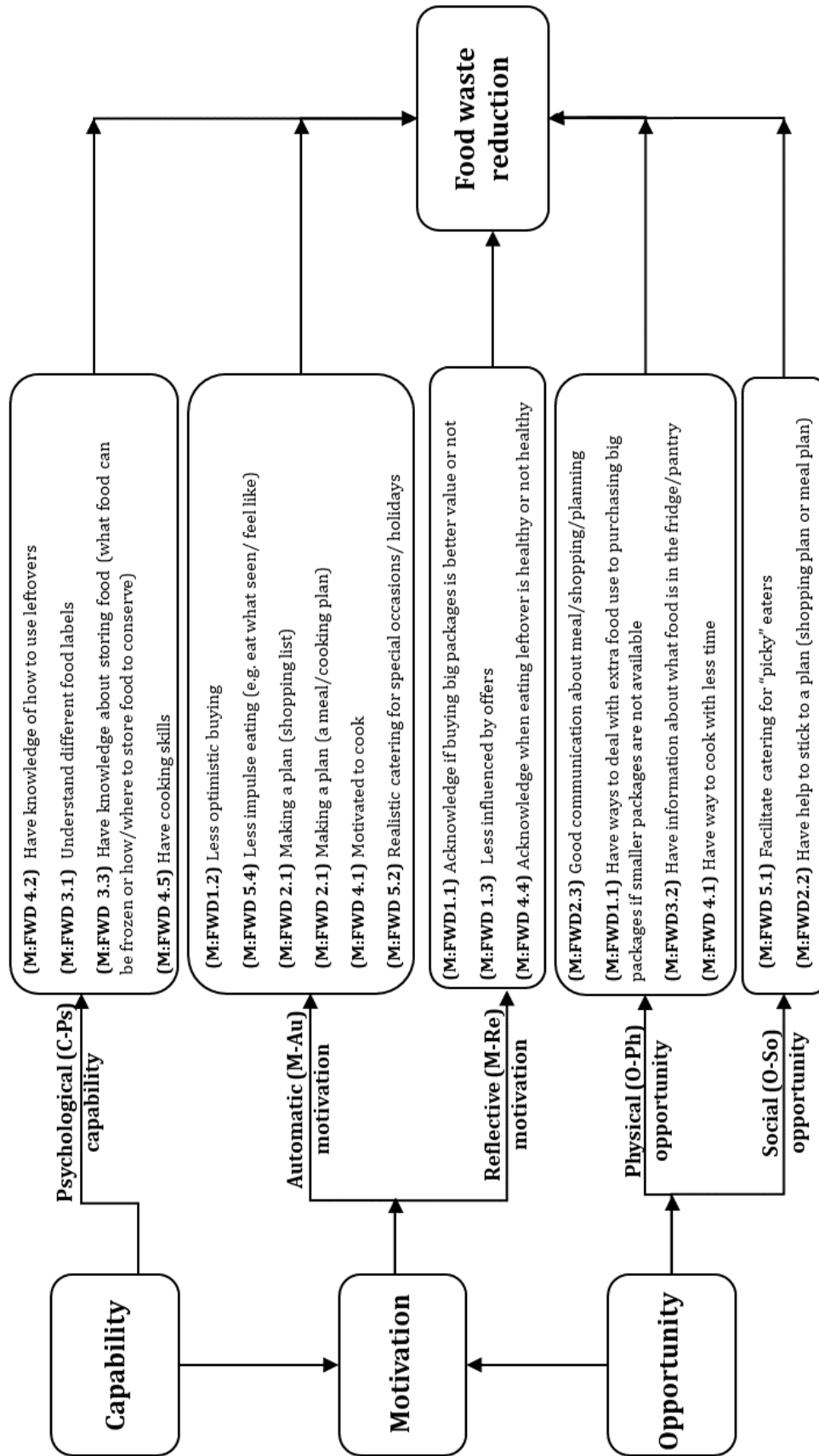
Figure 6.3 Applying COM-B model to food waste driver mitigation

Note: M:FWD refers to mitigating food waste driver

Step 3 (Specify the target behaviour) is to specify what need to mitigate the *High importance* food waste drivers investigated earlier in this research. For example, the mitigation of food waste driver (M:FWD) can be: understand different food labels (M:FWD 3.1), for the food waste driver: Confusion about food labels (FWD 3.1).

Step 4 (Identify what needs to change) was partly conducted in the first phase in this programme of research, by highlighting the *High importance* food waste drivers resulted from study 1 and 2 via conducting focus groups, interviews and survey identifying the barriers, which in turn highlighted what needs to change. After that, I categorised the source of behaviour needed to mitigate food waste drivers investigated according to the main components of COM-B: capability, opportunity and motivation (for more details of the COM-B components, see Chapter 2, Section 2.3.1.2). This categorisation of the source of issue to mitigate food waste drivers was conducted to understand the source of the underlying type of behaviour need to address each food waste driver. This in turn assisted me in exploring potential intervention functions which could help to overcome or mitigate each of the food waste drivers (Step 5). Figure 6.3 illustrates the categorisation of the mitigation needed for food waste drivers according to COM-B. I carefully reviewed the main source of behaviour needed to mitigate each food waste driver and then categorised them to the most related COM-B component. In addition, Figure 6.3 shows the possible interaction between the COM-B components and illustrates the possible effect between the mitigation of food waste drivers within these components and the final effect on food waste reduction behaviour. For example, if individuals have cooking skills (M:FWD4.5), which is under the Psychological Capability component, this could have an effect on their motivation to cook, which is M:FWD4.1 (Motivated to cook), that is under Automatic Motivation component, which is about emotional responding and impulses (see Chapter 2, Section 2.3.1.2). To illustrate, individuals who have essential skills of cooking spending less time and effort to cook food compared to other who lack of cooking skills.

As shown in Figure 6.3, if the main issue to mitigate a food waste driver is related to users' knowledge and their understanding of food and food waste, the source of behaviour is categorised under Psychological Capability. This includes the following food waste drivers mitigation (M:FWDs): Have knowledge of how to use leftovers (M:FWD 4.2); Understand different food labels (M:FWD 3.1) ; Have knowledge about

storing food (what food can be frozen or how/where to store food to conserve) (M:FWD 3.3); Have cooking skills (M:FWD 4.5). However, if the main issue to mitigate a food waste driver is related to users' desires, emotional response and habits, the food waste driver mitigation is categorised under Automatic Motivation. This includes the following food waste mitigation: Less optimistic buying (M:FWD 1.2); Less impulse eating (e.g. eat what seen/ feel like) (M:FWD 5.4); Making a plan (shopping list) (M:FWD 2.1); Making a plan (a meal/cooking plan) (M:FWD 2.1); Motivated to cook (M:FWD 4.1); Realistic catering for special occasions/ holidays (M:FWD 5.2). The source of the behaviour related to this food waste driver mitigation (M:FWD 5.2) could be due to the desire of providing too much food for family or guests, which could be because of social or culture factors, for example as a gesture of welcome in some countries (Al-Buainain, 2015). Thus, this driver mitigation can be also categorised under Social Opportunity, which has its ultimate effect on individual motivation. If the issue is related with users' beliefs about what is good and bad, the food waste driver mitigation is categorised under Reflective Motivation. This includes the following food waste drivers mitigation: Acknowledge if buying big packages is better value or not (M:FWD 1.1); Less influenced by offers (M:FWD 1.3); Acknowledge when eating leftover is healthy or not healthy (M:FWD 4.4). As these mitigations of food waste drivers are within users' control and affected by internal factors, therefore these drivers mitigation were categorised under Capability or Motivation. However, there are other food waste drivers which are not under the control of users and can be affected by external factors, therefore these mitigations were categorised under Opportunity. Mitigations related to opportunity can be categorised as to whether they represent physical or social opportunities. If the main issue of a mitigation is related to external factors in the environment, the mitigation is categorised under Physical Opportunity. This includes the following mitigations: Good communication about meal/shopping/planning (M:FWD2.3); Have ways to deal with extra food use to purchasing big packages if smaller packages are not available (M:FWD1.1); Have information about what food is in the fridge/pantry (M:FWD3.2); Have way to cook with less time (M:FWD 4.1). However, if the main issue of a mitigation is related to external factors around culture and social factors, the mitigation is categorised under Social Opportunity such as: Facilitate catering for "picky" eaters (M:FWD 5.1); Have help to stick to a plan (shopping plan or meal plan) (M:FWD2.2), which might be

because of working time or other member requirements. None of the mitigations were related to physical capability, therefore the Physical Capability sub-component was not included in Figure 6.3.

Step 5 (identify intervention functions), is to identify the relevant BCW intervention functions, to be used following the COM-B analysis (further details can be found in Chapter 2, Section 2.3.1.2). Three intervention functions *Education, Persuasion and Enablement* were used in the WasteLess app. These are the most used intervention functions in BCW (Hedin et al., 2019). *Education* can be used as intervention function for a psychological capability-related issue. Enablement was used as an intervention for food waste driver mitigation that were related to opportunity. Education, persuasion and enablement were used for food waste driver mitigation that were related to motivation.

Along with these intervention functions, I used some persuasion techniques, as extending of *Persuasion* intervention function. For persuasion techniques, I was inspired by Fogg, (2003) and Oinas-Kukkonen and Harjumaa (2008, 2009) such as *Personalization*, *Reduction*, *Cooperation*, *Cooperative*, and *Tracking*. Details of these techniques can be found in Chapter 2, Section 2.3.1.1.

This helps to create user functional requirements of the WasteLess app, Step 6a.

Step 6 (identify policy categories) is to identify policies need to be made by authorities to support the intervention functions. This was not implemented, and was out of the scope of the application of BCW in developing of the WasteLess app.

Step 6a (Create functional user requirements), was an additional step I added to create the user functional requirements of the WasteLess. Figure 6.4 shows how identifying the source of behaviour according to COM-B, and using the BCW intervention functions can help to specify the user functional requirements of the intervention. For example, understanding different food labels is a behaviour related to psychological capability, which therefore can Education be used as an intervention function. Therefore, the corresponding user functional requirements can be:

> *Provide information to enable users to understand the meanings of different food labels (FR11, Section 6.3.1)*
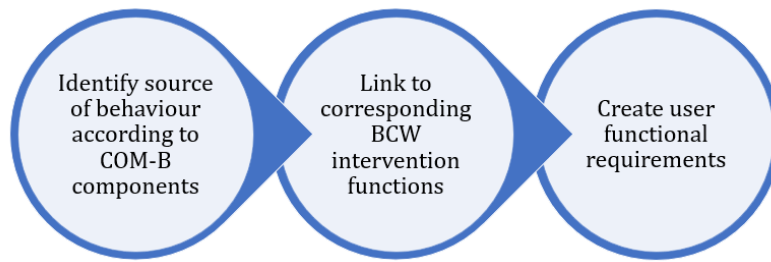
Figure 6.4 Creating user functional requirements using BCW

To Achieve the user requirements in Section 6.3.1, a number of functions in WasteLess app were proposed.

Step 7 (Identify behaviour change techniques), was not implemented in this application of the BCW, instead I added Step 7a.

Step 7a (Propose WasteLess functions), to achieve the user requirements in Section 6.3.1, I proposed a number of functions in the WasteLess. Table 6.3 illustrates the WasteLess functions designed using each intervention function and the persuasive technology principles used in the design of the app.

After categorising each of the food waste driver mitigation according to a particular COM-B component to identify the source of issue, I used the possible intervention functions in BCW which could help to mitigate the issue of each food waste driver. These high-level intervention functions formed the theoretical foundation for proposing and designing WasteLess functions. For example, the food waste driver mitigation "Have knowledge of how to use leftovers" is an issue that is categorised under psychological capability, according to COM-B. Following the BCW, education can be used as intervention function for a psychological capability-related issue. Therefore, I proposed "Use up food" function to mitigate an such issue by using education. "Use up food" function provides information via recipes about how to use up particular foods and leftovers. This reasoning was also applied to "Food labels", "Extending shelf-life", "Food storage advice", and "Recipes".

Table 6.3 Intervention functions (source: Michie et al., 2011) and persuasive technology principles (source: Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2008, 2009) used in the design of WasteLess. Intervention functions provided in BCW linked with the components of "COM-B" model

Interventions	Definition	Model of behaviour: sources					
		C-Ph	C-Ps	M-Re	M-Au	O-Ph	O-So
Education	*Increasing knowledge or understanding*		x	x			
WasteLess Functions Using up food Extending shelf life Food storage advice Food labels Food buying advice Food safety advice Recipes							
Persuasion	*Using communication to induce positive or negative feelings or stimulate action*			x	x		
Personalization	Providing users with personalised features or content						
WasteLess Function Set up							
Reduction	Simplifying the target behaviour by reducing the complexity of a task to a single or few easy steps						
WasteLess Functions Shopping list Meal plans Event plans Check food stock							
Tracking	Providing information to users about their past behaviour regarding food consumption and waste						
WasteLess Functions Food buying advice Event plans Check food stock Overall waste Item waste Goal setting							
Cooperation	Providing a way for users to cooperate towards performing the target behaviour						
WasteLess Functions Food sharing							
Competition	Providing a way for users to compete with each other						
WasteLess Functions Compete with friends							
Enablement	*Increasing means/reducing barriers to increase capability or opportunity*	x	x		x	x	x
WasteLess Functions Shopping list Longer lasting foods Check at home food Meal plans Food sharing Check food stock Event plans							

Note: C-Ph: physical capability; C-Ps: psychological capability; M-Re: reflective motivation; M-Au: automatic motivation; O-Ph: physical opportunity; O-So: social opportunity. Link of intervention function/ persuasive technology principles component is indicated with an x.

Enablement was used as an intervention for food waste driver mitigation that were related to opportunity. To illustrate, the "Share" feature in shopping list and the "Share" feature in meal plan were proposed to help users to have good household communication about meal or shopping planning. The "Share" feature in the shopping list was proposed to help users to share shopping lists between household members, and the "Share" feature in the meal plan was proposed to help them share meal plans. This reasoning was also applied to "Meal plans", "Food sharing", "Longer lasting food", "Check at home food", and "Check food stock". However, some functions such as "Set up" and "Filter" in Recipes were suitable to mitigate issues related to

Opportunity for some food waste drivers. "Set up" can help with the food waste driver mitigation "Facilitate catering for "picky" eaters" by facilitating accessing to personalised recipes according to the requirements of particular members of a household. Although this can be considered as a kind of enablement, the main support provided by the Set up function is personalization. In addition, "Filter" in Recipes can enable users in filtering recipes based on preparation time. However, the main support provided by Recipe function is education.

Education, persuasion and enablement were used for food waste driver mitigation that were related to motivation. Particular persuasion techniques were inspired by Fogg, (2003) and Oinas-Kukkonen and Harjumaa (2008, 2009). Further details of these techniques are provided in Chapter 2 (Section 2.3.1.1). Using education, the "Food safety advice" function proposed to help users with believe about healthy eating of leftovers, by providing advice about safety of eating leftover food, re-heating food and other safety advice. This was also applied to the "Food buying advice" function. Using persuasion as well as enablement, "Event plans" was proposed to help users who provide too much food during special occasions and holidays. In this function, I applied reduction and tracking as persuasion techniques to enable users to easily plan upcoming events, as well as providing information of previous similar event details. Persuasion using reduction and tracking techniques was also applied in the "Check food stock" function. Persuasion using a reduction technique was applied in the "Shopping list" and "Meal plan" functions. A tracking technique was applied in the "Food buying advice" function.

The "Extending shelf-life" function can also help with the food waste driver mitigation "(less) Motivated to cook", which is related to motivation, by facilitating access to ways of extending the shelf life of available food in users' households. This could be thought of as a kind of enablement, however the main support provided by the "Extending shelf-life" function is education.

Additional motivating functions for specific food waste reduction support were also included in the app. "Overall Waste" was proposed to help users monitor their overall food waste, using tracking as persuasion technique. This technique was also applied to "Item Waste", "Goal setting". Further, "Compete with friends" was proposed to motivate users to join a competition with friends and compare their

respective food waste, using competition as persuasion technique. "Food sharing" was proposed to facilitate food sharing with others, using cooperation as persuasion technique.

A general feature "Set up" for personalisation was included, to help users personalise the app according to their personal preferences, using personalisation as persuasion technique.

More details of the application of BCW, and the link between food waste drivers (indicating the barriers) and WasteLess functions is provided in Appendix D.1.4 (Table D.2).

Step 8 (Identify mode of delivery), the intervention was delivered using a mobile app, by embedding the proposed functions in the WasteLess app. Mobile app is a popular intervention for food waste reduction. The majority of the reviewed interventions for food waste reduction were designed as mobile applications or they extensively used a mobile application for providing functionality. In addition, it gives a flexibility in combing the range of functionality needed for food waste reduction, and it is affordable to be obtained by individuals.

6.3.3 Principles and guidance for designing user interfaces

Shneiderman's Eight Golden Rules (Shneiderman & Plaisant, 2005) were used in designing the screens for WasteLess app. This includes the following:

Strive for consistency (*1st Rule*) means to employ consistent colour, fonts, and layout in the app. This could help users to be familiar with the app and accomplish their goals easily (Wong, 2021). Examples of using this rule in WasteLess app:

- Consistent design of the landing screens of each section in the app, giving the same way of accessing the options of each section;
- Same style of call-to actions buttons used across different screens of the app;
- Same icons to represent some features in the app such as share and add new item;
- Provide similar landing screen for every section of the app, giving the same way of accessing the options.

Cater to universal usability (*2ndRule*) means to recognise the need of diverse users and design for plasticity, facilitating transformation of contents. Examples of using this rule in WasteLess app:

- Provide different options to users to input data, such as virtual assistant feature for users who do not use loyalty cards;
- Allow users to set up the app according to their diet type such as Halal, Kosher, vegetarian and so on;
- Provide users with all options in their favourite food list with predictive text when as they start typing a word. For example, if a user type "br", WasteLess starts to present a list of options starting with "br".

Offer informative feedback (*3rdRule*) means to provide system feedback for every user action. Examples of using this rule in WasteLess app:

- If users tap on "Buy" button in the Shopping List screen, the app will provide instant feedback indicating that one item has been bought;
- If users tap on the "Add" button in the Add from List screen, the app will provide instant feedback indicating that one item is added to the list;
- If users use the scanning feature to scan a barcode of a food item, the app will provide instant feedback with the name of the food product and option to add.

Design dialogues to yield closure (*4thRule*) mean to provide informative feedback to users after completing a group of actions. This rule would apply more in high fidelity prototypes or working implementations of systems, which are fully interactive. However, examples of using this rule in WasteLess app:

- After users add food items to their shopping list, they can view all the items in their list, and when they buy them, they can mark them as bought;
- After users make a meal plan using the app, they can view the meals of each day in the plan.

Prevent error (*5thRule*), this can be certainly implemented to avoid user errors such as providing incorrect account details and set past date for upcoming event. However, because this is a low-fidelity prototype and not offer a real interaction with users, this is not used although it would be important for the high-fidelity prototype of WasteLess.

Permit easy reversal of action (*6thRule*) means to make actions reversible as possible to relief users from being anxious of making errors. Examples of using this rule in WasteLess app:

- When users make a meal plan, they can view it and would be able to edit it;
- If users add food item to their food shopping by mistake, they could easily remove it.

Support internal locus of control (*7thRule*) means to provide users with control over the interface, and that the interface responds to their actions. Examples of using this rule in WasteLess app:

- Users can manage the details of setting a goal of food waste reduction including their weekly target (e.g., reduce waste by 10%), start date, and duration of their goal;
- Users can manage if they want to share food using a private pick up location (e.g., their home) or a public pick up location (e.g., some communities are setting up food sharing fridges in community centres);
- Users can manage measures they want to see in the app in metric units (kg, g, l, ml) or imperial units (lb, oz, pint, fl oz).

Reduce short-term memory load (*8thRule*) means to consider human memory load and not make users remember too many things. Examples of using this rule in WasteLess app:

- Provide easy access to all four sections of operations at the bottom of the app screen.

The Apple style guides[8] also inspired the design of user interfaces of WasteLess app. This includes five main areas: layout and organisation, menus and actions, navigation and search, presentation, and selection and inputs. However, due to the fact that this is a low fidelity prototype of WasteLess, some of the components were not extensively applied.

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[8] Designing for iOS - Platforms - Human Interface Guidelines - Design - Apple Developer

Layout and organisation guidelines were used, including the following:

- Boxes used to create a visually distinct group of related information using a visible border and providing a title to clarify the box's contents. Example in WasteLess app, in the Food Label screen, a box includes information of "Use by date".

- Disclosure controls used to help users focus on the essential information without overwhelming them with too many details. Example in WasteLess app, in the Overall Food Waste screen, users can tap on a disclosure triangle to find tips of how to waste less food related to particular food items.

- Labels used to display a small amount of uneditable text throughout the interface, which can be within buttons to convey what it does, or list items to describe each item. Example in WasteLess app, in Login screen, Sign In (within a button label).

- Lists and tables used to present data in one or more columns of rows. Example in WasteLess app, the Friend Waste Reduction screen (list), and food sharing screen (table).

Menus and actions guidelines were used, including the following:

- Buttons used to give users simple and familiar ways to do tasks in the app. It combines three attributes: style including its shape, size, and colour; content including it text label or icon; and its main role. It is also important to consider enough space around a button so that users can visually distinguish it from surrounding components or content. Example in WasteLess app, in the Meal Plans screen, "Next day" button.

- Pull-down buttons used to display a menu of items or actions which precisely relate to the button's purpose. Example in WasteLess app, in the Recipes screen, "Time" filtering.

Navigation and search guidelines were used, including the following:

- Search field used to allow users to search for specific terms they enter. This can consider providing hints to help guide users for searching. Example in WasteLess app, in the Food Available screen, the top search field.

- Tap bars used to enable users navigate among different sections of the app. Example in WasteLess app, providing ability to access all the four sections at the bottom of all screens.

Presentation guidelines were used, including the following:

- Scroll views used to enable users view large content by moving it horizontally or vertically. Example in WasteLess app, in the Recipes screen (horizontal scroll bar); in the Extending Shelf Life screen (vertical scroll bar).

Selection and inputs guidelines were used, including the following:

- Segmented control is a liner set of two or more segments, which each of them functions as a button. Example in WasteLess app, in the Recipe Details screen: "Cookware", "ingredients", "Method".
- Text fields used to request a small amount of information, like username or password. Example in WasteLess app, in Login screen, a field to enter username, and other for user password.

6.3.4 User interfaces for the WasteLess functions

The WasteLess used green as a main colour, which has a strong association with nature and the environment. Red used to indicate waste, as red has a negative association for European cultures and for Arab culture. However, this would need to be changed for the Chinese version. Because red is very positive in Chinese culture (Stuart, 2016). In addition, "traffic light" colours used to indicate the status of the food in some functions. For example, in Check Food Stock function, green used to indicate that food is still in good condition, orange to indicate food that is soon to expire and red to indicate food that is near to expire.

The WasteLess app starts with a *login* screen (see Figure 6.5), so that each user can have their own secure account. After logging in, the *Set Up* screen allows users to personalise the app according to their specific situation and preferences, such as tailoring recommendations to their dietary choices or avoiding foods they are allergic to (see Figure 6.6). The main *Home* screen of the WasteLess app is shown in Figure 6.7, from which users can navigate to the four main sections of functions. The following sub-sections describe the functions within each of the four sections.

6.3.4.1 Food shopping functions

The *Food Shopping* section includes six functions which help users plan and shop for food.

Figure 6.5 Login screen   **Figure 6.6** Set Up screen   **Figure 6.7** Home screen
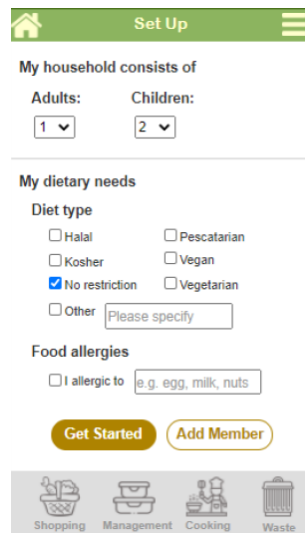
The Shopping list function helps users to make shopping lists rapidly and with little effort in order to encourage them to make a shopping list, particularly for users who do not have time or are not bothered about making a list. The app allows users to add items to the shopping list via four methods. Before adding items to shopping list, the app will show users that the list is empty and provide them with the four methods to add items (see Appendix E.1.5).

Method 1: *Search Favourites*, users can search within their favourite foods for items that they often buy to add to their shopping list (see Figure 6.8).

Method 2: *Add from List*, users can request a list of food items which they have completely used up of or have nearly used up (see Figure 6.9).

Method 3: *Scan Food Item*, users can scan the bar code on a food package to add the item to the shopping list (see Figure 6.10).

Method 4: *Add Food Item (manually)*, users can type in the food item details such as product name, food category and quantity to add to the shopping list (see Figure 6.11).

Within the shopping list function, users can also view the list at home or when they are out for shopping and share it with other members of the household to facilitate

communication around food planning, such as shopping and meal preparation (see Figure 6.12).

The shopping list groups food items into categories such as fruit and vegetables, dairy, meat and poultry, bakery, and snacks. This presentation is based on how supermarkets usually organise food in separate sections in their stores, so the app can help users to easily find items when shopping.
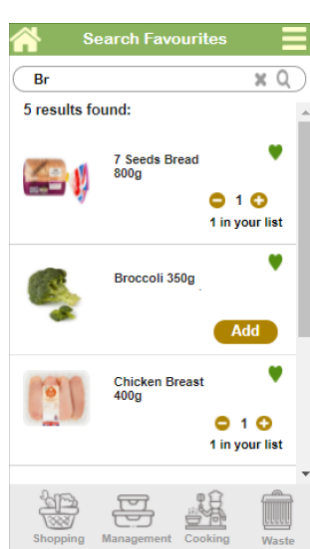
Figure 6.8 Method 1 for adding an item to the Shopping List: Search Favourites
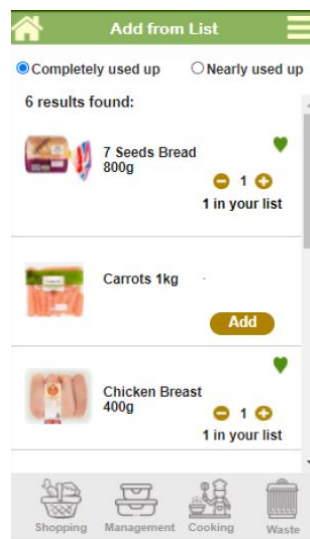
Figure 6.9 Method 2 for adding an item to the Shopping List: Add from List
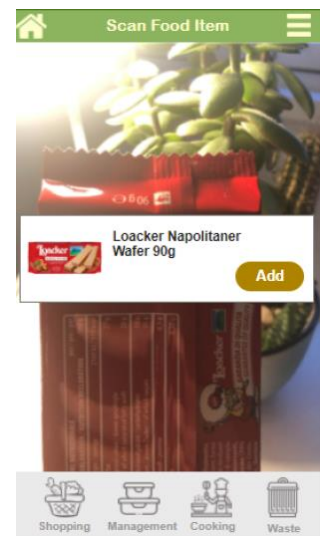
Figure 6.10 Method 3 for adding an item to the Shopping List: Scan Food Item

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[9] The group icon should be enabled whenever the user is using any function within that group. For example, if users use Search Favourite, the shopping icon in the main menu should be enabled to indicate that the function used in within the shopping group. However, this was not included in the WasteLess low-fidelity prototype which mainly focused on the idea of functions rather than the interaction features.
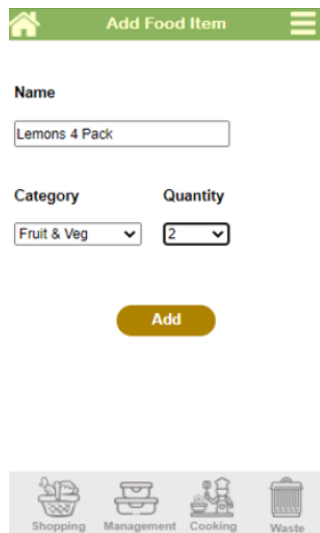
Figure 6.11 Method for adding an item to the Shopping List: Add Food Item (manually)
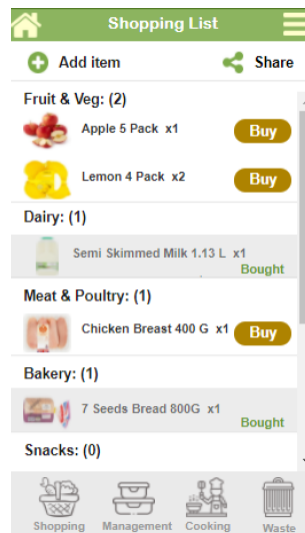
Figure 6.12 Viewing and sharing a shopping list

The Longer lasting foods function supports users during the shopping planning process by enabling them to find possible longer lasting substitutions for foods with short shelf-life, such as fresh fruit or vegetables. Purchasing longer lasting items helps eliminate potential waste of food (see Figure 6.13).

The Check at Home Food function enables users to check what food they have at home when they are out shopping. This can help users avoid overbuying foods that they already have at home (see Figure 6.14). Users can type in the name of a food item they want to check, and the app will provide them with details of whether they already have it, where it is stored, remaining amount of the item, and number of days before it will expire.

The Food Buying Advice function helps users buy an appropriate amount of a particular food by providing information about the shelf-life of that food. Advice on the amount of food that should be bought partly depends on the user's previous consumption of the item. So, users can make an informed decision while shopping about whether it is worth buying a particular food item, and if so, how much food is enough for them (see Figure 6.15).
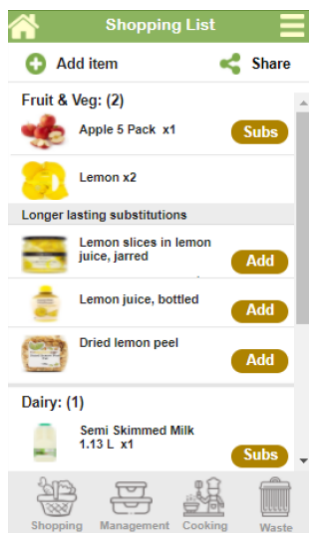
Figure 6.13 Finding longer lasting food substitutions
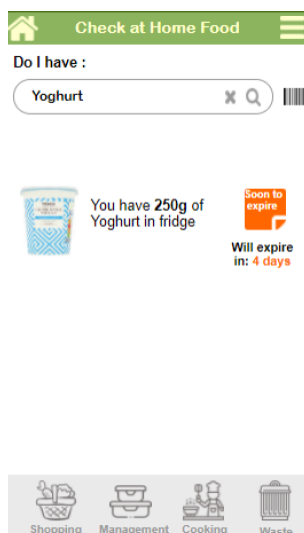
Figure 6.14 Check at Home Food function
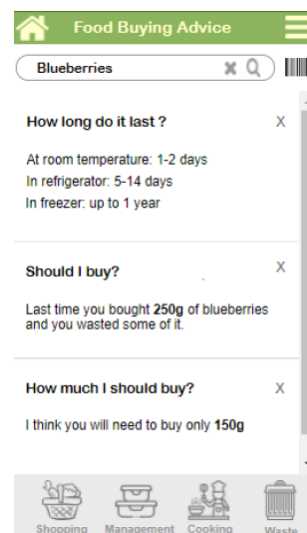
Figure 6.15 Food Buying Advice function

The Meal plans function enables users to plan their meals easily. It allows users to specify the start date and duration of the plan and the type of meals to be included. This will give users more flexibility in terms of how many days and what meals they plan for. The plan duration can be flexible, 3, 5 or 7 days. This flexibility can support users who find that it is difficult to stick to a long meal plan. In addition, the app provides recipe suggestions for each meal and day of the plan with the ability to edit these suggestions. The app also allows users to easily generate a shopping list for the meal plan and share the plan with others (see Figure 6.16).
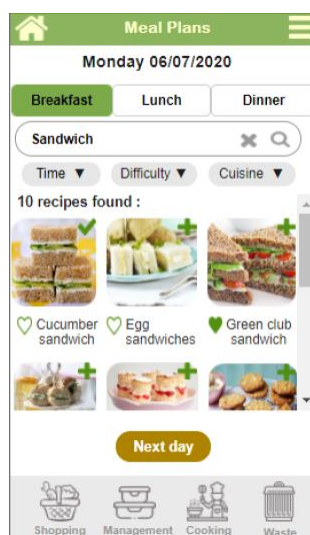
A Meal Plans: Finding recipes
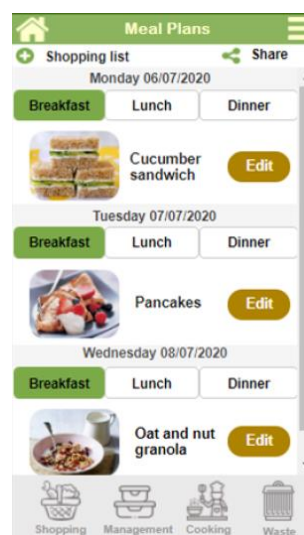
B View Meal Plan

Figure 6.16 Meal plan function

The Event plans function enables users to plan their meals and shopping appropriately and easily for special events or occasions to avoid potential waste. The app provides information about previous and similar events such as birthdays, Christmas and New Year, which were previously planned using the WasteLess app, including the shopping list, meals served and the percentage of food waste at that event. This can give users an overview of sufficient food and meals for such events and avoid overbuying and overserving food. Users can select the upcoming event or occasion details, and then all similar and previous events that were planned with the app will be shown. Users can select any of the previous events to see more details which includes when it was held, how many guests, dishes served and the shopping list. In addition, they can see how much food they wasted (see Figure 6.17-A).

If users want to have the same meals for the upcoming event, they can choose that option, and the app will generate a plan that includes meals and shopping list, retrieved from the selected previous event (see Figure 6.17-B). Users can also select particular dishes from the last event to serve again, and they can easily generate a shopping list and adjust it according to their waste at the previous event to avoid potential future waste.

A Details of a previous event   **B** Plan of upcoming event
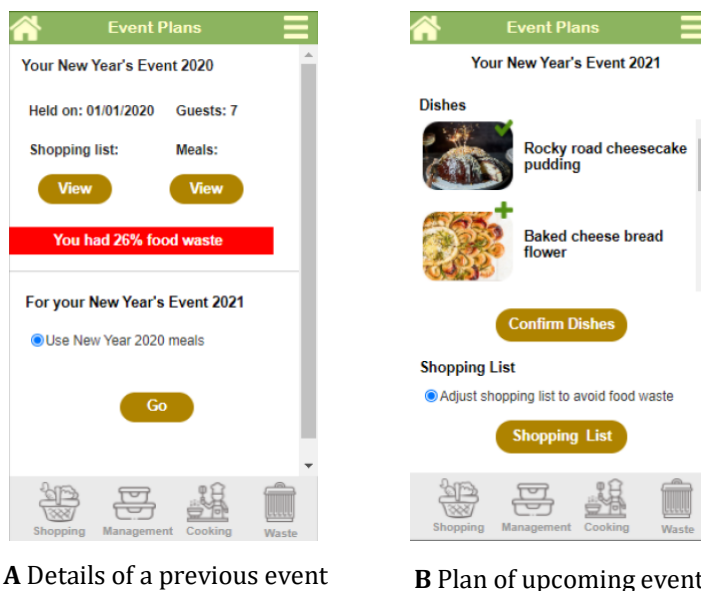
Figure 6.17 Event Plans

6.3.4.2 Food management functions

The *Food Management* section includes four functions which help users to manage and organise food in their household.

The Check Food Stock function helps increase the visibility of the food available at home. The function enables users to check what foods they have and where they are stored (e.g., in the pantry, fridge, or freezer). Instead of searching for food manually in different storage areas, they can check it easily via the app (see Figure 6.18-A). Increasing visibility can help users to use up available foods before they reach their expiry date. In addition, providing users with information about their stock of food can help them avoid buying more of the same items. The function also provides easy recipes to use up available food, and provides information about remaining amounts of food available and their expiry dates (see Figure 6.18-B). WasteLess offers this function by two methods, checking food stock by storage area and checking food stock by food item (see Figure 6.19).
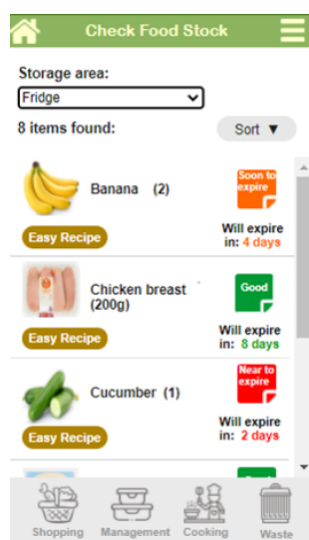
A Check Food Stock
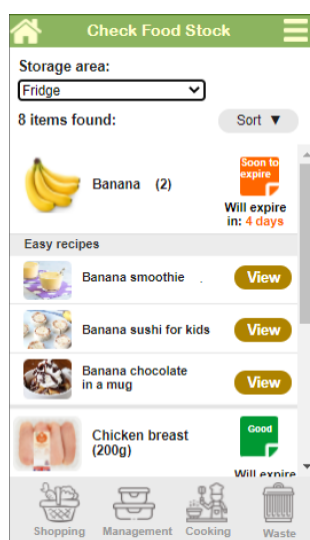
B Easy recipes within Check Food Stock
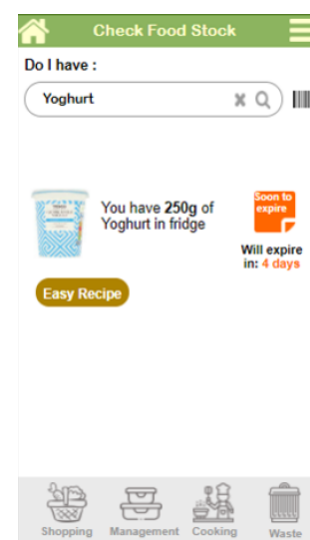
Figure 6.19 Check Food Stock for a particular food item

Figure 6.18 Check food stock by storage area

The Food Labels function provides information to users to understand the meaning of different food labels. This can help in avoiding unnecessary of food waste due to misunderstanding food labels (see Figure 6.20).

The Food Storage Advice function provides users with advice about where and how to store food appropriately. This function can help users who lack storage knowledge or skills. This can avoid food waste due to incorrect storage which may lead to shorter shelf-life or damage to the food (see Figure 6.21).

The Extending Shelf Life function provides users with ways to extend the shelf-life of their food. The function provides information about how to store particular foods for longer. This function is linked to the Food Storage Advice function, as it can help users to store food but more specifically this function is about providing information about how to make the food last longer. The function also enables users to select which storage area they would like to keep the food in, for example in the pantry, fridge or freezer or any other storage area they have. This can allow users know the available options for storing their food which depend on the available spaces they have at home. The app will provide information about how to store food in that storage area to last longer. This can help to preserve food at home and prevent waste (see Figure 6.22).
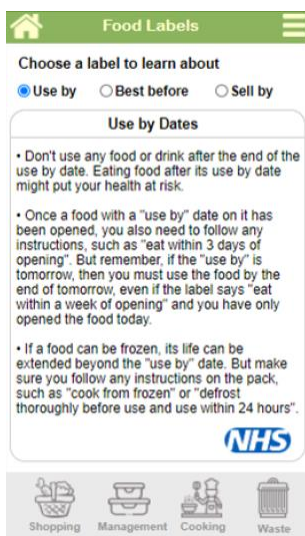
Figure 6.20 Food Labels
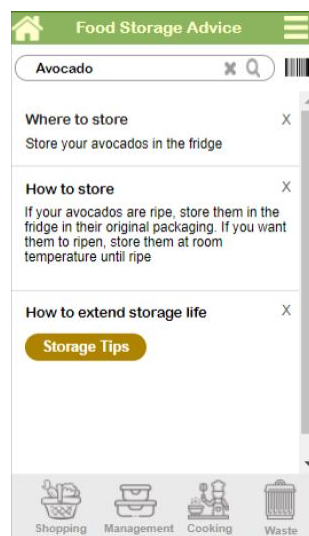
Figure 6.21 Food Storage Advice
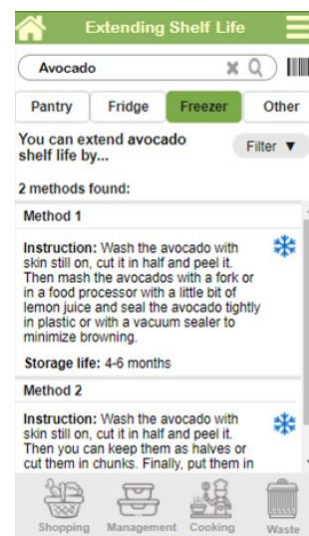
Figure 6.22 Extending Shelf Life

6.3.4.3 Cooking functions

The *Cooking* section includes the following three functions which help users in preparing and cooking food.

The Recipe function helps users find recipes for dishes to cook at home. Users can search for recipes using the name of an ingredient or a dish. This will help users to find recipes for particular ingredients they have at home that they want to use up. The app

enables users to filter recipes according to specific preferences. These include preparation time, difficulty level, and cuisine. Filtering by preparation time can help busy users to find recipes that are suitable for the particular amount of time they have available or want to spending cooking. Filtering by difficulty level can help users who are not very skilled cooks. Finally, filtering by cuisine is to satisfy the tastes of users from different cultural backgrounds or their interests in different cuisines (see Figure 6.23-A). The app also provides users with the amount of ingredients within a recipe based on how many people they want to serve. The app provides detailed information within each meal recipe including a link to a step-by-step video of how to prepare the dish (see Figure 6.23-B).
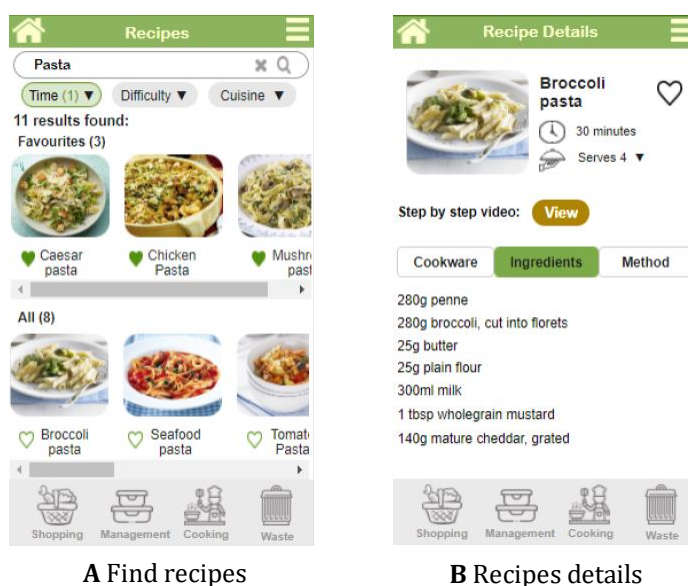
A Find recipes   B Recipes details

Figure 6.23 Recipes

The Using Up Food function provides users with recipes to use up particular foods and leftovers. Instead of wasting leftover food, they can use it to cook another dish or make it part of another meal. The app allows users to search for recipes by the name of an ingredient or dish. It is similar to the Recipe function in that users can filter the recipes according to preparation time, difficulty level, and cuisine (see Figure 6.24).

The Food Safety Advice function provides users with advice about food safety. For example, it advises users whether it is safe to eat particular leftover foods, to re-heat food and so on. The app allows users to search for safety advice on particular foods and dishes (see Figure 6.25).
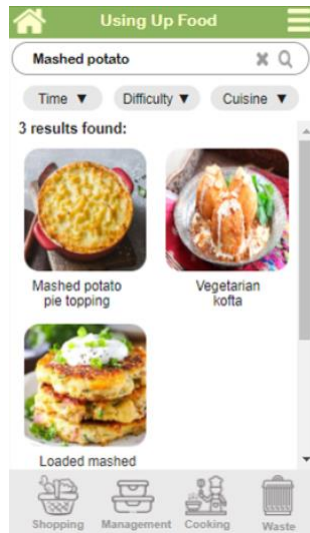
Figure 6.24 Using Up Food
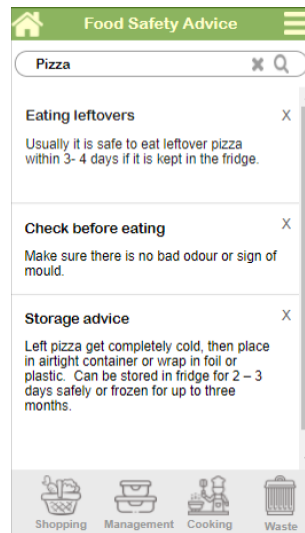
Figure 6.25 Food Safety Advice

6.3.4.4 Food waste functions

The *Food Waste* section includes five functions to motivate and encourage users to reduce their food waste.

The Overall Waste function helps users monitor their food waste. The app shows users how much food they have used up and wasted both in total and for each food item. Users can monitor their waste by week, month or year. It will also provide tips and advice on how to waste less of particular food items (see Figure 6.26).

The Food Item Waste function helps users monitor waste of a particular food item. The app shows users how much of a particular food item has been used up and wasted, with the ability to check by purchase date. The app also provides advice on how much of a particular food item should be purchased at a time, which is calculated according to their previous consumption and amount of that item previously wasted (see Figure 6.27).
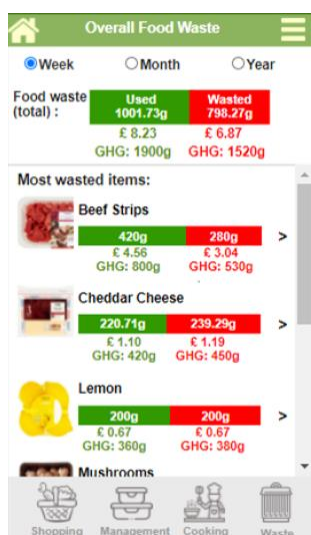
Figure 6.26 Overall Food Waste
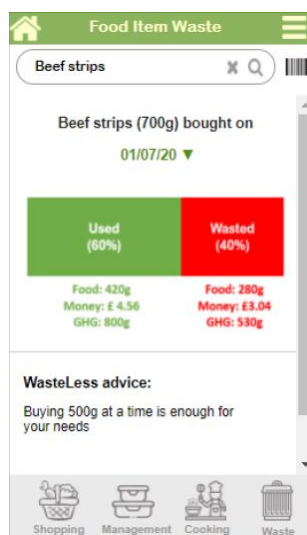
Figure 6.27 Food Item Waste

Figure 6.28 Goal setting

The Goal Setting function motivates users to reduce their food waste by allowing them to set a goal for food waste reduction over a particular period and to track their progress towards meeting that goal. Users can set a goal to reduce their food waste for a particular period of time such as one month, and by a certain amount such as reducing food waste 10% each week. The app shows users how much food waste they produce each week and the percentage of food waste reduction for each week compared with the previous week. Furthermore, the app will put a star to indicate that a user has met their weekly target as well as showing how much money saved each week (see Figure 6.28).

The Compete with Friends (Friends Waste Reduction function) motivates users to join a competition with friends and compare their respective food waste. The competition could also be between different households in the community. The app shows users a scoreboard including a rank from low to high food waste producers (see Figure 6.29).

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10 There is a consistency error in this screen, the tab "Monthly" should have black text (not white). However, the evaluation of the Wasteless prototype did not involve evaluation of the colour scheme. Because this was not noticed until after the WasteLess app was evaluated, I did not fix the issue. However, it is important to consider such issues for the design of the working version of the WasteLess app.

The Food Sharing function facilitates food sharing with others, so that food which might be wasted can be used by someone else. The app shows users a list of food available at home, which can be easily shared, whether one or more items at a time. In addition, users can take photo of a food item to show people who might use it how it currently looks. This function can be set up in two ways: (a) direct person-to-person, a user can specify a private pickup location (e.g. their home) for the receiver to pick up the food; or (b) a public space where the food will be available (e.g., some communities are setting up food sharing fridges in locations such as community centres). Figure 6.30-A illustrates how the app allows food donors to share their available food with others, and Figure 6.30-B shows how food receivers can search for available food to receive from others.
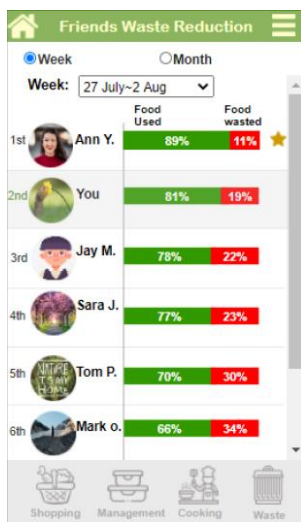
Figure 6.29 Friends Waste Reduction
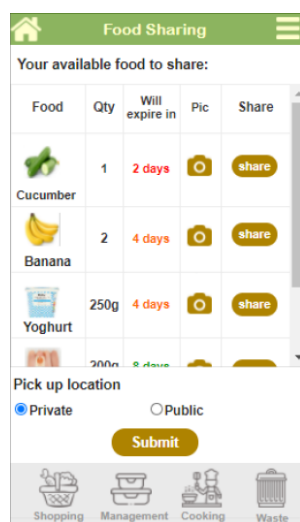
A Donor side
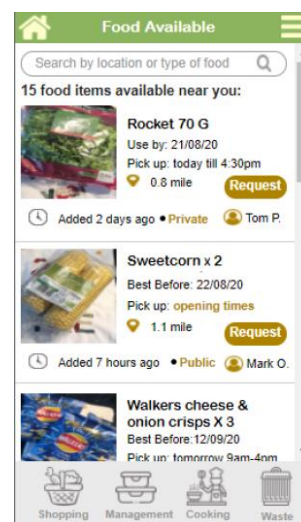
B Receiver side

Figure 6.30 Food Sharing

6.4 Collaborative Heuristic Evaluation of the WasteLess app

This section describes a Collaborative Heuristic Evaluation (CHE) which was undertaken on the first version of the WasteLess prototype.

Petrie and Buykx (2010) proposed the CHE, which allows expert evaluators to work together as a group. During an evaluation session, each evaluator can propose any potential issue related to usability, and then they all have to agree on the definition of the proposed issue. One of the evaluators should create a description of the proposed issue, and each of them rates the severity of the issue privately (on a scale from 5 = very major to 1 = very minor). If any of the evaluators does not believe it is an issue, they can provide a rating of zero. At the end of the evaluation session, it is

very quick to create a prioritized list of usability issues which need to be addressed, based on an appropriate metric from the ratings (usually the mean rating).

6.4.1 Expert participants

The evaluation of WasteLess prototype was conducted by three experts, who were members of Human Computer Interaction Research Group at the University of York. All experts were academics with usability expertise and had at least five years of experience with conducting CHEs.

6.4.2 Materials

The WasteLess prototype was designed using Axure software (see www.axure.com). The CHE was conducted online via Google Meet due to Covid-19 restrictions. A set of heuristics, proposed by Petrie and Power (2012) (see Appendix D.1.1, Table D.1), was used to indicate and classify the usability problems discovered in the collaborative heuristic evaluation. A 5-point scale rating was used for rating the level of severity of the problems, from 1 being very minor problem to 5 being very major problem. An online problem recording sheet, on Microsoft Office Excel, was used to record the problems.

6.4.3 Procedure

Before started the evaluation, the materials including a set of heuristics and rating scale were sent via email to the experts. At the beginning of the evaluation session, a text description of the WasteLess app was presented to the experts (see Appendix D.1.2).

As there were a large number of functions to evaluation, the evaluation was spread over two evaluation sessions, each session lasting approximately one hour and 30 minutes. During the valuation sessions, one of the experts noted the potential usability problems as they were identified (i.e., acted as the scribe). Once the problem description had been agreed, the experts rated the level of severity of the problem on the severity scale privately.

6.4.4 Results of CHE

44 usability problems were identified in the app. Table 6.4 (Column 1) gives the categorization of the ratings, based on the mean ratings of the three experts. As Table

6.4 illustrates, most of the problems (77.25%) were minor and less than minor. However, no problem was rated as a very major or major problem during the CHE.

Table 6.4 Overview of severity ratings of problems identified in the CHE

Range of mean ratings	Problem	Number (%)
0.0 – 0.99	Less than very minor problem	4 (9.0)
1.00	Very minor problem	10 (22.7)
1.01 – 1.99	Between very minor and minor problems	10 (22.7)
2.00	Minor problems	10 (22.7)
2.01 – 2.99	Between minor and not minor nor major	9 (20.4)
3.00	Not minor nor major	1 (2.2)
3.01 – 3.99	Between not minor nor major and Major problem	0 (0.0)
4.00	Major problem	0 (0.0)
4.01 – 4.99	Between major problem and very major	0 (0.0)
5.00	Very major	0 (0.0)

Examples of usability problems include:

- Better label description of screens or items;
- Considering gestalts and removing unnecessary lines in the interfaces;
- Better alignment of icons and texts;
- Adding home icon on the top of panels;
- Adding scrolling bar of screens.

The detailed results of the CHE are provided in Appendix D.1.3.

After the first evaluation session, I re-designed the app based on the problems identified from the experts. The amendments were implements on all screens of the app, which resulted in a new design of the app. For example, if there was a need for adding a scrolling bar of screens for one screen, I made this for other similar screens. This also includes improvements such as: ordering items alphabetically, adding instant feedback for actions, re-designing landing screens of function sections and adding new screens such as a screen to show users the current shopping lists. After that, another evaluation session was conducted with the experts to evaluate the updated design of the app.

6.5 Discussion and conclusions

This chapter presented the design and expert evaluation of the WasteLess app, which aims to support users to manage their food-related practices and reduce their

household food waste. The design of WasteLess app was to answer RQ3 in this programme of research (RQ3: To what extent can the design of a mobile app (WasteLess) provide comprehensive support for food-related practices and techniques for behaviour change?).

The RQ3 was addressed by answering three sub-RQs. In relation to providing comprehensive support for food-related practices (RQ3.1: To what extent can the design of a mobile app (WasteLess) provide comprehensive support for food-related practices?), the WasteLess app proposed 18 functions to provide support for users during different food-related practices: food shopping, food storage and management, food preparation and cooking, and food waste reduction. This includes six functions in the food shopping section which support users to plan and shop for food for their household; four functions in the food management section which support users after purchasing food to help them to properly manage and store food at home; three functions in the cooking section which support users to cook and prepare food at home; five functions in the food waste section which motivate, encourage and help users to monitor and reduce their food waste. For each function, illustrations as well as screenshots of user interfaces were provided, guided by Shneiderman's eight golden rules of interface design and the Apple Style Guidelines.

In relation to incorporating food waste drivers (RQ3.2: To what extent can a mobile app (WasteLess) incorporate the full set of food waste drivers elicited in Studies 1 and 2 of this programme of research?), the WasteLess encompasses the complex list of food waste drivers, the 16 food waste drivers, previously investigated in this programme of research (see Chapter 4, Section 4.23). Designing the WasteLess app helped to explore the possibility of incorporating these drivers and using them to provide support in a single app for food waste reduction.

In relation to incorporating techniques for behaviour change (RQ3.3: To what extent can a mobile app (WasteLess) incorporate theory-based techniques for behaviour change (i.e., the BCW and persuasive technology techniques?)), the design of the WasteLess app was largely based on COM-B and BCW theory. In addition, specific persuasive technology principles which provided by Oinas-Kukkonen and Harjumaa (2008, 2009) and Fogg (2003) was used (e.g., personalization, tracking, cooperation, competition and reduction).

The utilisation of BCW was just a guidance of development of the WasteLess app. So, the categorisation of the mitigation of food waste drivers according to the COM-B model was based on my thoughts about the source of issue of the behaviour. Further, the BCW intervention functions were used as inspiration and boundaries of possible support that can be provided to mitigate each food waste driver. Therefore, some WasteLess functions could be found to provide more support than what was initially designed, that can help with other food waste drivers. This might be due to that some functions could support more than one kind of intervention function, rather they incorporated multiple functionalities or features. However, the main intervention support provided by each function is the one that would be used a designer point of view for each function in the next chapter. The next chapter (Chapter 7) will present the user evaluation of the proposed WasteLess app.

The WasteLess app used a comprehensive approach in supporting individuals to waste less food. In comparison, previous interventions (e.g., Comber et al., 2013; Farr-Wharton et al., 2014a; Farr-Wharton et al., 2014b; Ganglbauer et al., 2015; Thieme et al., 2012) were rather specific in terms of providing supports for food waste reduction. For example, BinCam (Thieme et al., 2012), was developed to show items in the household bin and visualize recycling and preventing food waste (see Chapter 2, Section 2.3.2). However, as mentioned by Ganglbauer et al. (2013), food waste is complex issue and can occur during many food-related practices such as shopping, storing, and cooking. Thus, it was important to create the WasteLess app to explore the possibility of designing a comprehensive app to support food waste reduction. The comprehensiveness in the design of the WasteLess app refers to three main aspects: (1) providing support during different food-related practices, (2) encompassing the complex list of food waste drivers, and (3) applying different theory-based techniques for behaviour change.

With regards to providing support during different food-related practices, the design of the WasteLess app was based on providing support during food shopping, management, cooking, and provide support for food waste. The WasteLess prototype covers four out of the five Filtering dimensions discussed by Lim et al. (2008). The prototype focuses on the functionality rather than interactivity (see Table 6.1) because the aim of the design is to assess the users' likelihood of using different functionality support for food waste reduction. However, other dimensions of Filtering such as

Appearance, Data, and Special Structures were also considered, as well as all dimensions of the Manifestation aspect such as Materials. This was because, as discussed by Lim et al. (2008) the materials used for a prototype have direct effects on users' views when it is used for evaluating the design. So, I used Axure to design the prototype as this created a visual design which would be quite similar to a final app. Therefore, my evaluation of the WasteLess will be useful and add to the knowledge about what kind of app-based functionality and interventions and persuasion techniques have the potential to support individuals for food waste reduction. This evaluation is presented in Chapter 7. This can provide a direction for future designers and researchers of the potential app-based supports which worth further investigation.

With regard to the applying different theory-based techniques for behaviour change, the design of the WasteLess app was largely based on COM-B and BCW theory. In designing the WasteLess app, I used COM-B to analyse food waste issues in terms of the drivers, to explore the underlying source potentially responsible to mitigate each driver. In addition, BCW theory proposes intervention functions which can be applied to different COM-B components. The application of COM-B to the complex list of food waste driver mitigation is important to demonstrate its suitability to cope with the complexity of the food waste drivers.

 In relation to using theoretical backgrounds, Hedin et al. (2019) confirmed the lack of using a clear behavioural change theoretical grounding in the interventions reviewed before (e.g., Comber et al., 2013; Farr-Wharton et al., 2014a; Farr-Wharton et al., 2014b; Ganglbauer et al., 2015; Thieme et al., 2012). Some researchers did refer to behaviour change theories in a general way. For example, Farr-Wharton et al. (2014b) referred to persuasion and gamification. However, none of these researchers specifically explained how they used theories in the design and evaluation of their interventions (see Chapter 2, Section 2.3.3). However, using theory was recommended to improve the effectiveness of behaviour change interventions (Bluethmann et al., 2017). In addition, Bartholomew and Mullen (2011) mentioned that theory is important for behaviour change research because it helps researchers identify causal factors of the behaviour and change method for that. In addition, it helps researchers to describe the pathways through which change is happening, making the results helpful in informing following research (Bartholomew & Mullen, 2011).

The WasteLess app therefore was designed using a comprehensive theory (COM-B and BCW theory) to help analyse the food waste drivers, and design possible intervention functions (see Chapter 2, Section 2.3.1.2). In the design of the WasteLess app I considered three most used intervention functions in the BCW (Hedin et al., 2019), which are *Education, Persuasion and Enablement*. In addition, the persuasive techniques proposed by Fogg (2003) and Oinas-Kukkonen and Harjumaa (2008, 2009).

The design of the WasteLess app could help to explore the design space of incorporating all these techniques in a single mobile app, providing such a comprehensive experience for users. In addition, it can help to investigate the potential of intervention functions and persuasive techniques to be used by individuals for food waste reduction (further details of this investigation is provided in Chapter 7).

Chapter 7

Study 4: Evaluation of the low fidelity prototype for the WasteLess app with participants from different cultures and at different life stages

7.1 Introduction

This chapter presents the fourth and final study in my programme of research, which was conducted to achieve the objective of the fifth phase, evaluation, in the research. The study evaluated the low fidelity prototype for the WasteLess app with a range of potential users. The study investigated the potential of different types of app-based functionality support, as well as the potential of BCW intervention functions and persuasive technology techniques in supporting users in food waste reduction.

The study assessed the usability and perceived usefulness of the app and its range of functions for users at three stages of life: students, individuals living in family situations with children and older people; and for individuals from two different cultures: Arab and UK. I had hoped to investigate differences between these two cultures in this study. However, due to the Covid-19 pandemic I was only able to collect data from 24 Arab participants, in comparison to 215 UK participants. The comparisons with the UK data therefore were not statistically feasible, and the research questions in this chapter only investigated *Life stage* differences. Future research should investigate the reactions of Arab participants to the app in greater detail and cultural differences with British participants.

In particular, the study investigated what kind of functionality would motivate potential users to reduce their waste. In addition, what users think are the most important forms of support in such an app to help them with food waste reduction, and their opinions in relation to intervention and persuasion support provided in the app. The study will provide information for future researchers and designers about which

app functionality as well as what BCW interventions and persuasive techniques have the potential to support users at three different life stages in waste reduction.

The study addressed RQ4 in my programme of research:

RQ4: For potential users at different life stages and from different cultures, what are their opinions of different WasteLess functionalities, different BCW interventions and persuasive technology techniques, and the design of the app?

RQ4.1: What are the different groups of functionality proposed for the WasteLess app and their importance for potential users at different life stages?

RQ4.2: To what extent do the opinions of potential users at varying life stages and from different cultures support the BCW intervention functions and persuasive technologies proposed for the WasteLess app?

RQ4.3: For potential users at different life stages, which are the most important app-based interventions and persuasion technology approaches to support food waste reduction?

RQ4.4: What are the usability and accuracy issues with the prototype of the WasteLess app?

7.2 Method

7.2.1 Design

Before the Covid-19 pandemic, I planned to conduct the study using face-to-face user testing. However due to pandemic restrictions, the study was conducted using an online questionnaire. As mentioned in Chapter 6, the WasteLess low fidelity prototype app with 18 functions was proposed to support people to mitigate a range of food waste drivers identified in previous studies (see Chapter 6, Section 6.3.1). Therefore, the survey was designed to collect data from participants about their opinions of the usability by using estimates of how likely they would be to use each of the proposed functions to help them reduce their household food waste.

The study was conducted with participants at different life stages: students and family members from two cultures: Arab and UK; as well as older people from the UK. Older Arab people were not included in this study because they do not prefer to do an online

survey and would not be comfortable with answering questions online. If it had not been for the pandemic, I would have done evaluations with older Arab people face-to-face.

The study presented a series of screenshots to illustrate the proposed functions in WasteLess with brief text explanations of the function. Participants were asked to rate the likelihood they would use the function, and other questions about the function as appropriate.

7.2.2 Participants

The criteria for inclusion were that the participants must be engaged in food-related activities in their households such as food shopping, storage and management, cooking and food waste. In addition, they must be one of the following:

> Students from either of the two target cultures (United Kingdom or Arab countries) studying for an undergraduate or postgraduate degree, aged between 18 and 39 years and living in the UK,

> UK or Arab individuals aged between 30 and 49 years living in a family situation in their own country (or for Arab individuals, in the UK) with children under the age of 18,

> UK individuals living without children, aged 60 years or older.

Participants were recruited via three methods:

- Through participants recruitment sites (Prolific and Call For Participants). For the UK sample, an online screening survey was distributed on the Prolific participant recruitment website (prolific.co). 107 responses were received, however, only 31 met all the inclusion criteria. In addition, I used the Call For Participants participant recruitment website (callforparticipants.co.uk).
- Community groups. For the UK sample, emails were sent to student groups at the University of York, and a local online community group (NextDoor.co.uk). For the Arab sample, messages were posted on social media (e.g., WhatsApp.com) for Arab society groups in the UK
- Personal contacts. For both the Arab and UK samples.

The second two methods yielded a further 241 British and 24 Arab participants.

Thus, in total 296 participants were recruited, 272 (91.89%) were British and only 24 (8.10%) were Arab. Table 7.1 illustrates the number of participants within each target group.

Table 7.1 Total number of respondents for each target group

Target group		Number of respondents		Total
Culture	Life stage	Prolific	Other methods	
British	Students living in the UK	9	91	100
	Family members living with children in the UK	19	82	101
	Older people living in the UK	3	68	71
Arab	Students living in the UK	0	18	18
	Family members living with children in Saudi Arabia	0	6	6
Total number of participants		31	265	296

The demographics of the participants are summarized in Table 7.2. 239 participants were included in the analyses for the study (see Section 7.2.5.1, for further details of data preparation for analysis). British participants were 63 British students, 89 British family members with children and 63 were British older people. Arab participants were 12 Arab students and 12 Arab family members with children (six were living in Saudi Arabia, six in the UK). Arab participants were from Egypt, Iraq, Jordan, Morocco, Palestine, Saudi Arabia, Sudan, Syria, Tunisia, and United Arab Emirate. Further demographic details of participants are provided in Appendix E.1.1.

Table 7.2 Demographic information for the participants in Study 4 (Number and percentage)

	British students N = 63	British family members N = 89	British older people N = 63	Arab students N = 12	Arab family members N = 12	All N = 239
Gender						
Women	38 (60.3)	55 (61.1)	31 (49.2)	7 (58.3)	10 (83.3)	141 (58.9)
Men	25 (39.7)	34 (37.8)	32 (50.8)	5 (41.6)	2 (16.6)	98 (41.0)
Age						
18-29	61 (96.8)	7 (7.8)	0 (0.0)	10 (83.3)	2 (16.6)	80 (33.4)
30-39	2 (3.2)	52 (57.8)	0 (0.0)	2 (16.6)	9 (75.0)	65 (27.1)
40-49	0 (0.0)	30 (33.3)	0 (0.0)	0 (0.0)	1 (8.3)	31 (12.9)
60-69	0 (0.0)	0 (0.0)	56 (88.9)	0 (0.0)	0 (0.0)	56 (23.4)
70+	0 (0.0)	0 (0.0)	7 (11.1)	0 (0.0)	0 (0.0)	7 (2.9)
Education						
High school	35 (55.6)	17 (18.9)	16 (25.4)	9 (75.0)	1 (8.3)	78 (32.6)
Bachelor's degree	21 (33.3)	41 (45.6)	31 (49.2)	1 (8.3)	1 (8.3)	95 (39.7)
Master's degree	6 (9.5)	20 (22.2)	8 (12.7)	2 (16.6)	9 (75.0)	45 (18.8)
PhD	0 (0.0)	4 (4.4)	5 (7.9)	0 (0.0)	1 (8.3)	10 (4.1)
Other	1 (1.6)	7 (7.8)	3 (4.8)	0 (0.0)		11 (4.6)
Employment						
Students	63 (100.0)	9 (10.0) *	0 (0.0)	12(100.0)	6 (50.0) *	90 (37.6)
Employed or self-employed	0 (0.0)	68 (75.6)	7 (11.1)	0 (0.0)	6 (50.0)	81 (33.8)
Unemployed	0 (0.0)	11 (12.2)	1 (1.6)	0 (0.0)	0 (0.0)	12 (5.02)
Retired	0 (0.0)	0 (0.0)	55 (87.3)	0 (0.0)	0 (0.0)	55 (23.01)
Other	0 (0.0)	1 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.41)

Note: * The students who live with children were included in the family member group.

7.2.3 Equipment and materials

A screening survey of recruiting participants was developed on the Qualtrics Survey software (Qualtrics.com), and the survey link was published on the Prolific participant recruitment website (prolific.co) (see Appendix E.1.2). It comprised some basic questions to ask participants whether they met the inclusion criteria and were suitable to participate in the main study. The questions were mainly close-ended questions, such as participant age, current status of studying/working and living, country of origin and living, and whether they were involved in any food-related activities. On average, the survey required one minute and 44 seconds to be completed. Each participant who completed the screening survey received a reward of GBP 0.63 via Prolific.
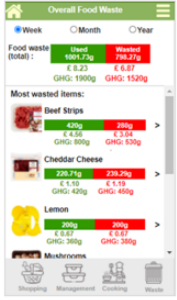
The main questionnaire was used to evaluate the design, usability and motivational potential of WasteLess app, which was deployed online through the Qualtrics Survey Software (see Appendix E.1.5). It comprised four sections: introduction, screening questions, demographic questions and questions about attitudes and behaviour of food practice and waste, and questions about the WasteLess app.

The introduction section provided an overview of the study including its purpose, expected time to complete the questionnaire and reward for taking part. It also included a statement to ensure the anonymity and confidentiality of collected data and the contact details of the researchers.

The screening questions section was similar to that in the screening survey used on Prolific. It includes basic questions to ensure participants met the inclusion criteria to take part in the survey. This is because the questionnaire was distributed to Prolific participants, but also to non-Prolific users who did not complete the initial screening survey. The Demographic section collected participants' personal information and information about their general attitudes and behaviour around food practice and waste. The questions about attitudes and behaviour of food practice and waste were the same as asked in the previous studies in understanding and investigation phase.

The evaluation of WasteLess app was the key section of the questionnaire. It comprised a brief description of the WasteLess app, and four sections: Food Shopping, Food Management, Cooking, and Food Waste, which corresponded to the sections of the WasteLess app. Each section included a series of screenshots of the function screens, with brief text explanations of the function. Participants were asked to rate the likelihood they would use the function on a Likert item from "very unlikely" (scored as 1) to "very likely" (scored as 7). In addition, for every likelihood rating participants were invited to add comments in an open-ended question (see Figure 7.1).

The rating questions on the likelihood they would use functions were all compulsory. However, the open-ended questions for adding comments on the likelihood ratings were optional.

Figure 7.1 Example of how function including Likert item of likelihood and adding comment questions were presented to participants in the questionnaire

On average, the questionnaire took 45 minutes to complete. Each participant who completed the questionnaire received a reward of GBP 5.00 via Prolific or a gift voucher from a range of online options. For participants who completed the survey in Saudi Arabia, as it was difficult to find an appropriate reward and they were happy to do it for free.

A pilot questionnaire was conducted with three participants to check if the questions were understandable and appropriate as well as how long participants could take to answer the questionnaire.

For the analysis, NVIVO (qsrinternational.com) was used for qualitative analysis; SPSS and Excel were used for quantitative analysis.

7.2.4 Procedure

The survey was advertised and published online in March and April 2021.

For participants recruited via Prolific, the screening survey was advertised first. After completing the screening questionnaire, participants who met the inclusion criteria

were invited to answer the main questionnaire. For participants recruited via other methods, the link of the main questionnaire was provided in the invitation message.

The survey started with agreement page including a description of the nature of the study, a statement of the confidentiality and anonymity of data. Participants were asked to check the consent box as agreeing to participate in the study and start the questionnaire. Then, participants were asked the screening questions to check if they met the inclusion criteria. If participants were suitable to take part in the study, they would be directed to the next sections.

Before submitting the questionnaire, participants were asked to provide their email address if they wished to receive a gift voucher.

7.2.5 Data analysis

7.2.5.1 Data preparation for analysis

Before making any analysis, preparation of the collected data was conducted in three stages. The first stage includes the following steps:

- The data files from Qualtrics were anonymised to remove any identifiable information about the participants, then

- Participants' demographic data was used to assign them to only of the target user groups: students, family members (living with children), or older people (living without children).

- To avoid overlap between the student and family member groups, student participants who were living with children were considered as part of the family member group rather than the student group. This is because of the possibility of the presence of children affecting user behaviour related to food practices and waste.

- Two participants potentially in the British older people group were living with children, so their responses were excluded from the analysis. This resulted in a total of 294 participants (see Table 7.3).

Table 7.3 Number of participants after re-categorising user groups

Culture	Life stage	Number
British	Students living without children in the UK	83
	Family members living with children in the UK	118
	Older people living in the UK	69
Arab	Students living without children in the UK	12
	Family members living with children*	12

Note: * This includes Arab family members living with children either in the UK or Saudi Arabia.

In the second stage, the remaining 294 responses were carefully checked in order to exclude any participant who did not answer the questionnaire in a meaningful way. The strategy for rejecting any participants used three criteria in the following sequence:

- Response time
- Answers to initial open-ended questions
- Demographic information

After that, the following steps were conducted:

First step, any participant who took less than 10 minutes in answering the survey was rejected.

Second step, I carefully reviewed participant answers to the initial four open-ended questions in the questionnaire: (for more details, see Appendix E.1.5)

- What do you think you would find in food shopping group?
- What do you think you would find in food management group?
- What do you think you would find in cooking group?
- What do you think you would find in food waste group?

Then, if a participant:

- Provided meaningless answers in any of these questions, they were rejected immediately,
- Provided very minimal or odd answers, then I and my supervisor reviewed both participant ratings and open-ended answers to the other questions. If a participant provided meaningless answers in any of the other open-ended questions or if they provided the same rating for all or most questions, they were rejected.

Third step, I carefully reviewed answers to the demographic questions. If a participant provided very clearly conflicting answers to the demographic questions, they were rejected. For example, a one participant answered to one question was that they lived alone, however they answered that they were living with one or more children for other question.

Table 7.4 illustrates the resulted number of participants for each user group after these data cleaning strategies, which resulted in a total of 239 participants.

Table 7.4 Final number of participants of this study

Culture	Life stage	Number
British	Students living without children in the UK	63
	Family members living with children in the UK	89
	Older people living in the UK	63
Arab	Students living without children in the UK	12
	Family members living with children*	12

Note. * This includes family members living with children in the UK or Saudi Arabia.

The third stage of data preparation was the thematic analysis. I used NVIVO as the qualitative data analysis tool, and a NVIVO project was created for each user group. Within each project, I uploaded participants' answers to all the open-ended questions related to WasteLess functions.

7.2.5.2 Quantitative data analysis

Quantitative was conducted for data collected from the demographic section about food practice and waste; and participant likelihood ratings of using WasteLess functions. Although the ratings were often not normally distributed and did not have equal variances, given the large sample of participants, analysis of variance was used in the data analysis, using the Geisser-Greenhouse correction for unequal variances. In the debate on whether 7 point rating scales are suitable, given the number of points on the scales and the large sample size, I have assumed that the data are at least pseudo-interval and appropriate for parametric analysis (Norman, 2010).

A principal components analysis (PCA) was to answer RQ4.1: What are the different groups of functionality proposed for the WasteLess app and their importance for potential users at different life stages? This was conducted to find the groupings of the WasteLess functions, simplify the data and reduce the number of functionality

support to a smaller number of dimensions. Confirmatory factor analysis (CFA) was conducted to assess the fit of the resulting model, its validity and reliability.

The quantitative data was analysed using Statistical Package for the Social Sciences (SPSS) version 28 and Analysis of a Moment Structures (Amos) version 28.

7.2.5.3 Thematic data analysis

Two forms of thematic analysis were used in this study to analyse answers submitted for the open-ended questions for each function of the WasteLess app: Codebook thematic analysis (Crabtree & Miller, 1999) was used to answer RQ4.2: To what extent do the opinions of potential users at varying life stages and from different cultures support the BCW intervention functions and persuasive technologies proposed for the WasteLess app? This was to investigate participants' opinions on different interventions and persuasion support provided within the WasteLess functions.

In addition, an inductive thematic analysis (Braun & Clarke, 2006) was used to answer RQ4.4: What are the usability and accuracy issues with the prototype of the WasteLess app? As the data set included information about other aspects of the WasteLess evaluation in addition to the intervention supports, the inductive analysis was used to investigate participants' reactions to the design of the app.

Codebook thematic analysis

As mentioned above, codebook thematic analysis was used to answer RQ4.2. This analysis was conducted based on the procedure set out by Crabtree and Miller (1999). The procedure was similar to that described in Chapter 3, (see Section 3.2.5.2), but with some differences described below.

Step 1 (Create the codebook) in the analysis of this chapter was similar to that conducted in Chapter 3 in terms of using pre-defined themes and creating a codebook in advance of the analysis. This included using the same structure of a codebook, which included four components (code labels, full definitions, descriptions, and examples). However, unlike the analysis in Chapter 3, before moving to the second step in the analysis, in this chapter I calculated the intercoder reliability.

For Step 2 (Code the texts), I used NVIVO for the coding process whereas in Chapter 3, I coded the data manually. This is due to the larger corpus of material to code in this study.

For Step 3 (Sort the coded segments, including creating counts of the frequency of different code occurrences to identify key areas), I counted the frequency of different code occurrences to establish a quantitative estimate of participants' views of the intervention-related support provided by each WasteLess function.

As in Chapter 3, I did not implement Step 4 (Connect and corroborate related texts).

Using these steps as a guide, I undertook the following process:

(1) I created a codebook in advance of conducting the analysis. This consisted of codes that were inspired by the different intervention and persuasion supports. The interventions functions proposed by Michie et al. (2011) and applied in the design were Education, Enablement, and Persuasion. In addition, the specific persuasion techniques provided by Oinas-Kukkonen and Harjumaa (2008, 2009) and Fogg (2003), which were applied in the design were Personalization, Tracking, Cooperation, Competition and Reduction. These intervention and persuasion supports were used as the initial set of pre-defined themes as theory-driven codes, using a deductive approach.

Further, sub-themes were used about more specific levels of Persuasion namely Personalization, Tracking, Cooperation, Competition and Reduction. Similar to the codebook created for Study 1 and Study 2, for the codebook of this study, I used four components: code labels, full definitions, descriptions (including inclusion criteria), and examples.

Following the recommendations by Miles and Huberman (1984), I coded some pages of the text to test the codebook and then modified the codebook accordingly. For this analysis, I conducted an initial test of the codebook with 10% of the data. This resulted in finding a one additional sub-theme (i.e., Reminder) which emerged from the data (inductively elicited sub-theme). Accordingly, I modified the codebook to include the additional sub-theme (Appendix E.1.3). The hierarchal

framework of the themes is provided in Figure 7.2. Table 7.5 provides further descriptions of the sub-themes illustrated in Figure 7.2.
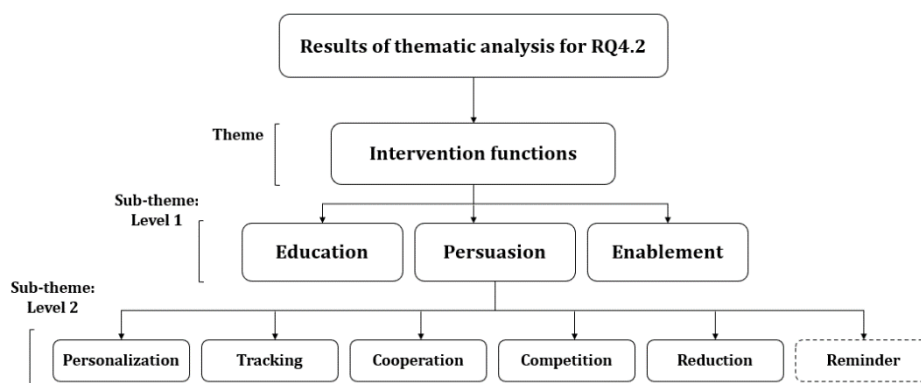
Figure 7.2 Pre-defined and emergent themes to answer RQ4.2
Note: Inductive sub-theme represented by a dotted line.

Table 7.5 Description of sub-themes used in codebook thematic analysis (O-K & H: Oinas-Kukkonen & Harjumaa, 2008, 2009)

Theme	Intervention functions	Reference
Sub-theme level 1	**Education** means increasing knowledge or understanding of people.	Michie et al. (2011)
	Enablement means increasing means or reducing barriers to increase capability or opportunity.	Michie et al. (2011)
	Persuasion means using communication to induce positive or negative feelings or stimulate action.	Michie et al. (2011)
Sub-theme level 2	**Personalization** is providing users with personalized features or contents. Note. In the WasteLess app personalization is supported by considering users personal preferences for food-related practices and activities.	O-K & H
	Tracking is providing information to users about their past behaviour regarding food consumption and waste.	
	Cooperation is providing a way for users to cooperate with each other in performing the target behaviour.	O-K & H
	Competition is providing ways for users to compete with each other, towards performing the target behaviour.	O-K & H
	Reduction is simplifying the target behaviour by reducing the complexity of a task.	Fogg
	Reminder* refers to prompting users to perform the target behaviour. Note. reducing food waste is not a simple behaviour that can be prompted with direct reminders. Thus, reminding in this context refers to indirect reminders such as remind users what food they have at home or what food items they need to buy.	O-K & H

Note: * Reminder is not a pre-defined sub-theme.

Miles and Huberman (1984, 1994) suggested for the development of the codebook, individual researchers should code a number of pages of the text independently to test for intercoder reliability and the utility and suitability of the codes. To undertake such an analysis and to calculate the intercoder reliability, five functions were chosen across the range of Wasteless functions. For each function, approximately 10% of the comments was selected at random (O'Connor & Joffe, 2020).

An independent coder (my supervisor) was given the codebook and coded the sample of comments blind. Overall intercoder reliability (calculated as a simple percentage of agreements) was 84.9%, which for complex content is considered acceptable. For a number of the coding categories (Cooperation, Reduction, Reminder and Tracking), agreement was 100%. However, there were two codes on which there was clearly some difference in interpretation: Enablement and Education. The two coders discussed the definitions and boundaries of these two coders to ensure that further coding was consistent (detailed data in provided in Appendix E.1.4). Thus, there was no need to modify the codebook.

(2) I then coded all the text. I used NVIVO for the coding process. I started by carefully reading and re-reading all the answers of each WasteLess function, and categorised them under the appropriate code, intervention function (sub-theme level 1) or persuasion sub-theme (sub-theme level 2), (see Table 7.5). After that, I reviewed all the material that had been categorised under each code, in order to ensure that they were related to it.

(3) I then counted the frequency of comments related to the intervention functions and persuasions occurrences in WasteLess functions, to establish participants' views of the support provided by each WasteLess function in relation to intervention functions and persuasions. This includes the following:

For each participant group:

- Calculate the total number of comments given for all WasteLess functions related to an intervention or persuasion, then

- For each WasteLess function, calculate the number of comments related to each intervention or persuasion, then

- Calculate the percentage of comments received by each WasteLess function related to each intervention or persuasion. This based on the total number of comments received from all WasteLess functions related to an intervention or persuasion, then if

    o The percentage of comments received by a WasteLess function was less than 10% of the total comments provided from WasteLess functions related to the intervention, the WasteLess function is not considered as providing that intervention support for the participant group.

    o The percentage of comments received by a WasteLess function was 10% and above of the total number of comments provided from WasteLess functions related to the intervention, the WasteLess function is considered as providing that intervention support for the group.

To further investigate the importance of each intervention and persuasion for participant groups (RQ4.3), the data from the 7-point Likert items of WasteLess functions were analysed quantitatively, to assess quantitatively each participant group's view of the support provided by WasteLess functions for each intervention and persuasion.

I did not implement Step 4 of the Crabtree and Miller process. This is because I do not want to make connections between the themes.

Data that were not coded under the themes in this analysis, were categorised under uncoded data and used as input for to the inductive thematic analysis (see the following section).

Inductive thematic analysis

The data coded for the codebook thematic analysis formed only a limited set of features of the dataset. Therefore, I used inductive thematic analysis to answer RQ4.4. In comparison to the thematic analysis already described in this chapter (Codebook thematic analysis) or in Chapter 3 (Section 3.2.5.2) and Chapter 4 (Section 4.2.5.2), this

was a broader inductive thematic analysis. I followed the Clarke and Braun (2006) process, and conducted the analysis in the following six steps:

(1) Familiarizing myself with the data**:** I started by immersing myself in the data by reading the comments repeatedly. Through this step, I developed some ideas about different aspects for coding the data.

(2) Generating initial codes: I re-read the uncoded data and started coding them using an inductive approach. I started to produce initial codes from the data, by organising the data into meaningful groups (Tuckett, 2005). Using NVIVO, I coded meaningful extracts numerous times, as appropriate, by tagging and naming selections of the text within each code (Clarke & Braun, 2006). However, the meaningless extracts were left uncoded. As a result of this phase, the inductive codes were moved to Step 3, to search for new potential themes.

(3) Searching for new themes after coding the data: I started sorting the inductive codes to form initial themes. This resulted in one main theme namely "design evaluation", and five sub-themes, namely "technological barriers", "trust", "clarity", "simplicity", and "similar apps". As a result of this phase, I produced the initial inductive themes and sub-themes which I would later assess to see if they were sufficiently frequently mentioned by participants (10%) to be included in the overall thematic analysis.

(4) Reviewing themes after producing initial themes and sub-themes: I started reviewing and refining the themes at two levels. First, I read the extracted data for each theme to check whether they formed a coherent pattern. At this level, if a potential theme seemed to form a coherent pattern, I moved the theme to the second level of this step. However, if the potential theme did not form a coherent pattern, I reviewed the theme data. So, if some of the data fit other existing themes, then I mapped the data to the appropriate related themes. However, if some of the data formed a new pattern that was not covered by an existing theme, I mapped the data to a new theme. If neither case was applicable, I discarded the theme from the analysis. Second, I re-read the whole dataset to check if the potential themes provided accurate representation of the dataset as a whole. In addition, during re-reading, I tried to code any previously uncoded data within the themes. This resulted in a refined thematic map of the data-

driven themes (see Figure 7.3). It shows one main theme namely "design evaluation", and three sub-themes, namely "clarity", "accuracy", and "technological barriers".

(5) Defining and naming themes after having the final thematic map of data driven themes: I started defining and refining the themes. This also included describing each theme and determining which aspects of the data were captured by that theme. So, a hierarchal framework of the themes and sub-themes was created (see Figure 7.4). As a result of this step, the complete set of final and refined emerged themes were created.
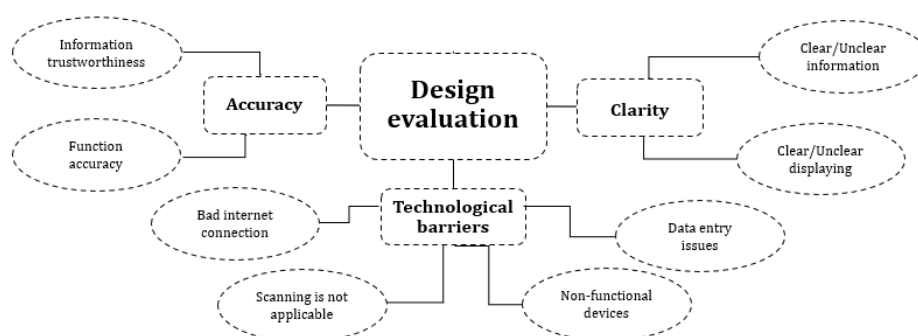
Figure 7.3 Final thematic map of the inductive themes
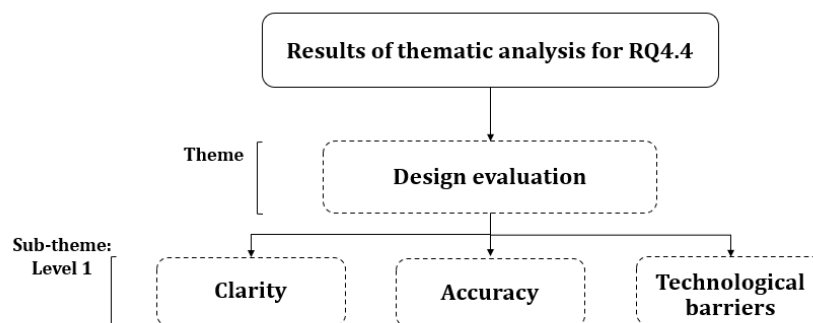
Figure 7.4 Final results of inductive thematic analysis to answer RQ4.4

7.3 Results

The results of the quantitative analysis of the ratings of the likelihood of using WasteLess functionality are presented first (Section 7.3.1). Then, the results of the importance of WasteLess function components (Section 7.3.2). After that, the results of participants' views of intervention and persuasion supports provided in the WasteLess app, based on the qualitative analysis (Section 7.3.3). Then, the results of the importance of interventions and persuasions support towards reducing their food

waste for users (Section 7.3.4). Finally, the results of the evaluation of the design of the WasteLess app, based on a qualitative analysis are presented (Section 7.3.5).

Participants were asked questions about their attitude and behaviour around food practice and waste, which were similar to previous studies. The results of the quantitative analysis about these questions can be found in Appendix E.1.6.

For clarity of presentation in this chapter, I have modified the name of some WasteLess functions, see Table 7.6.

Table 7.6 Function names in Chapter 6 and in this chapter

Function name in Chapter 6	Function name in this chapter
Check at Home Food	Check Food: Home
Check Food Stock	Check Food
Food Item Waste	Monitor Particular Foods
Goal Setting- monitor a goal	Monitor Goal
Compete with friends	Join a Competition
Meal Plans- Shopping list	Meal Plan: Shopping List
Extending Shelf Life	Extend Food Shelf Life
Longer Lasting Food	Advice: Longer Lasting Food
Food Buying Advice	Advice: Food Buying
Food Storage Advice	Advice: Food Storage
Food Safety Advice	Advice: Food Safety
Food Labels	Advice: Food Labels
Goal Setting- set a goal	Set Goal

7.3.1 Underlying groups of ratings of the likelihood of using WasteLess functions (RQ4.1)

To investigate RQ4.1 (What are the different groups of functionality proposed for the WasteLess app and their importance for potential users at different life stages?), a principal components analysis (PCA) was conducted on the likelihood of use ratings of 32 questions about WasteLess functions. This was conducted to investigate how participants group the WasteLess functions in terms of how likely participants say they would use them. This is taken to reflect their opinion of the usefulness of the group of functions for them. Using the resulting groups will eliminate the Type I errors, which would arise from analysing each of the 32 functions separately.

As illustrated in Table 7.7, the PCA yielded six components which explain a total of 60.77% of the variance. Questions with component loadings more than 0.400 were considered to contribute to a component. This resulted in 28 out of the 32 questions about WasteLess functions being loaded into these six components (see Table 7.7).

Table 7.7 Component loadings of the WasteLess functions in the principal components analysis

WasteLess function	Component loading					
	Comp1 Checking and managing food at home	**Comp2** Community aspects of food waste reduction	**Comp3** Planning meals and sharing them with others	**Comp4** Extending food shelf life	**Comp5** Making and using shopping lists	**Comp6** Advice on buying and storing food
% of variance	34.32	7.84	5.37	4.81	4.25	4.16
Check Food: Home[1]	.429	.096	-.111	-.026	.473	-.192
Check Food: By Storage Area	.547	.138	-.105	-.084	.320	.053
Check Food: By Food Item	.577	.064	-.076	-.019	.327	-.093
Recipes	.658	.039	-.233	.007	-.220	.164
Using Up Food	.519	-.061	-.072	.083	.185	.174
Overall Food Waste	.550	.025	.065	-.085	.247	.291
Monitor Particular Foods	.515	.103	.076	-.001	.115	.266
Monitor Goal	.403	.208	-.019	-.258	.180	.352
Join a Competition	-.222	.453	-.272	-.042	-.018	.333
Food Sharing as a Donor	.068	.741	-.098	-.140	.136	.030
Food Sharing as a Receiver	-.090	.801	.139	.183	-.059	-.035
Food Sharing: Public Spaces	.055	.845	.007	.058	-.066	-.066
Food Sharing: Private Spaces	-.010	.822	-.114	-.125	.008	-.006
Shopping List: Share	-.078	.072	-.694	.005	.308	-.046
Meal Plans[1]	.556	.057	-.530	.086	-.159	.066
Meal Plan: Shopping List	.483	.099	-.578	.254	-.258	-.055
Meal Plan: Share in Household	.014	.061	-.831	-.011	.091	.051
Meal Plan: Share outside Household	-.055	.038	-.697	-.102	.041	.222
Shopping List: Add Item Manually	-.243	.057	-.029	.799	-.010	.064
Extend Food Shelf Life	.236	-.061	-.034	.432	.117	.299
Set Up	.071	-.038	-.328	.258	.444	-.039
Shopping List: Completely Used Up	.012	.034	-.039	.024	.724	.187
Shopping List: Nearly Used Up	-.072	.029	-.087	.057	.789	.151
Advice: Longer Lasting Food	.197	.053	.004	-.108	.253	.426
Advice: Food Buying	.025	.033	-.008	.209	.113	.557
Advice: Food Storage	.377	.028	.053	.229	-.135	.548
Advice: Food Safety	-.052	.002	-.083	.059	.048	.730
Advice: Food Labels	-.047	.033	-.141	-.108	.003	.690
Shopping List Search Favourite[2]	.214	-.082	-.129	.383	.358	.116
Shopping List Scan Food Item[2]	.264	.160	.196	.364	.152	-.080
Event Plan[2]	.192	.185	-.379	-.187	.033	.269
Set Goal[2]	.345	.202	.001	-.286	.229	.398

Notes: 1 = item loaded in two components, however it categorised under the more conceptually related component. **2 =** No loading over .500, so not included on any factor.
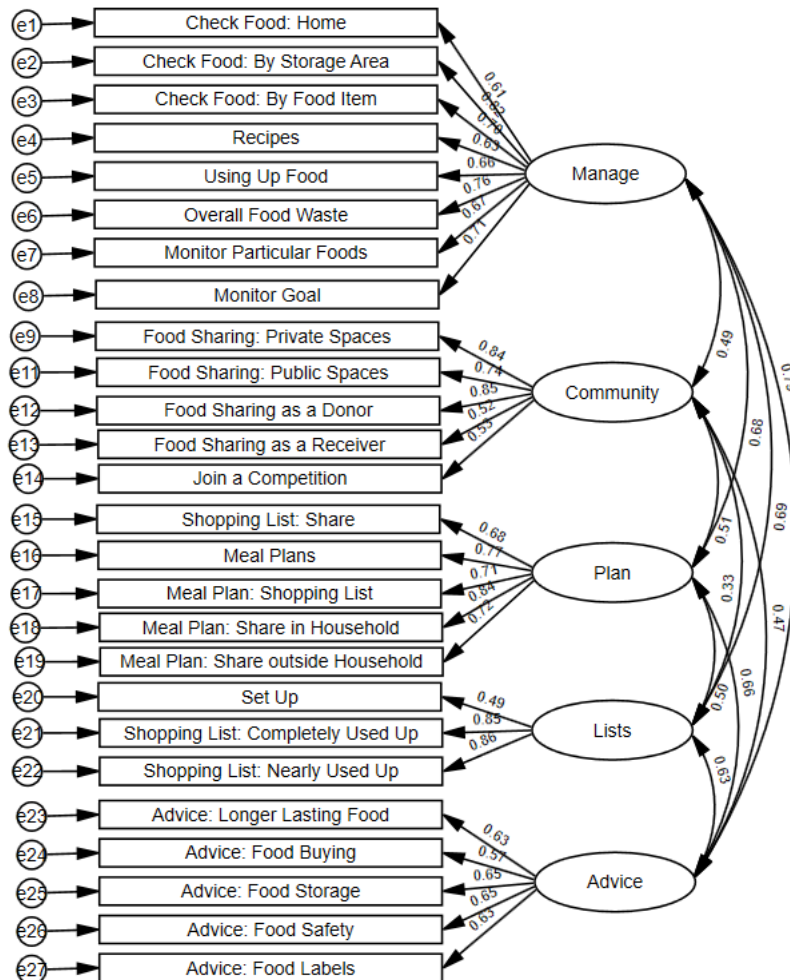
Figure 7.5 Five-factor model of WasteLess functions (Model A)

Note: Factor loading displayed in the figure are standardized estimates. **Manage** = Checking and managing food at home, **Community** = Community aspects of food waste reduction, **Plan** = Planning meals and sharing them with others, **Lists** = Making and using shopping lists, **Advice** = Advice on buying and storing food.

To assess the goodness of fit of the resulting model, its construct validity and reliability, a confirmatory factor analysis (CFA) was conducted (Brown, 2006) on the five-factor model with 26 items of WasteLess functions (i.e., Model A). Although the PCA resulted in six-factor model with 28 items, one component (i.e., Component 4) was excluded because it does not conceptually make sense to the model.

The cut-off levels for the indices of a good model fit are described in Section 5.3.2.1, Chapter 5. The results of the CFA showed that Model A did not have a good fit (see Figure 7.5), as indicated by the following fit indices (x^2 = 754.385, with p-value = 0.000; x^2/df = 2.610; CFI = 0.849; TLI = 0.830; RMSEA = 0.082; and PCLOSE = 0.000).

To investigate whether a better fitting model could be obtained, Model A was revised iteratively while maintaining conceptually sensible groups. This was conducted in the following steps:

- Remove items with factor loading less than 0.500, as recommended by Hair et al. (2010). Removing was done item by item in Amos, as this might affect the factor loading of other items. I start by removing the item "Set Up" from Component 5, which had the lowest factor loading (0.49). Although 0.49 is very close to 0.500, but the item "Set Up" does not conceptually fit with other items in the that component as it is about shopping lists.

- Modification indices (MIs) were also used to improve the model by making four correlations between unobserved variables (e16 - e17; e6 - e7; e2 - e3; and e1 - e3) (see Figure 7.5).

Therefore, I used two measures in the revision of Model A: factor loadings and modification indices. This resulted in a revised model (Model B, see Figure 7.6), which was further assessed in terms of the goodness of model fit. The results showed that Model B has a good model fit, as indicated by the fit indices (x^2 = 522.876, with p-value = 0.000; x^2/df = 2.003; CFI = 0.913; TLI = 0.900; RMSEA = 0.065; and PCLOSE = 0.002). As illustrated in Figure 7.6 Model B is a five-factor model with 25 items. Although the Chi-square (with p-value < 0.000) is still significant, according to Vandenberg (2006), Chi-square is very sensitive to sample size, and if the sample is large, this can result in statistically significant chi-square.

Assessment of the validity and reliability of the constructs of Model B was conducted. Convergent validity and discriminant validity were conducted to assess the construct validity of the model, whereas composite reliability was conducted to assess the construct reliability.

Convergent validity is measured by considering factor loading of the items, the average variance extracted (AVE) and composite reliability (CR) (Hair et al., 2010). As shown in Figure 7.6, all factor loadings of all statements were more than 0.5, which is the acceptable value according to Hair et al. (2010). In addition, the results of the AVE showed that three components achieved the convergent validity (see Table 7.8). Because, according to Fornell and Larcker (1981), an AVE equal or more than 0.5

indicates a good convergent validity. However, the AVE of Component 1 was slightly below 0.5 (0.469), and the AVE of Component 5 was also less than 0.5 (0.389)

Further, the results showed that the composite reliability was achieved for all components. This is because the value of composite reliability (CR) for all components were more than 0.7 (Fornell & Larcker, 1981) (see Table 7.8). As mentioned in Chapter 5 (Section 5.3.2.1), according to Fornell and Larcker, 1981, based on the result of CR alone, the researcher might conclude that the convergent validity of the construct is adequate.
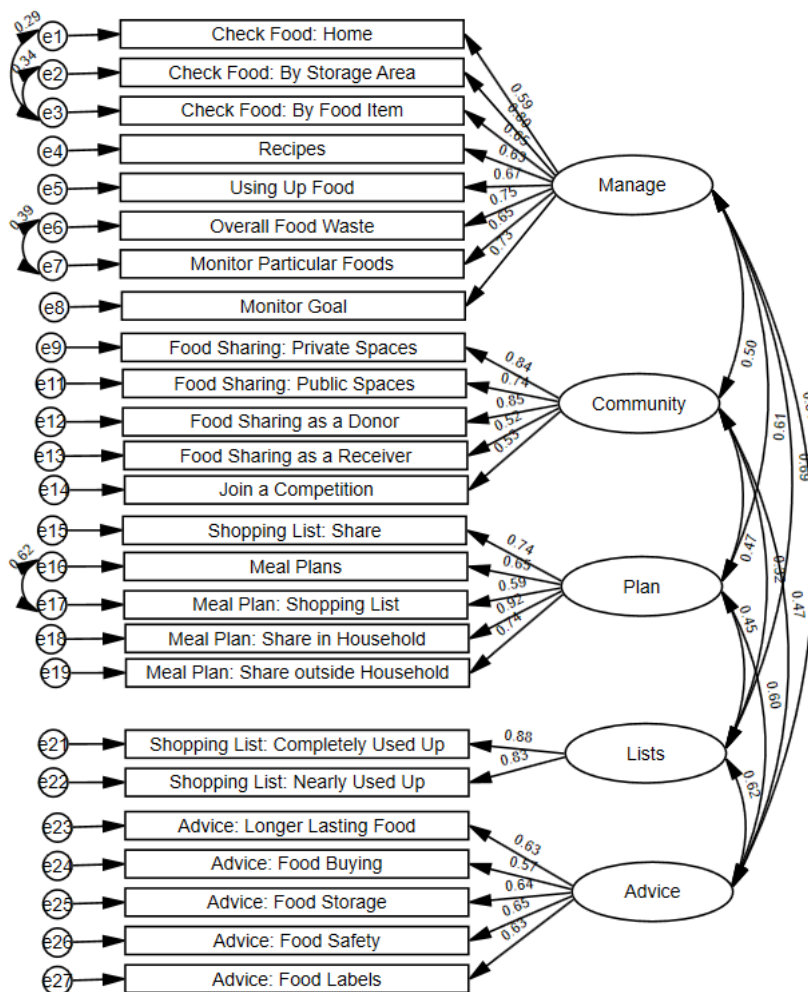
Figure 7.6 Five-factor model of WasteLess functions (Model B)

Note: Factor loading displayed in the figure are standardized estimates.

The discriminant validity (DV) is calculated using the square root of the AVE, and then compared with the correlation of the latent constructs. The results showed that the discriminant validity was achieved for all components, except component 1 where the

DV is less than the correlation between Component 1 and 5 and between Component 1 and 4.

For construct reliability, the composite reliability (CR) was used as indicator. Further Cronbach's alpha was also calculated for each component in Model B. As mentioned above and illustrated in Table 7.8, composite reliability was achieved; and the values of Cronbach's alphas for all components were not below 0.6, which is the minimum acceptable value according to Griethuijsen et al. (2014).

This analysis concluded that Model B has a reasonably good level of construct validity and reliability, although discriminant validity was not achieved for all components.

Table 7.8 Results of convergent validity of the five components

Component	Average variance extracted (AVE)	Composite reliability (CR)	Cronbach's Alpha
Manage	0.469	0.875	0.879
Community	0.508	0.832	0.823
Plan	0.540	0.851	0.855
Lists	0.737	0.848	0.846
Advice	0.389	0.761	0.758

Table 7.9 Results of discriminant validity against correlations of the five components

Component	Discriminant validity (DV)				
	Manage	Community	Plan	Lists	Advice
Manage	0.685				
Community	0.503	0.713	0.474		
Plan	0.615		0.735	0.451	
Lists	0.686	0.317		0.858	
Advice	0.810	0.475	0.601	0.615	0.624

Figure 7.7 summarises the model of food waste reduction functionalities, developed in this study. The model involves five components and 25 functions for food waste reduction. Each component depicted in a different colour. The large hexagons are the components, and the small hexagons are the individual items within the component. The colours are used to distinguish between the different components.

Figure 7.7 Model of app-based functionality supports for food waste reduction

7.3.2 Importance of WasteLess function components (RQ4.1)

To investigate RQ4.1 (What are the different groups of functionality proposed for the WasteLess app and their importance for potential users at different life stages?), importance was measured by the components based on ratings of likelihood of use.

To investigate the importance of the five components of WasteLess functions, the mean score of the ratings contributing to each component was calculated for each participant.

A two way mixed ANOVA was conducted for only British participants, because there was no older people group from Saudi Arabia. The between participant variable was *Life stage* (student, family member or older person) and the repeated measures variable was Wasteless function component.

There was a significant main effect for WasteLess Function with a large effect size, $F_{(3.24, 763.91)} = 69.72$, $p < 0.001$, $\eta^2 = 0.228$. Figure 7.8 illustrates the mean scores on the five components. Bonferroni post hoc analysis showed that all components differed significantly from each other apart from Lists and Advice. So, Checking and Managing food was rated the most likely to be used, with Shopping Lists and Advice on buying

and storing food significantly less likely, Planning meals significantly less likely again and Community aspects significantly the least likely to be used.
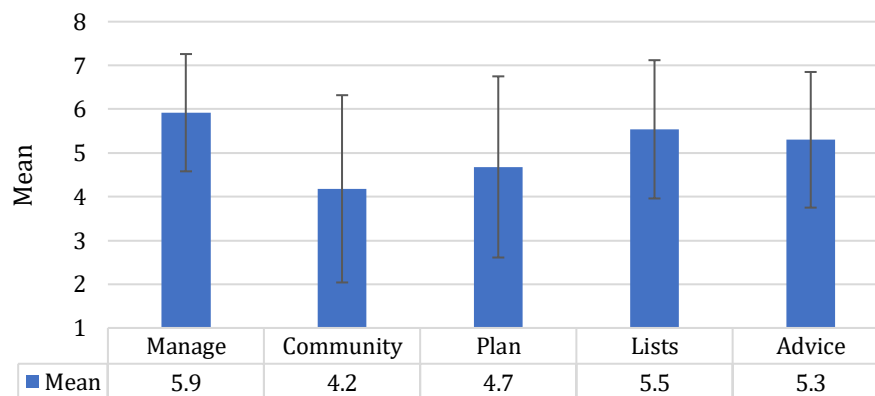
Figure 7.8 Mean scores (and standard deviations) for WasteLess function components for all participants

There was also a significant main effect due to *Life stage* but with a small effect size, $F(1, 236) = 6.38$, $p = 0.002$, $\eta^2 = 0.051$. Figure 7.9 illustrates the mean scores (across all components) for the three life stages. Bonferroni post hoc analysis showed that students and family members did not differ significantly in their likely of using the Wasteless components ($p = 1.00$), but both these groups were significantly more likely to use them than older people (Students vs Older People: $p = 0.015$; Family members vs Older People: $p = 0.002$).
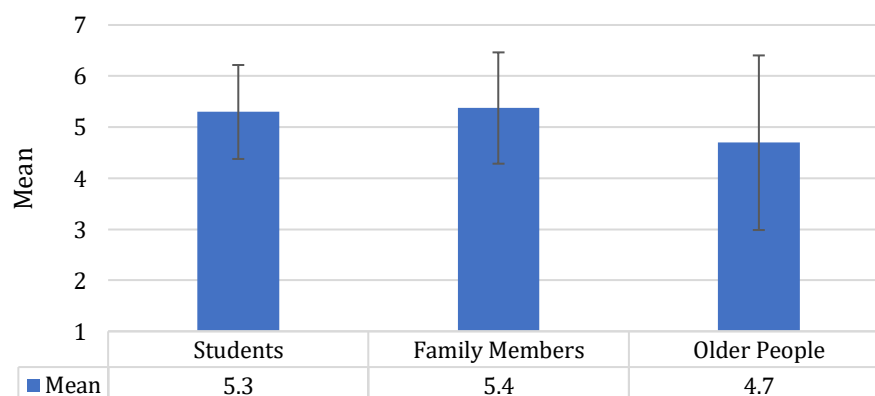
Figure 7.9 Mean scores (and standard deviation) for all WasteLess Function Components for participants at the three life stages

There was also a significant interaction between Component and Life Stage but with a small effect size, $F_{(6.47, 763.91)} = 3.42$, $p = 0.002$, $\eta^2 = 0.028$. Figure 7.10 illustrates the mean scores of each component for the three life stages. The most interesting significant differences in the Bonferroni post hoc analysis were that older people were significantly less likely to use both the Manage and Community functions compared to the other two groups (For Manage: Students vs Older People: $p = 0.004$; Family members vs Older people: $p = 0.003$; For Community: Students vs Older People: $p = 0.032$; Family members vs Older people: $p = 0.010$). Older people were also significantly less likely to use Plan functions than students ($p < 0.001$). On the Lists and Advice functions there were no significant differences between the groups.

	Manage	Community	Plan	Lists	Advice
Student	6.1	4.4	4.6	5.7	5.7
Family Member	6.1	4.5	5.2	5.6	5.4
Older Person	5.4	3.5	3.9	5.2	5.5
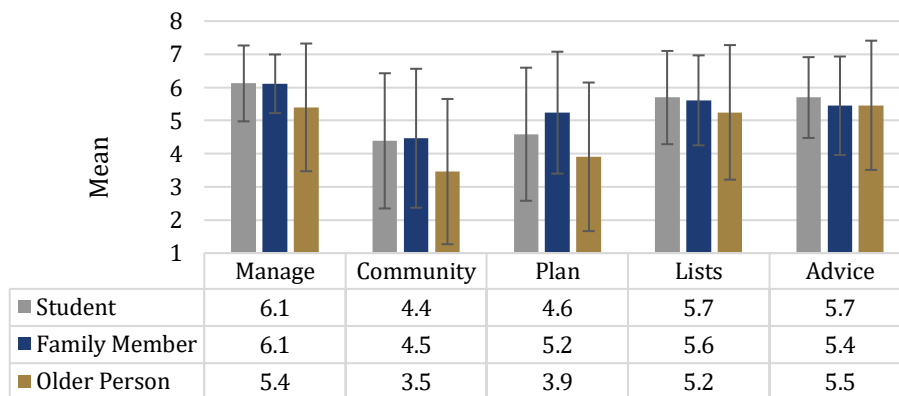
Figure 7.10 Mean scores (and standard deviation) for WasteLess Function Components for participants at the three life stages

7.3.3 Participants' views on the intervention and persuasion supports proposed in the WasteLess app (RQ4.2)

To investigate RQ4.2 (To what extent do the opinions of potential users at varying life stages and from different cultures support the BCW intervention functions and persuasive technologies proposed for the WasteLess app?), the codebook thematic analysis of the open-ended questions was used (Section 7.2.5.3). A participant group's views of the support provided in WasteLess function, related to intervention and persuasion, is indicated by 10% and above of comments provided for the function (see 7.2.5.3, Step (3) in Codebook thematic analysis). Therefore, this section presents the WasteLess functions provide support for intervention and persuasion with 10% and above of comments given by any group.

The theme of relevance here, which resulted from the codebook thematic analysis, is Intervention Functions which has three Level 1 sub-themes:

- Persuasion, education, and enablement

The Persuasion sub-theme in turn has six Level 2 sub-themes

- Personalisation, tracking, reduction, cooperation, competition, reminder

Additional details including number of comments provided by participants for each theme can be found in Appendix E.1.7.

7.3.3.1 Persuasion

Persuasion 1: Personalization

Set Up is the only Wasteless function that was initially designed to provide personalization support for users. Participants made comments on this function, which were relevant to personalization support (see Table 7.10, for details see Table E.9, Appendix E.1.7).

Table 7.10 Comments from participants about the Set Up function which are relevant to the personalisation sub-theme

Level 2 Sub-theme Description	Example Comments
Allow users to set general preferences	Perhaps some more choices based on age or background (BO55)
	Offering the WasteLess in variety of different languages (BF56)
Allow users to set particular diets or dietary goals	I think it would be nice to set a calorie goal if you're trying to lose weight. (BS39)
	I [am] setting a goal or intention to only eat meat a certain number of days a week that one could track could be useful (AS8)
Provide information about available food stock at households	Dates on food to help keep track of when you need to eat things by. (BS7)[11]
Provide budget management support	Maybe a budget you have every week so you can see if you're going over budget too? (AS12)
	Prefer to shop supermarket (Waitrose) or inexpensive (Aldi/Lidl) (BS14)
Allow users to set personal cooking preferences	Type of available cooking equipment - e.g., if you have access to a microwave/oven etc (or which you prefer using if both). (BS31)
	Time you can spend cooking. Meals you prioritise making (e.g., my son is at nursery so the priority for our shopping is a healthy home-cooked meal in the evening (BF8)

Note: AS refers to Arab students, BS refers to British students, AF refers to Arab family members, BF refers to British family members, and BO refers to British older people.

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[11] This kind of functionality was provided in the prototype, but participants commented on it.

Persuasion 2: Tracking

Some of the Wasteless functions were initially designed to provide tracking support for users, namely:

- Advice: Food Buying
- Event Plan
- Check Food (By Storage Area, By Food Item)
- Overall Food Waste
- Monitor Particular Foods
- Set Goal (and monitor it)

Participants made comments on these functions, which were relevant to tracking support. For example, tracking food consumption and waste, monitoring their progress towards food reduction goal. In addition, providing details of their previous activities related to their food stock and hosting people. Participants made comments on this function, which were relevant to tracking support (see Table 7.11, for details see Table E.10 in Appendix E.1.7). However, other functions were not designed to provide tracking support, but participants made comments about them which showed they perceived them to be relevant to tracking support. Table 7.11 summarizes the comments made relevant to the Tracking sub-theme in relation the Shopping List function (more details can be found in Table E.10, Appendix E.1.7)

Table 7.11 Comments from participants relevant to the tracking sub-theme

Level 2 Sub-theme Description	Function	Example Comments
Comments on functions designed to provide tracking support		
Help to track food consumption habits	Advice: Food Buying	Very helpful to know past usage and wastage to avoid wasting more food in future (BF16) So, I know what I've done in the past. And whether I know I wouldn't waste it this time around (AS4) **Negative opinions** I am confident in my own choices (BS36) Would be fun to try out, but may become irritating (BO15) I usually have a specific list and in hurry (AF11)
Provide details of what and how much food is wasted in the household	Overall Food Waste	I think this is particularly innovative and useful to understand where most food wastage is occurring (BS38) I know my household wastes too much food, but don't know how to track and change these habits, so a platform for tracking it would be very useful (BS44)
Comments on other functions		
Help to know how well they use food at their household, as well as what food have totally run out and need to be restocked	Shopping List	It would help to tell me when foods I commonly use and need to stock up on is running out and needs added to the shopping list (BF82) To know on which products, I need to add (BO37)

Persuasion 3: Competition

Join a Competition is the only Wasteless function that was initially designed to provide competition support for users. Participants made comments on this function (see Table 7.12, for details see Table E.11, Appendix E.1.7).

No other functions were perceived by participants to provide competition support.

Table 7.12 Comments from participants on the competition sub-theme

Level 2 Sub-theme Description	Function	Example Comments
Comments on functions designed to provide competition support		
Competition could motivate to do better for food waste reduction	Join a Competition	Competing with waste reduction can become competitive with family members or friends and this will encourage you wanting to reduce waste reduction (BF56)
		Negative opinions
		I'm little sceptical on this, I don't think I would want to compete as this is a personal goal (BS20)
		Not super interested in making it a competition, just want to reduce my own waste (AF6)

Persuasion 4: Cooperation

Food Sharing is the only Wasteless function that was initially designed to provide cooperation support for users. Participants made comments on this function, which were relevant to cooperation support (see Table 7.13, for details see Table E.12, Appendix E.1.7).

Table 7.13 Comments from participants on the cooperation sub-theme

Level 2 Sub-theme Description	Function	Example Comments
Comments on functions designed to provide cooperation support		
Help less fortunate people with food that might be not used by them and that they would end up wasting it	Food Sharing	This is a really good initiative to help unfortunates get food on their tables which might have gone to waste (BS20)
		Because if it helps others, whilst reducing waste, then it is worthwhile (BF12)
		Negative opinions
		Just isn't something I would do particularly during COVID times (BS26)
		Don't like random strangers dropping by (BS2)

Persuasion 5: Reduction

Some Wasteless functions were initially designed to provide reduction support for users:

- Shopping List
- Meal Plans
- Event Plans
- Check Food (By Storage Area, By Food Item)

Participants made comments on these functions, which were relevant to reduction support (see Table 7.14, for details see Table E.13, Appendix E.1.7).

No other functions were perceived by participants to provide reduction support.

Table 7.14 Comments from participants on the reduction sub-theme

Level 2 Sub-theme Description	Function	Example Comments
Comments on functions designed to provide reduction support		
Easily add items that purchased regularly Save time as regularly buy same items	Shopping List	I often buy the same things at the supermarket so this would save time rather than using a raw search (BS2) Easiest way of finding regular purchases (BF4) **Negative opinions** Hard to search for all food that I got. Imagine I bought 20 items! (AS1) Too time consuming to do for large shops (AS8)
Help to easily and efficiently search for what food items they have in stock	Check Food (By Storage Area, By Food Item)	Saves on time to check each place (BO34)

Persuasion 6: Reminder (emergent sub-theme)

This sub-theme emerged from the data. No function in WasteLess was initially designed to provide reminder support for users. However, participants made comments about some functions which showed they perceived the functions to be relevant to reminder support. Table 7.15 summarizes the comments made relevant to the Reminder sub-theme in relation the Shopping List and Check Food: Home functions. In addition to these functions, comments relevant to reminder were found in the following functions, which can be found in Table E.14, Appendix E.1.7:

- Advice: Food Buying
- The Event Plan
- Check Food (By Storage Area, By Food Item)
- Meal Plans

Table 7.15 Comments from participants on the reminder sub-theme

Level 2 Sub-theme Description	Function	Example Comments
Comments on other functions		
Reminding of what food do they not have a sufficient amount at home, so that they can remember to buy them when they go shopping	Shopping List	It will help for the avoidance of missing anything out/forgetting anything! (BF47)
It could help them to remember what food they have at home, especially in some situations.	Check Food: Home	Because I usually buy exactly the same items, all my shopping trips "run in" to each other so it's hard to remember if I bought x y or z on the last trip or 3 trips ago. This would be brilliant (BF27) Very useful way to remember what is exactly needed (AF1)

7.3.3.2 Education

Some Wasteless functions were initially designed to provide education support for users:

- Advice: Food Buying
- Advice: Food Labels
- Advice: Food Storage
- Extend Food Shelf Life
- Recipes
- Using Up Food
- Advice: Food Safety

Participants made comments on these functions, which were relevant to education support (see Table 7.16, for details see Table E.15 in Appendix E.1.7).

However, other functions were not designed to provide education support, but participants made comments about them which showed they perceived them to be relevant to education support. Table 7.16 summarizes the comments made relevant to the Education sub-theme in relation the Advice: Longer Lasting Food function.

Table 7.16 Comments from participants on the education sub-theme

Level 1 Sub-theme Description	Function	Example Comments
Comments on functions designed to provide education support		
Educating people who do not really know or understand the meaning of different food labels, so that they would know what to consume first. It could reduce anxiety that arises from not knowing if they can use food after dates on specific food labels such as "best before"	Advice: Food labels	Useful info if unsure about food labels (BO55) It is quite helpful and informative, and you might not think about it but if its provided I would pay attention to it (AS9) **Negative opinions** I already know what they mean, plus I could just google it if I didn't (BS2)
Giving some tips and information especially in some situations	Extend Food Shelf Life	Educate me on storing food for longer (BF39) Very important features helping to know the best way of storing food longer (AF1) **Negative opinions** It is sometimes hard to extend shelf life of some products (BS30)
Comments on other functions		
Provide them with information and ideas about other available options of food which could last longer when they are struggling to think about last longer options, or they might not be thought about it	Advice: Longer Lasting Food	This is a good idea as it helps awareness of other options that I may not know about (BO9) Good to have an idea about other choices (AF11)

7.3.3.3 Enablement

Some Wasteless functions were initially designed to provide enablement support for users:

- Shopping List
- Advice: Longer Lasting Food
- Check Food: Home
- Meal Plans
- Event Plan
- Check Food (By Storage Area, By Food Item)
- Food Sharing

Participants made comments on these functions (except Advice: Longer Lasting Food), which were relevant to enablement support (see Table 7.17, for details see Table E.16 in Appendix E.1.7).

No other functions were perceived by participants to provide enablement support.

Table 7.17 Comments from participants on the enablement sub-theme

Level 1 Sub-theme Description	Function	Example Comments
Comments on functions designed to provide enablement support		
Enable household members to communicate, share thoughts and update their shopping lists.	Shopping List	My mum always asks me what I need from the shop and if this share option was available, then she could just share it with me and she would be able to see instantly the items I would like. (BS58) **Negative opinions** Usually the driver prefer simpler method (AF11) I live alone (AS9)
Enable them to have access and know if they have food at home or not when they are out shopping, to prevent buying more food than they need.	Check Food: Home	I am able to know the foods I have in stock (BS51) **Negative opinions** I would probably know and am already a frugal shopper (BF62) This is something I would have done before the shop (BS26)

The summary of my original view, as the designer and the opinions of the different user groups in relation to BCW intervention functions and persuasive technologies for WasteLess functions is illustrated in Table 7.18. This summary is based on the results of the codebook thematic analysis on participants' comments made by each user group, as described earlier in this section. For each WasteLess function, comments (10% and above) made by participants within a user group which related to intervention and persuasive supports reflected their opinions about the kind of supports provided though that function.

There was some agreement between the original design view and the opinions of the different user groups in terms of the support provided for some of the functions. For example, functions that were designed to provide *Education* support (e.g., Advice: Food Labels, Advice: Food Storage, Advice: Food Safety) were perceived as providing education support by different user groups. This also applied to *Competition* and *Cooperation* support, such as Join a Competition and Food Sharing. However, for some persuasive support such as *Reduction*, different user groups perceive other supports such as *Reminders* (e.g., Shopping List, Check Food).

Table 7.18 Original design versus participants' view of the WasteLess app

WasteLess Function	Designer point of view			Participants view														
				British students			British family members			British older people			Arab students			Arab family members		
	E	P	B	E	P	B	E	P	B	E	P	B	E	P	B	E	P	B
Set up screen		*p*			*p*			*p*			*p*			*p*			*p*	
Food shopping																		
Shopping List[1]		*r*	x		*r, n*	x		*r, n, t*	x		*r, n, t*			*r, n, t*	x		*r, t*	
Advice: Longer Lasting Food			x										x			x		
Check Food: Home			x			x		*n*	x		*n*	x			x		*n*	
Advice: Food Buying	x	*t*								x				*t*			*n*	
Meal Plans		*r*	x							x	*r*					x	*r, n*	
Event Plan		*r, t*	x							x	*r*					x	*t, n*	
Food management																		
Check Food [2]		*r, t*	x		*t*	x		*r, t*	x		*r, n, t*			*t*			*t*	
Advice: Food Labels	x			x			x			x			x			x		
Advice: Food Storage	x			x			x			x			x			x		
Extend Food Shelf Life	x			x			x									x		
Cooking																		
Recipes	x			x			x			x						x		
Using Up Food	x															x		
Advice: Food Safety	x			x			x			x			x			x		
Food waste																		
Overall Waste		*t*			*t*			*t*									*t*	
Monitor Particular Foods		*t*			*t*			*t*									*t*	
Set Goal[3]		*t*			*t*			*t*			*t*			*t*			*t*	
Join a Competition		*ct*			*ct*			*ct*			*ct*			*ct*			*ct*	
Food Sharing [4]		*co*	x		*co*			*co*			*co*	x		*co*			*co*	x

Notes: **E** means Education, **P** Persuasion and **B** Enablement. *p* means personalization support, *r* reduction support, *t* tracking support, *n* reminder support, *co* cooperation support, and *ct* competition support. N/A means not available. **1**= Shopping List includes Search Favourite, Completely Used Up, Nearly Used Up, Scan Food Item, Add Item Manually, and Share the list. **2**= Check Food includes By Storage Area and By Food Item. **3**= Set Goal includes Set Goal and Monitor Goal. **4**= Food Sharing includes Share as a Donor, as a Receiver, in Public Spaces, and in Private Spaces. Original design view and participants view in different user groups is indicated with an x.

7.3.4 The importance of BCW interventions and persuasion technologies support in reducing their food waste (RQ4.3)

To investigate RQ4.3 (For potential users at different life stages, which are the most important app-based interventions and persuasion technology approaches to support food waste reduction?) a two way mixed ANOVA was conducted on the scores for the Interventions and Persuasions supports derived in section 7.3.3. This has been conducted for only British participants, because there was no older people group from Saudi Arabia. The between participant variable was Life Stage (Student, Family Member or Older Person) and the within participant variable was Intervention or Persuasive Technology Technique (henceforth, Intervention for short) (Enablement, Education, Personalization, Reduction, Tracking, Reminder, Competition, and Cooperation).

There was a significant main effect for Intervention with a large effect size $F_{(3.38, 716.94)} = 94.76$, $p < 0.001$, $\eta^2 = 0.31$. Figure 7.11 shows that the most important significant difference between Interventions is that Competition and Cooperation are rated significantly lower than all the other Interventions (Bonferroni post hoc analysis, $p < 0.001$ in all cases). In addition, Enablement was also rated significantly lower than Tracking and Education. However, Personalization was rated significantly higher than Education, Reduction and Reminder (Bonferroni post hoc analysis, $p < 0.001$ in all cases).

	Enablement	Education	Personalization	Reduction	Tracking	Reminder	Competition	Cooperation
■ Mean	5.1	5.5	5.7	5.3	5.4	5.3	3.4	4.1
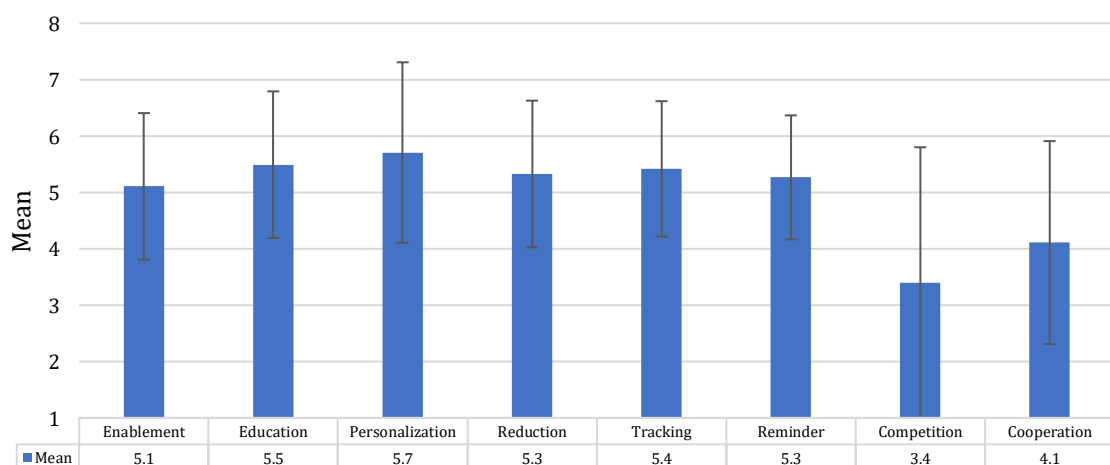
Figure 7.11 Mean scores (and standard deviation) for Intervention components for all participants

There was also a significant main effect for Life Stage, with a medium effect size, $F_{(2, 212)} = 13.00$, $p < 0.001$, $\eta^2 = 0.11$. Bonferroni post hoc analysis showed that the

only significant difference was that Older People gave significant lower ratings than the Students or Family Members (Students vs Older people: p < 0.001; Family Members vs Older People: p <0.001) (see Figure 7.12).

	Students	Family Members	Older People
■ Mean	5.2	5.2	4.4
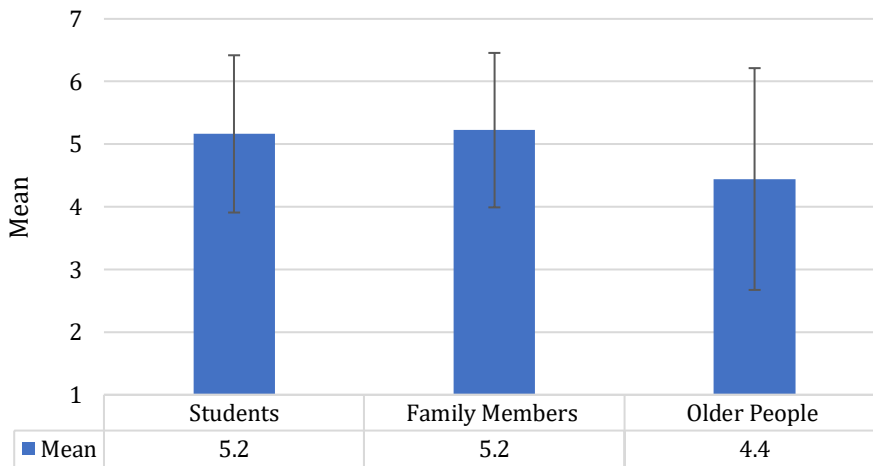
Figure 7.12 Mean scores (and standard deviation) for all Intervention Components for participants at the three life stages

There is a significant interaction between Intervention and Life Stage with a small effect size, $F_{(6.76, 716.94)} = 3.37$, $p = 0.002$, $\eta^2 = 0.03$. Figure 7.13 illustrates the mean scores of each intervention for the three life stages. The most interesting significant differences in the Bonferroni post hoc analysis were that older people were significantly less likely to use both the Tracking and Enablement interventions compared to the other two groups (Bonferroni post hoc analysis, p < 0.001 in all cases). Older people were also significantly less likely to use Personalization, Reminder, and Competition, compared to Family Members (For Personalization: p = 0.023; For Reminder: p = 0.010; For Competition: p = 0.004).

	Enablement	Education	Personalisation	Reduction	Tracking	Reminder	Competition	Cooperation
■ Student	5.6	5.5	5.8	5.3	5.8	5.3	3.6	4.4
■ Family members	5.5	5.6	6.0	5.5	5.6	5.5	3.9	4.2
■ Older People	4.1	5.4	5.2	5.0	4.8	4.9	2.5	3.7
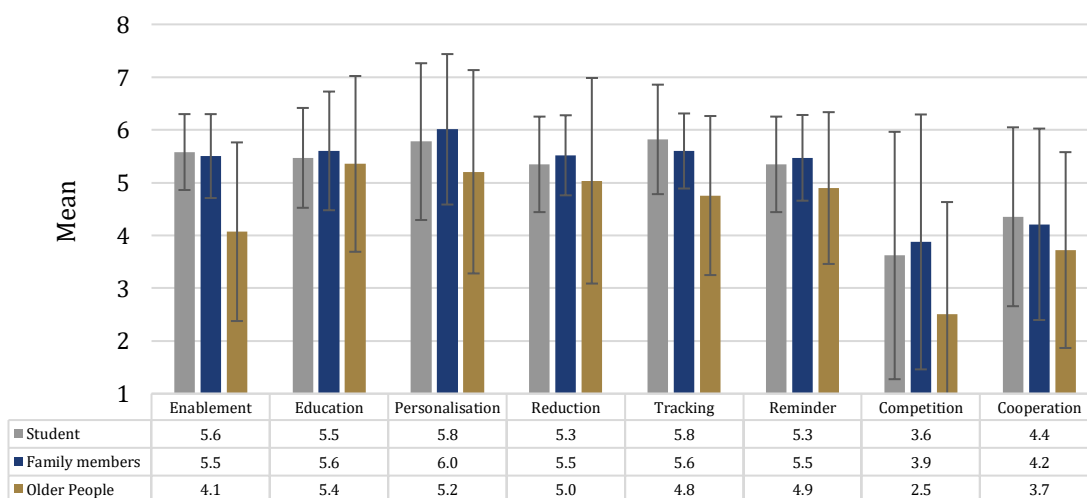
Figure 7.13 Mean scores (and standard deviation) for interventions for participants at the three life stages

7.3.5 Usability of the design of WasteLess app (RQ4.4)

To investigate RQ4.4 (What are the usability and accuracy issues with the prototype of the WasteLess app?), the inductive thematic analysis of the open-ended questions was used (see Section 7.2.5.3). This section illustrates the three sub-themes related to the design of the app: Clarity, Accuracy, and Technological Barriers.

7.3.5.1 Clarity

The results of quantitative analysis conducted on the rating questions about clarity of the Home screen for each WasteLess section are presented in Table 7.19. Overall, ratings were significantly above the midpoint of the scale for all participants, showing positive thought of the clarity of Home screen for each WasteLess section (see Table 7.19, Wilcoxon columns[12]).

Table 7.19 Results of participants' rating of the clarity of Home screen

Question How clear or not is it what is in the ...	Median	SIQR	Wilcoxon
Food Shopping group?	6.0	2.0	9.39***
Food Management group?	6.0	0.5	12.45***
Cooking group?	6.0	0.5	12.91***
Food Waste group?	6.0	0.5	13.05***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The thematic analysis showed that participants identified some aspects related to clarity in terms of the information provided in WasteLess and the visual display of information (see Table 7.20).

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[12] Non-parametric tests were conducted as these results are based on the raw ratings, which are not normally distributed (e.g., in this case medians were calculated, not mean).

Table 7.20 Comments from participants on the Clarity sub-theme

Level 3 sub-theme Description	Functions	Example Comments
Clear information	Overall Food Waste Recipes Shopping List: Nearly Used Up Monitor Particular Foods	Very clear info [information] which is useful in budgeting and wasting less (BO60) Useful clear info [information] about ingredients for different recipes (BO55) **Negative opinion** 'Nearly used up' … don't understand this (BO3) I'm not sure what the GHG number means (BS39)
Clear visual display/ representation of information.	Monitor Particular Foods Shopping List: Completely Used Up Advice: Food Buying Set Goal Advice: Longer Lasting Food	I think this is a really good visual representation that people don't think about when they waste food! (BS56) Clear view (BF33) I like seeing visually displayed statistics so this is good (BF78)
Simple appearance	Set Up Check Food (By Storage Area, By Food Item) Shopping List: Search Favourite Shopping List: Search Favourite	The features are considerate. The appearance inviting and simple (BS9) This looks to be a straightforward search method (BF25) It is user friendly (BF12) I have ADHD and the list being able to be added to in chunks rather than all at once is great (BS19)

7.3.5.2 Accuracy

Participants highlighted aspects related to the accuracy in the information and functionalities provided in some of the functions proposed for the WasteLess app (see Table 7.21).

Table 7.21 Comments from participants on the Accuracy sub-theme

Level 3 sub-theme Description	Functions	Example Comments
Accurate information/method	Shopping List: Scan Food Item Shopping List: Add Item Manually Advice: Food Buying Shopping list: Completely Used Up Shopping list: Nearly Used Up Check Food: Home Check Food (By Storage Area, By Food Item)	Accurate way to log food" (BF71) **Negative opinion** [It] gives illusion that information may be more accurate (BS24) I cannot really trust the info in the app unless link to original articles (AF8) I am not sure how difficult it would be to use and keep accurate (BS59) Wouldn't trust accuracy of app's stock levels, since it would depend on all household members remembering to enter what has been used/thrown away (BO5)

7.3.5.3 Technological barriers

Participants identified possible technological barriers when using some of the WasteLess functions, which might hinder them from effectively using the functions (see Table 7.22).

Table 7.22 Comments from participants on the Technological Barriers sub-theme

Level 3 sub-theme Description	Functions	Example Comments
Date entry/update require effort and time	Shopping List: Completely Used Up Check Food: Home Check Food (By Storage Area, By Food Item) Monitor Particular Foods Meal Plans	Not sure as it would depend on updating the app as items are eaten which could be a lot of effort (BF8) But young kids and teenagers are unlikely to follow the rules so how good would it be? (BF64) My fridge and freezer are so close as to make no difference in that regard. Also, if I know I have something, I'll know where I put it. I also wouldn't take the time to categorise the storage areas in the app (BS2)
Poor internet connections	Shopping List: Scan Food Item Shopping List: Add Item Manually	Takes time with bad internet connection (BO34)
Non-functional devices	Shopping List: Scan Food Item	I don't have a good camera to scan (BF36)

7.4 Discussion and conclusions

This study evaluated the design of the low fidelity prototype of the WasteLess app with a range of potential users. It addressed RQ4 in my programme of research (RQ4: For potential users at different life stages and from different cultures, what are their opinions of different WasteLess functionalities, different BCW interventions and persuasive technology techniques, and the design of the app?).

RQ4 was addressed by answering four sub-RQs. In relation to the opinions of potential users about different WasteLess functionalities (RQ4.1: What are the different groups of functionality proposed for the WasteLess app and their importance for potential users at different life stages?), the study showed that there were reliable and meaningful components of app-based functionality accounting for 25 functions (see Figure 7.7).

The model was based on the evaluation of the proposed functions in WasteLess app. In comparison, the previous proposals for technological solutions for food waste reduction were more focused on specific interventions (e.g., Farr-Wharton et al., 2012; Farr-Wharton et al., 2013; Farr-Wharton et al., 2014a; Farr-Wharton et al., 2014b; Thieme et al., 2012). However, none of the previous work tried to model the functionality supports of food management and food waste. Modelling the functionalities is useful, and could contribute to the area of sustainable HCI, by providing researchers and designers who are interested in developing app-based interventions for food waste reduction with groupings of app-based functionalities to investigate what kind of supports different user groups are likely to find useful, taking into account their life stage. To illustrate, the usefulness of functions and the design about different functions used in this model can be replicated by future researchers and designers to facilitate investigation of the likelihood of using different functionality supports with different user groups considering factors such as such as social, cultural, or material situations. Acquiring such information at early stages of development of interventions might improve the effectiveness and success level of the intervention.

The technological interventions discussed by previous researchers were mainly mobile apps, apart from that proposed by Farr-Wharton et al. (2012) (the colour-coding system). This emphasizes the important role of mobile apps in addressing food waste issues. Therefore, the proposed model is based on mobile app-functionality support. In addition, the proposed functionality supports were designed based on a behavioural change theory, Behaviour Change Wheel (BCW) and persuasive technology. BCW was developed as evidence-based tool which help to design and choose intervention functions according to the nature of the behaviour. Therefore, this should enhance the success of the functionalities proposed.

According to Bederson and Shneiderman (2003) cited in Rogers (2012), the proposed model (Section 7.3.1) is *descriptive*, as the model provides a description of possible app-based functionalities for each main category of support to help with food waste reduction. In addition, it is *generative*, as it provides a basis from which to generate design solutions for food waste issues. However, according to Rogers (2004, cited in Rogers, 2012), the model is also *conceptual* because it developed a

set of high-level dimensions of food waste reduction supports, which could inform the design of technological interventions to help individuals reduce their household food waste. It is also important that the model used a statistical scale development process (DeVellis, 2003) to provide a valid and reliable model of high-level constructs of app-based functionality supports, which enabled me to explore the relationships between them.

In relation to the importance of different groups of functionality, the study found that students and family members did not differ significantly in their likelihood of using the Wasteless components. In fact, both these groups were significantly more likely to use them than older people. In particular, older people were significantly less likely to use both the "Checking and managing food at home" and "community aspects of food waste reduction" functions compared to the other two groups.

With respect to the "Checking and managing food at home" component in the proposed model, it covers functions related to checking at home food, using recipes, monitoring food waste and the goal for food waste reduction. This component includes supports provided by previous research efforts (e.g., Colour-coding system, EatChaFood (Farr-Wharton et al., 2013,2014a), and FridgeCam (Farr-Wharton et al., 2014b) provided support to check food at home; EatChaFood provided recipes). The present study found that students and family members were more likely to use this kind of support compared to older people. The component provides support such as checking what food users have at home, and where they store it. Thus, it might be less likely to be used by older people as they probably spend more time at home compared to younger people. In addition, this can be due to older people preferring non-technological tools for food management at home. For example, a British older person commented on the Check Food function (see Table E.10, Appendix E.1.7):

> "I know where I keep my food, it is easy to locate & check. This system is way more complicated" (BO4)

With respect to the components "Making and using shopping lists" and "Advice on buying and storing food", the study found no significant differences between the users at different life stages. This finding is interesting because it contradicts the prevailing idea that older people would be less interested than younger people in

support to enhance their knowledge and provide advice about food shopping and management. This might be due to that some features provided in this component are quite similar to manual tools, which might be currently used by older people. For example, advice provided in WasteLess can be similar to what they used to use. Providing support for making shopping lists is popular in research projects, for example Fridge Pal (Farr-Wharton et al., 2014a) provided this functionality. The component includes functions to help users make their shopping lists based on what foods have completely or nearly run out.

With respect to the "Community aspects of food waste reduction" component, the study found that this functionality support was the least likely to be used by users at all life stages. In addition, older people were significantly less likely to use this functionality support compared to students and family members. Mitigating food waste by food sharing and joining a competition is a controversial solution. Farr-Wharton et al. (2014a) discussed the issue of trust in food sharing, especially if sharing food was with unfamiliar people. This was even more challenging in my study, as it was conducted during the Covid-19 pandemic. So, individuals could be more concerned about food hygiene and contact with other people, particularly those outside the household. In addition, my study added to the findings by Farr-Wharton et al. (2014a) that regardless of individuals' life stage, giving food is more preferred than receiving it. As participants explained, this could be related to food hygiene and being uncomfortable of collecting food (see Table E.12, Appendix E.1.7):

> "I'd be embarrassed to pick up food" (BS8)

In relation to potential users' opinions in terms of different BCW interventions and persuasive technology techniques (RQ4.2: To what extent do the opinions of potential users at varying life stages and from different cultures support the BCW intervention functions and persuasive technologies proposed for the WasteLess app?), the study found that potential users' opinions were generally in agreement with my initial view as a designer in terms of intervention and persuasive technology support provided in functions. However, for some functions, users suggested additional supports that were not initially thought by myself as the designer, when creating the functions. For example, participants from different cultures and at different life stages suggested *Reminder* support in some functions, however, none

of the functions was initially designed to provide such support. Having an evaluation in the early stages of development of an app helps to indicate what support users would value, although of course their views may change when they experience a working app in a real-life situation. Thus, it is important to explore what kind of support potential users are positive about and propose themselves in early stages of development and include them in later stages of the design in order to provide a more usable and acceptable app to help people with food waste reduction.

In relation to the importance of different BCW interventions and persuasive technology techniques (RQ4.3: For potential users at different life stages, which are the most important app-based interventions and persuasion technology approaches to support food waste reduction?), the study found that generally, Competition and *Cooperation* had far lower potential to support individuals for food waste reduction compared to other interventions and persuasion supports such as *Enablement, Education, Personalization, Reduction, Tracking* and *Reminder.* In addition, older people were less likely to use all interventions and persuasive techniques compared with other user groups. In particular, older people were less likely to use both *Tracking* and *Enablement* compared to family members and students; and *Personalization* and *Competition* compared to only family members.

The interventions and persuasion support in this study are based on theoretical work by Fogg (2003), Michie et al. (2011) and Oinas-Kukkonen and Harjumaa (2008, 2009). These supports can be used for behaviour change issues for food waste reduction. Therefore, finding the potential of different interventions and persuasion supports for the context of food waste reduction is important. This finding can help researchers of technological systems to have an idea about promising interventions, worth evaluating with individuals to help with food waste reduction. In the same why, it can benefit researchers to avoid unnecessary cost when developing technological systems based on low-potential interventions (e.g., *Competition* and *Cooperation)*.

The potential of using these techniques in technological interventions for the issues of food waste had not been explored in previous research. Although it was clear that some of the existing technological interventions for food waste reduction applied some behaviour change techniques, but this was not explicitly stated in research

papers. For example, the *Education* was used in EatChaFood, and *Competition* technique was used in BinCam. This study found that the potential of *Education* is much higher than *Competition* in the context of food waste reduction. *Competition* is one element of gamification (Deterding, 2011). Recently, gamification has been widely used in different contexts to motivate individuals' positive behaviour change, for instance, in mental healthcare and quitting smoking (Bassanelli, 2022). However, this study found that among a number of interventions and persuasive technology such as *Education* and *Tracking*, generally *Competition* had low potential to support individuals for food waste reduction. This may be because of that in the context of food waste reductions, individuals' intentions is not the only factor; individuals' knowledge and other external factors around them are also have effect to perform food waste reduction.

This finding also showed that the potential of the potential of these interventions is varied, depends on the life stages of individuals. For example, *Enablement* and *Tracking* have high potential for younger adults such as family members and students, but not for older people. This might be due to that younger people spend more time outside the home compared to older people, so they need such supports such as helping them access information about what is in their household fridge or pantry or track their consumption of food. Personalization also has potential for family members but not for older people. This may be because they were living with children who may have different food preferences and requirements and therefore need to management food for a number of different individuals in the household with different preferences and requirements.

This study addressed the gap in the research on technological interventions to support food waste reduction by investigating the potential of interventions and persuasive techniques in relation to food waste reduction for user groups at different life stages. The findings are useful because the resulting knowledge can support researchers and designers about which techniques have the potential to be applied in technological interventions for food waste reduction, especially if they aim to design for users at different life stages. This could provide more suitable and effective solutions for food waste reduction. Further investigation of the effectiveness of these techniques using long-term studies is needed.

In relation to the design of the prototype of the app (RQ4.4: What are the usability and accuracy issues with the prototype of the WasteLess app?), the study found that clarity, accuracy, and technological barriers were the main design aspects raised by participants. In terms of clarity, this covers both information and visual representation in the WasteLess function. For example, some information on the screens were not understandable such as "Nearly used up" and GHG. However, participants commented on the clear visual representation in some functions like Monitor Particular Foods. In relation to accuracy, participants highlighted the value of this design aspect to some functions such as Shopping List: Scan Food Item. In relation to technological barriers, data entry and update was the key issue raised by participants. This was an issue with other mobile apps such as EatChaFood and Fridge Pal (Farr-Wharton et al., 2014a). The final version of the WasteLess app should consider these aspects to enhance the usability of the app.

The study had some limitation which should be mentioned. The study used self-report measures, so the results reflect participants' thoughts of their likelihood of using the proposed functions in the WasteLess app. This does not necessarily reflect their actual use of these functions. However, a low fidelity prototype like WasteLess gives indications of how the design should be developed which then need to be assessed with further evaluations and field studies. In addition, participants answers might be susceptible to social desirability bias (Nederhof, 1985). However, techniques applied in previous studies in this programme of research to avoid social desirability bias were also applied in this study (e.g., assuring the anonymity and confidentiality of the responses).

Further, the study used an online survey due to the restriction of Covid-19 pandemic, although it had been planned initially to collect data using face-to-face interviews. This might have hindered obtaining more detailed information about participants' reactions to the functions and meant that I could not simulate interaction with the app using a Wizard of Oz prototype.

The study included only a small sample size of Arab participants (24 participants, divided between two life stages). This was the number of participants I was able to recruit at that time due to the pandemic. For Arab older people, it was not possible to recruit any people from this group, as they are not accustomed to doing online

surveys and would not be comfortable with answering questions online. If it had not been for the pandemic, I would have conducted evaluations with older Arab people face-to-face in Saudi Arabia. However, I recruited a large sample of British participants (215 participants, divided between three life stages).

The Arab family member group included participants who were living in both the United Kingdom and in Saudi Arabia. This was not the plan for this study, but this was also due to the Covid-19 restrictions. Country of living may have an effect on people's practices around food and food waste, and thus they may likely to need different supports. For example, foods are sold in big packages in Saudi Arabia compared to the United Kingdom. Further, Saudi Arabia is a very hot country compared to the United Kingdom. So, this may affect how people store and manage their food at home. However, this may have a small effect on this study, as there was no comparison made on different culture groups.

The study developed a model of app-based functionality supports for food waste reduction. This study concluded that future researchers and designers should consider life stage when providing particular support rather than others. In addition, future researchers and designers should not devote much attention to *Competition* and *Cooperation* types of support. Generally, participants thought that these types of support had lower potential to provide support for food waste reduction compared to other interventions such as *Enablement, Education, Personalization, Reduction, Tracking* and *Reminder.*

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Chapter 8

General discussion and conclusions

The programme of research presented in this thesis investigated how to use behaviour change theories to inform the design of a digital technological intervention, the WasteLess app, to support food management and reduce food waste. To do this, it first investigated what drives individuals to waste household food, considering their *Culture* and *Life stage*. A further aim was to investigate the potential of app-based functionality and BCW intervention functions and persuasive technology techniques in the area of food waste reduction by an initial evaluation of a low fidelity prototype of the WasteLess app.

To achieve these aims, this research was divided into five phases (**analysis**, **understanding and investigation**, **validation**, **design**, and **evaluation**) through which it achieved five contributions, and addressed four main research questions (RQs).

The next section provides discussion of the phases, how the RQs were addressed and the contributions of this research.

8.1 Overall discussion of the findings and contributions of this programme of research

The *first contribution* was in the first phase of the research, **analysis**, providing a comprehensive review and analysis of existing literature on individuals' food practices, food waste and food waste reduction. This included reviewing papers from different disciplines such as environmental and social psychology, economics, nutrition studies, policy studies, sustainability studies, waste management studies as well as HCI (see Chapter 2, Section 2.2). There is a clear lack in the previous research of a comprehensive set of food waste drivers, only one paper identified had conducted an extensive review of the food waste issues and produced a set of drivers, although their methodology was unclear (Hebrok & Boks, 2017). Other research has been limited in the aspects of food waste investigated, concentrating on a small number of drivers (Chapter 2, Section 2.2). My review of 30 papers dealing with a wide range of

theoretical and empirical work from 24 different countries on food waste issues has contributed to deepening the understanding of these issues. This also showed that about 74% of the reviewed papers studying food waste issues were conducted in Western countries.

The understanding of the issues of food waste led to the development of a set of 35 statements around different food-related activities: food shopping, food storage and management, preparation and cooking food, and eating and socializing around food. The statements used drivers discussed in 24 of the papers reviewed in this research. These statements were then refined and investigated in this programme of research (see Figure 8.1).
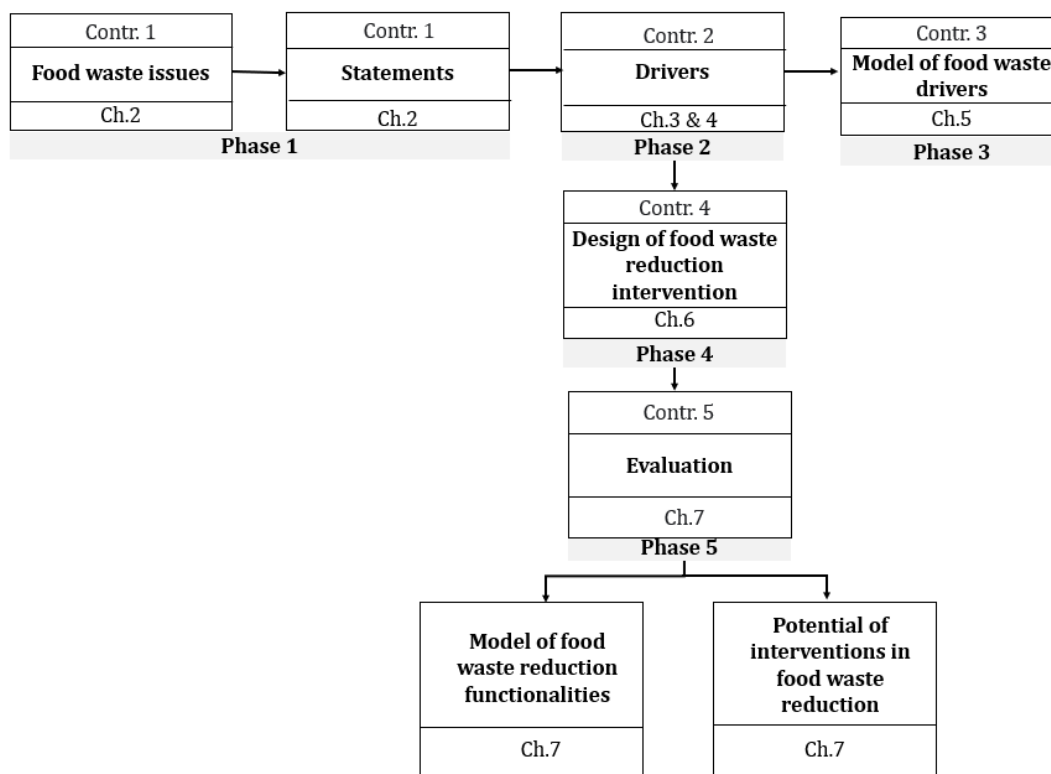
Figure 8.1 Flow of contributions in different phases and chapters in the thesis

This contribution also included identifying two major gaps in the previous research. Firstly, very little previous research has systematically addressed cultural differences in food waste attitudes and practices, and I could not find any research between Western or non-Western cultures. Secondly, there has been very little systematic research investigating differences in food waste practices between individuals at different *Life stages* (e.g., students, family members living with children, or older people). Therefore, these two variables became a main focus of my research, and I

investigated these two variables in relation to developing technological interventions to support food waste reduction.

The *second contribution* was in the second phase, **understanding and investigation**, investigating the similarities and differences between individuals in relation to food consumption and waste, considering their *Culture* and *Life stage.* This contribution addressed RQ1. This included investigation of the similarities and differences between postgraduate university students from one Western culture (British) and two non-Western cultures (Arab and Chinese) in relation to food consumption and waste (RQ1.1) (Study 1, see Chapter 3). There were some common attitudes and practices between students from these cultures around food consumption and waste, as well as some differences. For example, the students, regardless of culture, believed that their households did not waste much food; also, they wasted the same food items in their households (fresh food such as fruits and vegetables). However, the students from different cultures had different motivations to reduce their food waste. Arab students were more motivated by religious beliefs and moral principles; Chinese students were more motivated by reducing the amount of money spent on food; while British students were motivated by both reducing the amount of money and minimising environmental impacts. This indicates that culture has effects on some aspects of food waste but not others for postgraduate students. Such similarities have also been found by other studies, some of which were conducted with British students (e.g., Clark & Manning, 2018), and others conducted with students from other cultures (e.g., Mondejar-Jimenez et al., 2016 studied Italian and Spanish students). The motivation for reducing food waste does seem to be affected by the students' culture. This may be due to different religions and cultural values, for example Arab students may be influenced by the Islamic view about extravagance (Yoreh & Scharper, 2020). This also might be due to students having different social cultures, and that they were from countries that have different educational systems. To illustrate, previous research has suggested that awareness about the environmental impacts of food waste could influence how students can be motivated to reduce food waste (e.g., Clark & Manning, 2018; Tsai et al., 2020; Yagoub et al., 2022). Researchers (e.g., Baig, Gorski, et al., 2018; Tsai et al., 2020) discussed the low level of knowledge and awareness about these issues in China and an Arab country such as Saudi Arabia, which can help explain the findings in this research.

This phase also used the food waste statements derived from the literature in the previous analysis phase (see Figure 8.1), refined them and produced a robust set of food waste drivers, including main and sub-drivers. Both the main drivers and sub-drivers were then classified as *High, Moderate,* or *Low* importance for each student group. Some drivers towards food waste were shared between student groups but there were also some differences. For example, *overbuying food* was found the *High importance* driver to food waste for both Chinese and British students; whereas *food preparation and cooking*, and *eating and socialising* were *High importance* drivers for Arab students. It was not surprising that overbuying food is important for some groups, as this driver was extensively discussed in previous research (e.g., Bravi et al., 2020). However, it is surprising that *overbuying food* was not *High importance* for Arab students. Although overbuying food has been discussed as an important driver in previous research in relation to Arab people (e.g., Baig, Al-Zahrani, et al., 2018; Yagoub et al.,2022), this finding may be affected by the cost of food in the UK being more expensive compared to Middle East countries, as the Arab students were living in the UK at the time of the research.

This research also investigated similarities and differences between student groups in the sub-drivers underlying the main drivers (see Chapter 3, Section 3.4.2). For both British and Chinese students, *packages too big* was the specific reason leading to *overbuying food*. However, for Arab students *impulse eating* was the specific reason for food waste in the *eating and socialising* main driver; and *lack of time or motivation to cook* and *belief that leftovers are not healthy* were the specific reasons leading to food waste in the *food preparation and cooking*. In fact, *lack of time or motivation to cook* was the reason for *food preparation and cooking* for all student groups. In addition, *failure to make a plan* was also the reason for all student groups leading to food waste in *shopping and meal planning*. This indicates the effect of *Life stage* of being a student regardless of *Culture*. Students might be busy with their studies and they might have less experience in planning and cooking food for themselves. Such issues have been discussed by some researchers in relation to younger adults (e.g., Bhatti et al., 2019; Bravi et al., 2019; Hebrok & Boks, 2017; Tsai et al., 2020). Knowledge about the specific food waste drivers can be useful for both researchers in the area of food waste and designers of technological interventions to reduce food waste, as it shows the role *Culture* may play for students in their food waste practices and can lead to ideas of how

best to support them in food waste reduction. For instance, interventions could target support for over buying for both Chinese and British students, particularly in relation to buying bigger food packages than their need, but it could target support for reducing food waste in relation to eating and socialising for Arab students, particularly for impulse eating.

In addition, this contribution included the investigation of the similarities and differences in relation to food consumption and waste between individuals at two life stages: family members living with children (under 18) and older people; and from a Western culture and a non-Western culture (British and Arab) (RQ1.2) (Study 2, see Chapter 4). People at these life stages have not received much attention from researchers on food waste: only one study found about food waste by family members (Teng et al., 2021), and one about food waste by older people (McAdams et al., 2019) (see Chapter 2, Section 2.2.6). Despite that, there is a prevailing view that older people waste less food than younger people, and some research has found this (e.g., Schneider, 2008). Other researchers (e.g., Quested et al., 2013) have found that older people generated about only 25% less food waste than younger people. Given this lack of demonstrated difference between life stage groups, it is perhaps surprising that so much emphasis has been placed on food waste reduction amongst younger people.

The current research found that there were some common attitudes and practices among family members and older people around food consumption and waste, for these two cultures, as well as some differences. Interestingly, the pattern of similarities and differences in this regard extends from students to the later life stages. To illustrate, family members and older people from the two cultures also believed that their households did not waste much food; and they waste fresh food such as fruits and vegetables, as well as dairy products. In addition, Arab family members were also motivated by religious beliefs or moral principles, while British family members were motivated by minimising environmental impacts. Persistence of this difference to later life stages in both cultures indicates the role that culture plays in how people are motivated to reduce their food waste. However, older people, either Arab or British, were motivated by reducing the amount of money spent on food. Technological interventions therefore should consider such cultural as well as life stage differences when motivating individuals for food waste reduction.

Similar to Study 1, this phase also included using the statements derived from the literature in the **analysis** phase (see Figure 8.1), refined them and produced a robust set of food waste drivers for family members and older people from the two cultures. Then, the main drivers and sub-drivers were classified as *High, Moderate,* or *Low* importance for each user group.

There were some drivers towards food waste for these groups in common but also some differences. For example, *overbuying food* was a *High importance* driver for all groups; but *eating and socialising* was a *High importance* driver only for family members from both cultures. For British participants, the *High importance* of *overbuying food* extended from students to family members as well as older people. This shows that this driver is not affected by life stage for British individuals. However, *overbuying food* was of *High importance* for those Arab family members and older people who were living in Saudi Arabia, in contrast to Arab students living in the UK, which agrees with previous research (e.g., Baig, Al-Zahrani, et al., 2018).

This research also investigated similarities and differences between family members and older people from the two cultures in the sub-drivers underlying the main drivers. Although *overbuying food* was a common driver for British individuals at three life stages, the specific reasons led to this issue were somewhat different. For students and older people, *packages too big* was a specific reason that led to *overbuying food*, but not for family members. This may be because students and older people usually have smaller numbers of members in households (Herzberg et al., 2020) compared to family members. For British family members, *influenced by offers* was the reason leading to *overbuying food*.

Similarly, despite the fact that *eating and socialising* was a common driver for family members from the two cultures, the specific reasons leading to this issue were somewhat different. For British family members, *catering for "picky" eaters* was the reason leading to *eating and socialising*; while for Arab family members, it was *catering for special occasions*. This finding was in line with previous research which has discussed the effect of living with children on food practices (e.g., Hebrok & Boks, 2017). However, what is interesting in this research is that it shows such effect seems to be less than others for some cultures. For Arab participants, the effect of Arab culture seems of higher important compared to living with children, in relation to the *eating*

and socialising main driver; such cultural effects has been discussed in research about Saudi Arabia (Baig, Al-Zahrani, et al., 2018; Khan & Kaneesamkandi, 2013).

Reflecting on the findings of RQ1.2, interventions should consider such differences and provide suitable support for each group to help reduce overbuying. For instance, for British family members, support could be provided to help with being influencing by offers by providing information about the actual value for money of offers; whereas for British older people, support could be provided to discourage buying overly large packages of food. Knowledge about the specific food waste drivers for these groups can be useful for both researchers in the area of food waste and designers of technological interventions to reduce food waste, as it shows the role *Life stage* plays in food waste practices and can lead to ideas of how most effectively to support people at different life stages in food waste reduction.

The contribution also included the investigation of the similarities and differences between individuals at all three life stages and from one Western culture (British) and one non-Western culture (Arab) in relation to food consumption and waste, this involved further analysis of all the data from Studies 1 and 2 (RQ1.3) (see Chapter 4, Section 4.3.3). To the best of my knowledge, no previous research has studied the two variables of *Culture* and *Life stage* in this detail (see Chapter 2, Section 2.2). Providing such knowledge helps to investigate the role of *Life stage* and *Culture* that may play in individuals' attitudes and practice around food waste.

There were some common attitudes and practices between individuals at the three life stages, for these cultures as well as some differences. This confirmed the results on RQ1.1 and RQ1.2, that regardless of *Culture* or *Life stage*, fresh foods were the most wasted food in individuals' households, and that individuals generally believed about that their households did not waste much food.

However, there were some difference between Individuals at different life stages and from different cultures in terms of attitudes and practices about food shopping (e.g., older people shop for food in specific shops and markets more than family members and students), food waste (e.g., rice, pasta, other starches found as wasted food items for only Arab participants), as well as how they are motivated to reduce their food waste. This confirmed the findings for RQ1.1 and RQ1.2, that Arab participants were

motivated by religious values; and older people were motivated by reducing the amount of money spent on food. For *Culture*, this confirmed previous research on the role of religious values in influencing individuals' motivations in relation of food waste (Elshaer et al., 2021), while being at an older stage of life and financially restricted might also have this effect (Schneider, 2008).

This phase also found that there was no significant interaction between *Culture* and *Life stage*, but there was a significant interaction between *Driver* and *Life Stage*. This reflected the fact that older people mostly reported the driver of *overbuying food*, whereas family members mostly reported the driver of *eating and socializing*. There were also some drivers towards food waste in common for individuals at different life stages and from different cultures groups but also some differences between groups. For example, *overbuying food* was a *High importance* driver for groups at all life stages and from all cultures. Interestingly, *over optimistic buying* was the reason underlying *overbuying food* for individuals at all three life stages. This sub-driver has not received much attention in previous research, although it has been discussed by some researchers (e.g., Block et al., 2016; Heng & House, 2022). However, for older people only, *influenced by offers* was the reason underlying *overbuying food*. This could be because being at an older stage of life and financially restricted might also have this effect (Schneider, 2008); and could be also explained by the findings of this research question (i.e., RQ1.3), that older people were motivated by reducing the amount of money spent on food. In relation to *Culture*, Arab and the British participants had different reasons underlying *overbuying food*, with *over optimistic buying* as the reason for Arab participants, whereas *packages too big* was the reason for UK participants.

The knowledge provided by this contribution can demonstrate which food practices that can be influenced by these variables and support designing effective food waste interventions specifically for individuals at particular life stages and from particular cultures. This can help know whether interventions need to consider *Culture* or *Life stage* or even both when providing support for particular practices or drivers. For example, *Culture* as well as *Life stage* needs to be considered for motivating individuals to reduce their food waste.

The ***third contribution*** was in the third phase, **validation**, validating the food waste drivers and practices for British individuals, considering their *Life stage.* This

contribution addressed RQ2. This included investigating the similarities and differences, in terms of food shopping and waste between British individuals at four different life stages: university students, adults living with children, adults living without children, and retired people (RQ2.1; Study 3, see Chapter 5). British individuals at all the four life stages were similar in terms of their attitudes about food waste. For example, they were concerned about food waste specifically in their household and in society in general, but they do not think their household wasted much food. However, there were also some differences between groups in relation to food shopping. Retired people do shopping themselves and with their partners, whereas for students, their parents or relatives do the shopping. This finding agreed with the findings of Study 2 that older people do shopping themselves; but contradicted the finding of Study 1, which found that students do their shopping themselves. This could be due to that Study 1 involved postgraduate students with an age range of 25 to 33 years old, while Study 3 involved mainly undergraduate students with age range of 18 to 29 years old. Although, there has been previous research on the food shopping and waste practices of British individuals, as well as in this programme of research, the specific contribution of this research was to compare individuals at these four different life stages.

This contribution also included developing a statistically-based model of food waste drivers for British individuals (see Chapter 5), using the 16 drivers classified as *High importance* in the **understanding and investigating** phase (see Figure 8.1). This model has five components of food waste: *lack of knowledge of food management issues*, *preparing too much food, negative attitudes towards cooking, lack of planning,* and *over shopping*; and involves 14 statements (RQ2.2). In comparison to the drivers resulting from the previous phase, **understanding and investigating**, the 16 food waste drivers (which can be illustrated in 24 statements) were reduced to only 8 drivers in the previous analysis (which are illustrated in 14 statements in the model). In addition, comparing to the main food waste drivers, the components in the model were more focused in that it highlights specific issues of food waste, and the statements which measure these issues.

The five components in the model explained a total of 55% of variance, which condensed the specific statements about food waste into its related food waste issue

(high-level constructs) to highlight the core areas of food waste issues. This is a comprehensive model in that it used all the food waste drivers identified as *High importance* in Study 1 and Study 2. This model is more comprehensive than previously proposed models (e.g., Aktas et al., 2018; Bravi et al., 2019; Grasso et al., 2019; Mondejar-Jimenez et al., 2016; Stancu & Lähteenmäki, 2022; Stancu et al., 2016; Tsai et al., 2020). The proposed model is *descriptive* and *conceptual* (Bederson & Shneiderman, 2003; Rogers, 2004, cited in Rogers, 2012), and makes a contribute to the area of sustainable HCI, by providing researchers and developers of interventions for food waste reduction with a small number of measures to assess the high-level constructs of food waste issues, that can be used at early stage in research and development of interventions.

As an extension of this contribution, the proposed model was used to investigate the importance of different food waste components for British individuals at different life stages (RQ2.2). This found that *over shopping* was the most important food waste component for all British *Life stage* groups. Over shopping includes a number of statements: *I often buy food in packages that contain more than I need because big packages seem better value; I often buy food in packages that contain more than I need because smaller packages are not available;* and *I am often influenced by offers in the shops.* These food waste issues have been already found as important for British participants in Studies 1 and 2. Therefore, this model validates the importance of the over shopping/over buying issue for British individuals. However, *negative attitudes towards cooking* (e.g., I am often not motivated to cook; I often do not have time to cook) was also an important issue for students. This was in line with the findings of Study 1, that *lack of time or motivation to cook* was a sub-driver for all students from the UK and several other different cultures. This knowledge can be useful for researchers and designers who are interested to provide food waste reduction support for British individuals.

The ***fourth contribution*** was in the fourth phase, **design**, the exploration of the use of behaviour change theories in the design of a mobile app for food waste reduction. This contribution addressed RQ3. This included the application of two behaviour change theories, the Behaviour Change Wheel (BCW) (Michie et al., 2011) and persuasive technology approaches (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2008, 2009), to

inform the design of a low fidelity prototype for a mobile app to support food waste reduction, the WasteLess app (see Chapter 6). The design of WasteLess used the drivers produced and classified as *High importance* in the **understanding and investigating phase** rather than the components identified in the model in Study 3 (see Figure 8.1). This was because of time restriction and the pandemic, so that this phase and the **validation** phase were conducted in parallel. Previous technological interventions have not systematically used behavioural change theories in their development and evaluation (Chapter 2, Section 2.3.3). Researchers such as Hekler et al. (2013) have emphasized the advantages of using behavioural change theories in technological systems for HCI and sustainability. This contribution therefore bridged the gap between theoretical and practical work and can be used to provide a technological intervention for food waste reduction. As part of the application of BCW, I investigated how practically the BCW theory can be used to transform the key food waste drivers identified earlier in this programme of research (in the **understanding and investigation** phase) to create user requirements for a technological intervention for food waste reduction. The application of the BCW was useful not just to understand the food waste issues and create user requirements, but also to propose supports in the WasteLess app, based on an evidence-based theory (i.e., BCW). This can add to the successful applications of BCW in other fields which have been developed such as an intervention to reduce sitting in the workplace (Ojo et al., 2019). This research has shown that BCW can be used in the development of a multi-functional technological intervention for food waste reduction such as WasteLess.

In addition, this included the exploration of the design space for the development of a mobile app to support individuals for food waste reduction (see Chapter 6). In particular, this included the exploration of three aspects for the design of the app: (1) providing support for different food-related practices (RQ3.1); providing support based on the set of food waste drivers investigated earlier in this research (RQ3.2); and (3) incorporating techniques from two different behaviour change theories (BCW and persuasive technology) (RQ3.3). The aim was to create a single mobile app, WasteLess, which was able to incorporate the full set food waste drivers investigated earlier in this research (see Figure 8.1). In addition, it would incorporate a range of functions to provide support during a range of food-related practices: food shopping, management, and cooking, as well as providing support for food waste reduction. In comparison, the

previous technological interventions (Chapter 2, Section 2.3.2) were much more specific in terms of the issues they tackled or the support they provided for food waste reduction (e.g., Comber et al., 2013; Farr-Wharton et al., 2014a; Farr-Wharton et al., 2014b; Ganglbauer et al., 2015; Thieme et al., 2012). Furthermore, exploration of the design space included exploring the possibility of incorporating techniques from different behaviour change theories in a single mobile app: *Education, Persuasion and Enablement* from BCW intervention functions (Michie et al., 2011); and *Personalization, Reduction, Tracking, Cooperation, and Competition,* from persuasive technology (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2008, 2009). In addition, individuals from different cultures and at different life stages will undoubtedly have different motivations and preferences in relation to managing their food and reducing food waste. Thus, having a number of techniques might help to make the technological intervention more acceptable to a wide variety of people.

The ***fifth contribution*** was in the fifth phase, **evaluation**, the evaluation of the low fidelity prototype of the WasteLess app (see Figure 8.1). This contribution addressed RQ4. The evaluation involved three aspects: likelihood of using different WasteLess functionalities, different BCW interventions and persuasive technology techniques, and usability and accuracy issues. This included the development of a statistically-based model of food waste functionality based on data collected from a large UK sample with a small Arab sample of potential users (see Chapter 7). This model has five components: *checking and managing food at home*, *community aspects of food waste reduction*, *planning meals and sharing them with others, making and using shopping lists,* and *advice on buying and storing food* (RQ4.1). This accounted for 25 of the 32 specific functions incorporated in the prototype. To the best of my knowledge, none of the previous work tried to model the functionality supports for food management and food waste in a technological intervention. The proposed model is largely *descriptive* and to a lesser extent *generative,* as well as *conceptual* (Bederson & Shneiderman, 2003; Rogers, 2004, cited in Rogers, 2012). This model contributes to the area of sustainable HCI, specifically for researchers and developers in the area of app-based interventions for food waste reduction, with designs and measures which can be used at early stage in the development to investigate what kind of functionalities have the potential for users.

As an extension of this contribution, the proposed model was used to investigate the potential of using different app-based functionality for individuals at different life stages for food waste reduction (RQ4.1). *Checking and managing food at home* was the most likely used component of WasteLess functions, both students and family members are more likely to use them compared to older people. *Checking and managing food at home* includes functions such as *Recipes*, *Check Food: Home, Monitor Particular Foods, and Monitor Goal* for food waste reduction. Similar functionality has been provided in some of the previous interventions but not as part of a multifunctional app (e.g., Farr-Wharton et al., 2013, 2014a, 2014b). However, *community aspects of food waste reduction* was the least likely function to be used, again both students and family members are more likely to use them compared to older people. *Community aspects of food waste reduction* includes functions such as *Food Sharing* and *Joining a Competition* about food waste reduction. It is not surprising that this is less likely to be used by people. Previous research discussed food sharing and trust issues related to this idea (e.g., Farr-Wharton et al., 2014a). In addition, because my study was conducted during the Covid-19 pandemic, the idea of food sharing might have been even more challenging for participants in this study due to the need to isolate and avoid infection. However, it is surprising that joining a competition was less likely to be used in the context of food waste reduction. Such functionality can be considered as gamification (Deterding, 2011), which has been widely used to motivate individuals' positive behaviour change in different contexts. But this might be because food waste reduction is not just affected by individuals' intentions, but also by other aspects such as individuals' knowledge and the external factors around them which can hinder or facilitate performing food waste reduction. This knowledge can help researchers and designers to get ideas about which app-based functionalities to provide as supports for food waste reduction.

This contribution also included the investigation of the opinions of potential users at different life stages and from two different cultures about the support provided in WasteLess app. These were generally in agreement with my initial view as a designer in terms of BCW intervention functions and persuasive technology support provided (RQ4.2; see Chapter 7). Such evaluation at early stages of development is useful, because it can assess if potential users can identify the intended BCW intervention and persuasive technology supports provided via app functions. This can reflect the clarity

of the design in presenting the ideas to users, which is key to the success of the app in supporting users in reducing food waste. This knowledge was used to investigate the potential of different BCW interventions and persuasive technology techniques to support individuals for food waste reduction (RQ4.3; see Chapter 7). In general, *Competition* and *Cooperation* had lower potential to support individuals for food waste reduction, compared to other interventions and persuasion supports such as *Enablement*, *Education, Personalization, Reduction, Tracking* and *Reminder.* This can provide a robust foundation based on (Fogg, 2003; Michie et al., 2011; Oinas-Kukkonen & Harjumaa, 2008, 2009) for app-based technological interventions for food waste reduction. The previous research lacked clear connections between these theories and their practical potential to be used in the context of food waste reduction, although some interventions used some techniques. For example, *Competition* was used in BinCam (Thieme et al., 2012), but without explicit evaluation (Chapter 2, Section 2.3.2). Investigating the potential of these techniques in relation of food waste reduction can help researchers and designers of technological interventions to provide suitable and effective solutions for food waste issues.

Furthermore, it included the finding that clarity, accuracy, and technological barriers were the main usability and accuracy issues raised about the WasteLess app (RQ4.4; see Chapter 7). This included clarity of information and visual representation in the WasteLess functions; the value of accuracy in information provided by some functions; and technological barriers such as data entry and update issues. These have also been issues with other mobile apps (e.g., EatChaFood and Fridge Pal; Farr-Wharton et al., 2014a). Therefore, working version of the WasteLess should consider these aspects, towards enhance usability of the app.

8.2 Lessons learned from the programme of research

This section highlights the lessons learned from the programme of research which may be useful for researchers and designers of technological interventions for food waste reduction, as well as for the public.

 Researchers and designers of technological interventions should:

- View food waste in a comprehensive way, as a set of multi-disciplinary issues that draw on various disciplines such as environmental and social psychology, economics, nutrition studies, policy studies, sustainability studies, waste management studies as well as HCI.

- Consider potential users' life stage and culture when providing support around food management and waste, and consider how different users are motivated to reduce their food waste.

- Consider placing more importance on the issue of overbuying food for individuals at different life stages and cultures, with special focus on the specific reasons leading to overbuying.

- In general, consider that older people may be less likely to use technological support for food waste reduction than younger people. Consider the methods older people previously used for food management and waste (e.g., paper shopping lists), building on these would be appropriate.

- Consider placing importance on providing support for checking and managing food at home particularly for students and family members.

- In general, do not focus on providing functionality around community aspects of food waste reduction, such as competitions and food sharing, for older people in particular.

- Consider individuals at all life stages when providing support for making and using shopping lists and advice on buying and storing food.

- In general, cooperation and competition may not be appropriate means to motivate users to reduce food waste in technological interventions.

In addition, BCW can be used by designers as an approach to design an app-based intervention for food waste issues. To do so, they should:

  o Follow the systematic guidance provided by BCW, including understanding the specific issues which lead to food waste.

  o Use the COM-B model to identify which sources of change are needed to mitigate each specific reason for food waste.

  o Consider using BCW intervention functions for COM-B components, based on the link provided by BCW; for this, designers should consider the type of technological interventions they are developing and whether it can incorporate the interventions suggested by BCW.

o Consider integrating the BCW with persuasive technology techniques (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2008, 2009) which can be used as specific principles for persuasion intervention.

Public should be provided with:

- Advice about overbuying food, particularly packages of food that are too big and offers.
- Information about different food labelling, to help better understand the types of labels available to them.
- Advice on the appropriate methods to store different foods at home, to keep the food last for longer.
- Advice on how to cater for special occasions with less food waste, perhaps by using the same ingredients in different dishes.
- Ways of providing food for picky eaters with less food waste, particularly for children.

8.3 Limitations of the work

While this programme of research had made a number of contributions in understanding how to use behaviour change theories in technological interventions to reduce food waste, there are a number of limitations that need to be highlighted.

The first limitation is that the studies in this research all used self-report measures. The disadvantage of self-reported data is that the results are based on what participants *say* they do and not what they *actually* do. For example, in Study 4, the results reflect participants' stated opinions of their likelihood of using a range of proposed functions in the WasteLess app. This does not necessarily reflect their actual use of these functions if they were provided with an app. However, this can give an initial idea of what people might use before going to all the effort of implementing an app.

In addition, using self-reported measures in understanding individual behaviour around such a sensitive issue like food waste can be susceptible to social desirability bias (Nederhof, 1985) and demand characteristics (Young et al., 2006). In terms of social desirability bias, food waste is strongly related to moral aspects for at least some cultural groups (Visschers et al., 2016), therefore participants might over-report

positive attitudes and behaviours in relation to reducing food waste and under-report a lack of interest or concern in food waste and wasteful behaviour. For example, when asking participants about whether they feel guilty when they throw food away, participants reported significant agreement about this. The possible effect of social desirability bias could be that participants might think they should feel guilty about this, rather than reporting how they really feel.

However, to mitigate the social desirability bias, some techniques were used. For example, I assured participants of the anonymity and confidentiality of their responses, to minimise the stress of reporting undesirable behaviours around food waste. I also informed participants at the beginning of each study that there were no correct "yes" or "no" answers, just their opinions, in order to make them feel more comfortable in answering the questions and not feeling that they were going to be judged by others.

A second limitation in this programme of research is the possible effects of researcher culture on understanding and interpretation the findings in this research. Being a Saudi person, growing up with Saudi culture might have helped me to better understand the views of my Arab participants, and interpret why some practices or issues are important for them or not. This unfortunately was not the same with participants from other cultural groups such as British and Chinese participants, although engaging with students from other cultures helped me understand more about their cultures. Being a woman might have meant that I have more knowledge about food preparation and cooking than men, and this may have influenced my vision about the issues and the proposed solutions. Being Muslim might have helped me to understand the views of Muslims about food waste. However, I lack such understanding about other religions. Finally, being international postgraduate student in the UK helped me understand the view of student participants in Study 1, and the pressures and stresses of students in this situation. However, reviewing the literature has helped me to know more about the groups for which I am an outsider.

A third limitation in this programme of research is that in some the studies there was a gender imbalance in the samples of participants. For example, in Study 1, 71.4% of the participants were women, although in Study 2 60.7% were women and in Study 4 58.9% of participants were women, so the gender imbalance was not so severe, and in Study 3 the sample was close to gender balanced with 47.4% women. This gender

imbalance might have an impact on the results, particularly of Study 1. Many previous studies have reported a gender imbalance in their participants (e.g., Yagoub et al., 2022 had 71.6% women; Nikolaus et al.,2018 had 63.7% women). Yagoub et al. (2022) reported that some studies including those by Buzby and Guthrie (2002) and Kijboonchoo et al. (2013) found that women waste food more than men. However other studies (e.g., Barr, 2007; Li, 2017) found that women are more likely to reduce food waste than men. Thus, having more women in studies about food waste study may not give an accurate picture of overall food waste.

A fourth limitation in this programme of research is the small sample sizes in some of the studies, particularly of some groups. For example, Study 4, involved only 24 Arab participants, divided between two life stages, so 12 students and 12 family members. This was the number of participants I could manage to recruit at that time, due to the Covid-19 pandemic. Because I was in York during that time, it was difficult to contact people in Arab countries personally to participate. I used a number of social media platforms to contact potential participants in those countries. However, the response rate was very low. This could be because that people were preoccupied with dealing with the pandemic and the change it made on their lifestyle, which made them less interested in doing other activities. For Arab older people, it was not possible to recruit any people from this group for Study 4, as they are not accustomed to doing online surveys and would not be comfortable with answering questions online. If it had not been for the pandemic, I would have conducted evaluations with older Arab people face-to-face in Saudi Arabia. However, I was able to recruit a large sample size of British participants (215 participants, across three life stages) for Study 4. The effect on the pandemic on recruiting British participants was positive. This might be because British people are more familiar doing online studies, compared to Arab people and perhaps because people were often isolated in their homes, doing an online study was a diversion. In addition, for British participants, there were more options to recruit participants online through dedicated recruitment websites such as participant recruitment sites like Prolific and Call For Participants, and through online community groups, as well as through personal contacts. However, for Arab participants, the options of recruiting participants were limited. I used community groups such as Arab society groups in the UK (e.g., WhatsApp.com), to reach Arab students, and personal contacts to reach Arab participants in Saudi Arabia, but the response rate was very low.

A fifth limitation in this programme of research is that Prolific was used to recruit all the participants for Study 3 and about 10% of the participants for Study 4. The need to use the Prolific platform was due to the Covid-19 restrictions, as direct contact with participants was impossible. Data quality is a key issue related to using such platforms for recruiting participants and conducting studies. As mentioned by Douglas et al. (2023), Mechanical Turk, a very widely used recruitment platform, does not guarantee high quality data. Douglas et al. (2023) found that Prolific provides higher data quality compared to MTurk, and Peer et al. (2017, cited in Douglas et al., 2023) and therefore recommend Prolific as alternative to MTurk. Another issue which is related to such recruitment platforms is what it is called "professional" survey takers (individuals who take hundreds or even thousands of surveys annually). Comparing MTurk and Prolific, MTurk has more experienced workers, while Prolific has less experienced workers (Peer et al., 2017, cited in Douglas et al., 2023). Although Eisele (2022, cited in Douglas et al., 2023) mentioned that individuals who take surveys frequently do not provide worse data quality compared to individuals who take surveys less frequently. Therefore, experience of taking surveys only does not predict differences in data quality (Douglas et al., 2023).

A sixth limitation is that this programme of research was conducted during the Covid-19 pandemic, which undoubtedly affected the findings in a number of ways. For example, the data collection for Study 3 was conducted in December 2020. The study collected data from British individuals in relation to food shopping and waste, and the drivers related to food waste issues. Although such effects are not explicitly noticeable in the results, I am aware of the possibility that pandemic changed individuals' practices and motivations around food and food waste. This is in addition to the fact that the data were collected at Christmas time, which is a special time of the year in the UK when individuals have important celebrations (Aktas et al., 2018). Major holidays like Christmas tend to change food preparation routines (Bernstad, 2014).

In addition, the data collection for Study 4 was conducted in March and April 2021. The study collected data from individuals mainly about using functions in WasteLess app. The pandemic might have had an effect on the way participants considered some functionalities such as food sharing to support food waste reduction. Food sharing is a controversial idea regardless of the pandemic situation, as has been discussed by some

researchers (e.g., Farr-Wharton et al., 2014a). In addition, the Covid-19 pandemic made these issues even more challenging for individuals, as they may have been more concerned about food hygiene and contact with other people outside their households.

In relation to effect of the pandemic on Study 4, the study had been planned initially to do an evaluation of the app in the lab with face-to-face interviews to obtain more detailed information about participants' reactions to the functions, but this was unfortunately not possible due to the restrictions of Covid-19 pandemic, so an online study was conducted instead.

8.4 Directions for future work

This programme of research made a start in investigating individuals' attitudes, practices and drivers around food consumption and waste, considering *Culture* and *Life stage*.

Building on Studies 1 and 2 in this research, future research should further investigate further why *Life stage* makes a difference in food waste drivers. For example, is this due to different household sizes, or material situation of individuals at different life stages? The current research relied on surveys and interviews, so it would be appropriate to use other methods, going beyond self-reports to investigate these issues in more depth. For example, using diary studies or observational methods with participants at different life stages to investigate their current food management and food waste practices. This would require collecting detailed information about participants' overall situation such as how many members (adults and children) living in the household, approximate household yearly income, and number of working hours a day for different family members. In addition, weekly interviews would be helpful to discuss the reasons for food waste with participants, following up on diary entries, as well as to gathering additional information that may affect their food practices.

In addition, the current research addressed food practices and food waste with Arab participants, but only small sample sizes could be obtained. Future research can investigate these issues further in Saudi Arabia and other Arab countries which all share Islamic culture. This would show in more detail the influence of Islam on food practices and food waste reduction, as well as variations within the Arab world.

Building on Study 3 in this research, future research could further investigate the influence of culture in relation to food waste and food waste reduction. The validation of the *High importance* food waste drivers in this research, was conducted only with British participants, can be extended with other cultures or to investigate other variables such as gender. The methodology used in Study 3 of asking people (e.g., from particular culture or specific gender) to rate a large number of potential food waste drivers can easily be extended, with only small adjustments needed to the wording to address cultural and gender variations.

In addition, future research can do further validation on the relationship between the food waste drivers developed in the **understanding and investigation** phase and the components in the model of food waste components developed in the **validation** phase. This can strengthen the understanding of the importance of different food waste issues.

Building on Study 4, future research can evaluate WasteLess with a much larger sample of Arab potential users. This could help to model the app-based functionalities and investigate the key support areas for Arab individuals. In addition, the evaluation with larger sample of Arab potential users can be used to help investigate the potential of BCW intervention functions and persuasive technology for Arab individuals. This in turn can be used in comparison with the findings of Study 4 in this research, and highlight the effects of culture further.

The evaluation of the WasteLess app was conducted with a low fidelity prototype and self-report measures. This gave initial idea of the likelihood of using the app-based functionalities and BCW intervention functions and persuasive techniques. Future research can extend develop the app further, by first implementing a high fidelity prototype of the WasteLess app and evaluating it with experts to identify any usability problems, for example the collaborative heuristic evaluation (CHE) method could be used again in this context. Then, field studies need to be conducted to establish the acceptance and effectiveness of WasteLess in changing users' behaviour. Field studies would require a pre-intervention baseline period to establish the initial level of food waste, followed by a period of use of WasteLess, in order to evaluation the effectiveness of the app in reducing food waste. Research should consider conducting field trials with users at different life stages and in different cultures, tailoring the WasteLess app to

the different groups, based on the results from this programme of research on the different food waste drivers for these groups.

8.5 Conclusions

Food waste reduction is one of the main objectives for a sustainable food system, and HCI researchers have begun to address issues associated with food and sustainability (Norton et al., 2017). This programme of research contributed to the area of sustainable HCI, by investigating and incorporating behaviour change aspects of technological interventions into an app to support users' food waste reduction, considering individuals' *culture* and *Life stage*.

This programme of research concluded that although culture has effect on some aspects but not others in relation to food consumption and waste; life stage has a more important effect compared to culture on individuals' practices around food waste drivers. In addition, overbuying food is an important issue for food waste for individuals from different cultures and at different life stages. For individuals at the three life stages, a particular buying behaviour, being over-optimistic about how much food one will consume, was the specific reason leading to overbuying food.

The Behaviour Change Wheel (BCW) (Michie et al., 2011) and persuasive technology (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2008, 2009) are suitable theories for developing a multifunctional technological intervention for food waste reduction. In relation to food waste reduction support, generally Competition and Cooperation (Oinas-Kukkonen & Harjumaa, 2008, 2009) have low potential to be used by individuals for food waste reduction, which was a surprising result.

In relation to functionality, despite the prevailing idea that younger people are likely to use functionality about advice on buying and storing food, this research concluded that there is no difference between older and younger people in using such functionality.

Finally, as expected the research concluded that older people are less likely to use technological interventions compared to younger people for food waste reduction.

Appendix A

Chapter 3

A.1. Study 1

A.1.1 Demographic Information of Participants

Table A.1 Demographic information of Chinese students

PC	Age	Gender	Marital status	Living on/off campus	Housing type	living with	N0. of people living with (except participant)		Degree	Country of origin	Length of time in the UK
							Adults	**Children**			
CS1	26	Female	Single	On	N/A	Other students	5	0	MSc	China	1 year
CS2	26	Female	Single	Off	House	Other students	4	0	MSc	China	10 months
CS3	25	Female	Single	Off	Apartment	Other students	5	0	MSc	China	10 months
CS4	23	Female	Single	Off	Apartment	Alone	N/A	N/A	MSc	China	9 months
CS5	28	Female	Married	Off	House	Parents/ relative	1	1	PhD	China	2.5 years
CS6	24	Female	Single	Off	Apartment	Alone	N/A	N/A	MSc	China	2 years
CS7	23	Female	Single	Off	Apartment	Other students	5	0	MSc	China	9 months
CS8	23	Male	Single	On	N/A	Alone	N/A	N/A	MSc	China	9 months
CS9	24	Female	Single	Off	House	Other students	4	0	MSc	China	1 year
CS10	25	Female	Single	Off	House	Other students	4	0	MSc	China	9 months

Note: N/A means information was not provided by the participant

Table A.2 Demographic information of Arab students

| PC | Age | Gender | Marital status | Living on/off campus | Housing type | living with | N0. of household members (excl. participant) | | Degree | Country of origin | Length of time in the UK |
							Adults	Children			
AS1	36	Female	Married	Off-campus	House	Her children	0	3	PhD	Saudi Arabia	4 years
AS2	35	Female	Married	Off-campus	House	Spouse/ partner	1	1	PhD	Saudi Arabia	5 years
AS3	22	Female	Single	Off-campus	House	Other students	2	0	Master	Libya	22 years*
AS4	31	Female	Single	Off-campus	House	Other students	1	0	PhD	Egypt	3 years
AS5	40	Female	Single	On-campus	N/A	Live alone	N/A	N/A	PhD	Oman	4 years
AS6	29	Male	Single	Off-campus	Apartment	Live alone	N/A	N/A	PhD	Saudi Arabia	4 years

Note: *Although one of Arab participants was living in the UK since birth, they were included in the study as they were raised in Arabic background culture. N/A means information was not provided by the participant.

Table A.3 Demographic information of British students

| PC | Age | Gender | Marital status | Living on/off campus | Housing type | living with | N0. of people living with (except participant) | | Degree | Country of origin | Length of time in the UK |
							Adults	Children			
BS1	33	Male	Married/ living with partner	Off-campus	House	Spouse/partner	1	1	PhD	UK	Since birth
BS2	26	Male	Single	Off-campus	Apartment	Other students	1	0	PhD	UK	Since birth
BS3	26	Male	Single	Off-campus	House	Other students	2	0	PhD	UK	Since birth
BS4	27	Male	Single	Off-campus	House	Other students	5	0	PhD	UK	Since birth
BS5	25	Female	Single	Off-campus	House	Other students	2	0	PhD	UK	Since birth

A.1.2. Study 1 and Study 2 Participant Consent Form

Consent Form

Helping Consumers Waste Less Food Using Technology

Thank you for offering to take part in this study.

It is part of our ongoing work on providing support for consumers to waste less food.

For this study, we will be discussing different reasons for food waste. There will be some general discussion and will also ask you to put your views on post-it notes.

Only Helen Petrie and Mashael Aljubairah have access to the results of the discussion. Any information you provide will be completely confidential and stored securely. If it is used in any public document (reports, journal papers), it will be reported in anonymised manner to protect your identity.

If you feel uncomfortable at any point, you are completely free to withdraw from the study. If you do not wish to answer particular questions, you are completely free to not answer.

Before you participate in this study, please complete Section A, printing your name in the first space and then sign at the end.

Once the study is over and you have been debriefed, you will be asked to initial the three statements in Section B, to indicate your agreement.

Section A

I, _____, give my consent to participate in this study concerning the food waste. I have been informed about, and feel that I understand the basic nature of the study. I understand that I may withdraw from the study at any time without prejudice.

I also understand that my information is confidential and anonymous. Only Helen Petrie and Mashael Aljubairah will have access to the data collected in its original format and anything made public will be in a completely anonymised format.

Signature: _____   Date: _____

Section B

Please initial each of the following statements when the study has been completed and you have been debriefed.

I have been adequately debriefed   Your initials:

I was not forced to complete the study   Your initials:

All my questions have been answered   Your initials:

I would like an Amazon gift voucher for £10   Your initials:

To receive a gift voucher, please provide an email address below. This will not be used for any other purpose.

A.1.3. Demographic Information Questionnaire in Study 1

[**Note:** Participants were given a version of the questionnaire appropriate for their group. In this Appendix, all versions of the questionnaire are combined]

P:

Participant Information Form

Some questions about you

[**Note:** Student participants were given Questions 1 - 7 and 11. Other participants were given Questions 8 -11]

1. **What degree are you studying for?**
   - ☐ Bachelor
   - ☐ Master
   - ☐ PhD
   - ☐ Other (please specify) _____

2. **What is your main area of study?** _____

3. **What is your mode of study?**
   - ☐ Full-time student
   - ☐ Part-time student

4. **Where do you live currently?**
   - ☐ On-campus
   - ☐ Off-campus housing

5. **If you live off-campus, what kind of accommodation do you live in?**
   - ☐ House
   - ☐ Apartment
   - ☐ Other (please specify) _____

6. **Do you…**
   - ☐ Live alone
   - ☐ Live with other students
   - ☐ Live with non-student roommates
   - ☐ Live with parents/ relatives
   - ☐ Live with spouse/partner

7. **How many adults and/or children you live with?**

   Adults: _____   Children: _____

8. **If your answer is 'employee', what is your job?** _____

9. **Where do you live currently?**
   - ☐ House
   - ☐ Apartment
   - ☐ Duplex
   - ☐ Other (please specify) _____

10. **Do you…**
    - ☐ Live alone
    - ☐ Live with parents/ relatives
    - ☐ Live with spouse/partner
    - ☐ Live with spouse and children
    - ☐ Other (please specify) _____

11. **How many adults and/or children you live with?**

    Adults: _____   Children: _____

Some questions about shopping for food

12. Who does most of the food shopping for your household? *(select only one option)*

- ☐ Myself
- ☐ My spouse/partner
- ☐ Housemates
- ☐ Other (please specify) _____

13. How often does the main shopper in the household shop for food?

- ☐ Everyday
- ☐ Once a week
- ☐ Several times a week
- ☐ Only when they need to
- ☐ Only when they have time to go shopping
- ☐ Other (please specify) _____

14. Can the main shopper do the shopping when it is convenient for them?

- ☐ Yes
- ☐ Usually
- ☐ No
  If no, please explain briefly _____

15. How is the shopping for your household usually done? *(select all that apply)*

- ☐ Online
- ☐ In a supermarket
- ☐ In specific shops and markets (e.g. bakery, in open air markets or farm shops)
- ☐ Other (please specify) _____

16. What types of food do you prefer to buy? *(select all that apply)*

- ☐ Pre-cooked foods (such as ready meals)
- ☐ Fresh foods
- ☐ Frozen foods
- ☐ Canned foods
- ☐ Other _____

Some questions about your eating habits

17. Typically, how often do you eat out in the student cafeteria?

- ☐ Less than once a week
- ☐ Once a week
- ☐ Several times a week
- ☐ Most days

18. Typically, how often do you eat out in a restaurant or café?

- ☐ Less than once a week
- ☐ Once a week
- ☐ Several times a week
- ☐ Most days

19. Typically, how often do you get take aways (that you collect or have delivered)?

- ☐ Less than once a week
- ☐ Once a week
- ☐ Several times a week
- ☐ Most days

Some questions about preparing food and cooking

20. Who does most of the food cooking for your household? *(select only one option)*

- ☐ Myself
- ☐ My spouse/partner

    ☐   Housemates [only in Study 1]
    ☐   Housemaid [only in Study 2]
    ☐   Other (please specify) _____

21. Typically, how often does the main cook prepare a meal in your household? (e.g. cooking at least one dish such as breakfast, dinner, snack)
    ☐   Several times a day
    ☐   Once a day
    ☐   Several times a week
    ☐   Less than once a week

22. Does the main cook normally use recipes when cooking?
    ☐   Hardly ever
    ☐   Rarely
    ☐   Sometimes
    ☐   Frequently
    ☐   Regularly

23. How do you decide whether food is still good to eat?
    ☐   Labelling (e.g. use by, best before labels)
    ☐   Appearance (e.g. it looks fresh)
    ☐   Smell
    ☐   Taste
    ☐   Other (please specify) _____

24. Do you throw away food which you have not opened the packaging?
    ☐   Hardly ever
    ☐   Rarely
    ☐   Sometimes
    ☐   Frequently
    ☐   Regularly

25. Are you…
    ☐   Vegetarian
    ☐   Vegan
    ☐   Halal [was not included for participants in Saudi Arabia]
    ☐   Currently in the process of becoming or trying to be vegetarian
    ☐   Currently in the process of becoming or trying to be vegan
    ☐   Pescatarian (eat fish but not meat)
    ☐   No restriction (eat everything)
    ☐   Other (please specify) _____

26. If you were to try to reduce your food waste, what would be the most important reason?
(choose only one)
    o   To minimise environmental impact
    o   To reduce the amount I spend on food
    o   Other _____

27. What are the three most thrown away food items in your household? *(Select only three items and write between the brackets:" 1" for the first most wasted food item, "2" for the second most wasted food item, and "3" for the third most wasted food item)*
    ☐   Fruit [ ]
    ☐   Vegetables [ ]
    ☐   Bread and other baked goods (muffins, cake, biscuits etc) [ ]
    ☐   Rice, pasta, other starches [ ]
    ☐   Dairy (milk, yoghurt, cheese) [ ]
    ☐   Meat/Fish [ ]
    ☐   Other (please specify) _____

28. Have you done any positive actions to reduce food waste? Yes/No

   If yes, briefly describe what have you done?

----

29. Do you know of any apps to help with food waste? Yes/No

   If yes, what are they?

   Have you used them? Yes/No
   If yes, what was your experience?

----

30. Please rate your agreement with the following statements by ticking one of the boxes using a scale of 1= Strongly Disagree to 7= Strongly Agree

   1. The main cook is a skilled cook

   Strongly   Strongly
   Disagree   Agree

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

   2. Our household wastes a lot of food

   Strongly   Strongly
   Disagree   Agree

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

   3. Reducing the food waste in our household would be difficult

   Strongly   Strongly
   Disagree   Agree

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

   4. Food waste has a significant effect on the environment

   Strongly   Strongly
   Disagree   Agree

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

   5. Food waste has a significant effect on my budget

   Strongly   Strongly
   Disagree   Agree

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

   6. I feel guilty when I throw food away

   Strongly   Strongly
   Disagree   Agree

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

7. I try not to waste food

Strongly   Strongly
Disagree   Agree

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

31. What is your age? _____

32. What is your gender?

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer not to respond

33. What is your marital status?

- ☐ Single
- ☐ Married/Living with partner
- ☐ Other (please specify) _____

34. What is your country of origin? _____

35. How long have you been in the UK? _____

Thank you

A.1.4. Questions and Topics for Initial Discussions About Food Waste in Focus Groups and Interviews (in Study 1 and Study 2)

No right or wrong answers. No judgements being made, we all waste food, we are trying to find out what people know about the issues, how we can use that to help people waste less with an app.

Before you heard about it from us, had you thought about wasting food as an important issue?

Just your initial thoughts – why is food waste important?

In Chinese/Arab/British society, what do people think about food waste?

Do you think this has changed from generation to generation? For example, would your parents and grandparents have different attitudes to your generation?

[reasons]

So, do you think you waste a lot of food in your current circumstances? Why / why not?

Did you think at all about food waste before you came to the UK?

Do you think you wasted food before you came to the UK? Why/why not?

Did your family think about food waste when you were growing up?

Do you think your family wasted food when you were growing up?

Why do you think you waste food?

Planning meals?

Shopping?

Cooking?

A.1.5. Presentation Slides About Food Waste Used in Focus Groups and Interviews (in Study 1 and Study 2)

Slide 1

Food waste: Why does it matter

Slide 2

The environmental argument

Climate change – I'm sure you have heard about it

The world is heating up
• sea levels are rising
• agriculture is affected

Decades of Warming
Average Global Surface Temperature
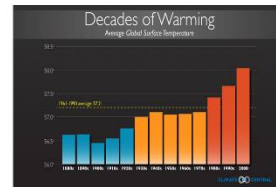
Slide 3

Producing food is an major source of greenhouse gases

About 10% of greenhouse gases come from food production

Also a lot of the food we eat contributes to deforestation and pollution of waterways

Waste management 4%   Other 2%
Business 17%   Residential 15%   Agriculture 10%
Transport 27%   Energy supply 24%
Source: Department for Business. Does not add up to 100% due to rounding.
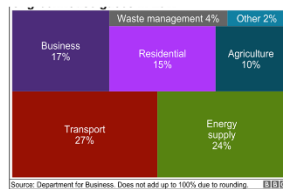
Slide 4

Then wasting food …

We produce greenhouse gases creating the food
and then
We produce more greenhouse gases disposing of the food (transport for our rubbish to be taken away, landfill which produces more gas…)

Slide 5

The economic argument

Globally it's estimated that 30% of the food produced is wasted

In the UK, £20 billion worth of food is wasted each year

That's £810 per household

Slide 6

In China

It is estimated that China wastes 18 million tonnes of food a year

That is enough to feed 30 – 50 million people

http://www.futuredirections.org.au/publication/wasteful-dragon-food-loss-waste-china/

A.1.6. Comments and Votes Exercise for Interviews in Study 1 and Study 2

Question: in this question there are a number of food waste causes, which arranged under four categories: shopping for food, food storage and management, food preparing and cooking and eating and socializing.

[**Note:** Participants were given a version including all categories. In this Appendix, an example of one category (Shopping for Food) is provided]

under each category there are a number of food waste causes,

(1) Please write your comment/s indicating your opinion and how a cause can affect you and lead you to waste food.

(2) You have only 10 votes, please vote for the causes which you think most affecting you and leading you to waste food. You can put **one** vote using one dot, two votes for a cause putting **two** dots, also you put all your votes/dots which is **10** to one cause.

Shopping for food

Food waste cause	*Comments*	*Votes*
I buy larger amounts of food when they are on offer (e.g., BOGOF – buy one get one free).		
I buy food because it is prominently displayed in the supermarket (e.g., at the end of the aisle).		
I buy food that is prominently advertised (on TV, in the supermarket).		
I buy packages of food that are too big for my needs - because smaller packages are not available.		
I buy packages of food that are too big for my needs – because they seem better value.		
I don't plan my food shopping (e.g., I don't make a shopping list, a meal plan).		
I am tempted to buy food which looks appealing in the shop.		
I buy multiple items of the same food (e.g., different flavours) and then don't eat them.		
I buy healthy food and then don't eat them.		
I am too optimistic that I will consume all the food I buy.		
I don't have a good communication with partner about what meals will be prepared to know what to buy. [only for Arab participants]		
Food in our country is affordable, so I would not be affected when I buy more food. [only for Arab participants in Saudi Arabia]		

A.1.7. Codebook of the Study Analysis for Study 1 and Study 2

Theme/ Code	Code label	Definition	Description	Examples
FWD1.	**Overbuying food**			
FWD1.1	Packages too big	Buying bigger packages of food than it is needed due to whether it is more economic than smaller one or there are no available small packages of food they want or like.	Cover participants comments about buying big packages of food, and related to the following food waste drivers: *Buy packages of food that are too big for my needs - because smaller packages are not available.* *I buy packages of food that are too big for my needs – because they seem better value* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	The yogurt that we like it only comes in big pot (in a kilo pot) ...they don't have smaller one (BO2)
FWD 1.2	Over optimistic buying	Overly optimistic about what kind of food to buy (e.g. buying extra fresh food than it will be used) or how much food would be enough to buy (e.g. buying extra amount of food than it will be used).	Participants comments about optimistic buying, and related to the following food waste drivers: *I buy healthy food and then don't eat them.* *I am too optimistic that I will consume all the food I buy.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	I tend to buy too much so I definitely don't go hungry! (BS3)
FWD 1.3	Influenced by offers	Influencing by special offers and discounts on food such as Buy One Get One Free or any kind of offer which encourages overbuying.	Participants comments about influencing by offers, and related to the following food waste driver: *I buy larger amounts of food when they are on offer (e.g., BOGOF – buy one get one free)* Total number of participants votes obtained for the above food waste driver were calculated for this code	This is a big reason to waste food on the occasion of the offer I bought many quantities and do not use them, which leads to expiration (SO5)
FWD 1.4	Impulse buying	Feel desire to buy food that looks attractive whether at supermarkets or food shops.	Participants comments about food looks appealing, and related to the following food waste driver: *I am tempted to buy food which looks appealing in the shop.* Total number of participants votes obtained for the above food waste drivers were calculated for this code	A lot of the time I am craving a food in the shop (AS3)
FWD 1.5	Advertising (on TV, in store)	Influencing by advertisements or marketing strategies on food whether on TV or at supermarkets.	Participants comments about influencing by advertisements or marketing on food, and related to the following food waste drivers: *I buy food that is prominently advertised (on TV, in the supermarket)*	Food is marketed in such a way that you feel you need it (BF4)

			I buy food because it is prominently displayed in the supermarket (e.g., at the end of the aisle) Total number of participants votes obtained for the above food waste drivers were calculated for this code	
FWD 1.6	Food is cheap*	Food is relatively economic and affordable in the country of living which encourages overbuying.	Participants comments about influencing by low cost of food, and related to the following food waste drivers: *Food in our country is affordable, so I would not be affected when I buy more food.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	I buy a meal such as rice which is the smallest meal and cheapest but still it is more than what I need so I waste it (SF3)
FWD 2.	**Shopping and meal planning**			
FWD 2.1	Failure to make a plan	Not making shopping lists or meal plans due to any reason such as doesn't have time to do or lack of motivation to do.	Participants comments about not making plans for shopping or cooking, and related to the following food waste drivers: *I don't plan my food shopping (e.g., I don't make a shopping list, a meal plan)* *I can't be bothered making a shopping/meal plan.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	I do not make plans so sometimes cannot help myself buying too much (CS3)
FWD 2.2	Failure to stick to a plan	Not committing to pre-planned shopping list or meals due to any reasons. For example, conditions changed.	Participants comments about not sticking with plans, and related to the following food waste driver: *I make a shopping/cook plan for meals, but I don't stick with it.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	Plans changed, my husband comes back late from work and does not want to eat so ending having toast (BF1)
FWD 2.3	Communication about meal/shopping/planning	Lack of communication between household members when food shopper buy food that is not required for the meals will be prepared by a person who responsible for cooking in the household.	Participants comments about lack of communication between household members, and related to the following food waste driver: *I don't have a good communication with partner about what meals will be prepared to know what to buy.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	Sometimes there is no communication and my husband buy some items we do not need it and we put it in the fridge until it become inedible and then wasted (SO5)
FWD 3.	**Food storage and management**			

FWD 3.1	Confusion about food labels	Misunderstanding of the meaning of different food labels such as 'use by', 'best before', 'sell by', and 'expiry' or 'production' as they are popular in Saudi Arabia.	Participants comments about confusing about food date labels, and related to the following food waste driver: *I don't know the difference between "sell by"/ "use by"/ "best before" date ['production' and 'expiry' date for participants in Saudi Arabia]* Total number of participants votes obtained for the above food waste driver were calculated for this code.	*I can't identify the difference between display by and use by (CS8)*
FWD 3.2	Lack of information about what food is in the fridge/pantry	Not knowing about what food available at home whether in fridge or cupboard leading to whether food become too old to eat or buying more of the food already available at home.	Participants comments about having no information of what food at home, and related to the following food waste drivers: *I forget what I have in the fridge/cupboards and then buy more of the same.* *I forget what I have in the fridge/cupboards and then things are too old to eat.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	I buy potatoes and then I don't have them for a while, and then I remember there is potato in the fridge and then gone off- so, I buy them then I don't use them and forget them in the fridge (BO4)
FWD 3.3	Lack of knowledge about storing food	Lack of knowledge or experience about how and where to store food at home; whether ingredients or leftover. For example, don't know if food can be frozen or not, how they can be packed and stored, and where they should be stored whether in fridge or cupboard.	Participants comments about having no knowledge about storing food whether food items, ingredients or leftovers, and related to the following food waste drivers: *I don't know what food can or cannot be frozen-how long things can be kept* *I don't know how to package some food to keep them edible for long time.* *I don't know what food is better to be kept in fridge and what food is better to be kept out.* *I don't know about freezing leftover food (what can be frozen, how to do it, how long things can be kept).* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	Chicken spread smell in the fridge as the package has been destroyed and then chicken fillet has been spread all the smell in the fridge lead the accommodation to change the fridge (CS8)
FWD 3.4	Lack of space to store food	Not enough storage places to store food at household such as small freezer.	Participants comments about having no enough places to store food, and related to the following food waste drivers: *I don't have a (big enough) freezer to keep leftover food.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	Student house has a very small freezer (AS3)
FWD 4.	**Food preparation and cooking**			

FWD 4.1	Lack of time/motivation to cook	Doesn't have time or is demotivated to cook food at home.	Participants comments about not having time or motivation to cook, and related to the following food waste driver: *I don't have time to cook.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	I work m-f then run around with after school clubs. I cook more at the weekend (BF1)
FWD 4.2	Lack of knowledge of how to use leftovers	Lack of knowledge or experience about how to use remaining food at household whether it is plate leftover or some ingredients.	Participants comments on not knowing what to do with leftovers, and related to the following food waste drivers: *I don't know what to do with ingredients left over when I cook a meal.* *I don't know what to do with leftover food* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	I am confused which may lead to store it for a period and then throwing after expiration (SF5)
FWD 4.3	Using leftover food is too much effort	Find saving or re-using leftover as bothering task.	Participants comments on saving leftovers is a bothering task, and related to the following food waste driver: *I can't be bothered saving leftover food.* Total number of participants votes obtained for the above food waste driver were calculated for this code.	I don't want to bother myself that's why I take food out of the house (SO1)
FWD 4.4	Belief that leftovers are not healthy	Consumer belief about eating leftover food can be unhealthy or risky for their health.	Participants comments on not eating leftover food sue to health risk, and related to the following food waste driver: *Eating leftover food is risky for one's health, so I throw away any leftover food.* Total number of participants votes obtained for the above food waste driver were calculated for this code.	Sometimes I feel it is unhealthy to eat cooked food couple of days ago (AS4)
FWD 4.5	Lack of cooking skills	Lacking skills and knowledge to cook food at household.	Participants comments on lacking cooking skills, and related to the following food waste driver: *I'm not a good cook – I make things, but they don't taste good, so they go to waste.* Total number of participants votes obtained for the above food waste driver were calculated for this code.	I am not a skilled cook, and when I cook something that I have not cooked it before its taste would be not good (SO6)
FWD 5.	**Eating and socialising**			
FWD 5.1	Catering for "picky" eaters	Household member/s are picky and selective in which food to eat, and do not like some meals or ingredients.	Participants comments on serving food to picky eaters, and related to the following food waste driver: *Family members/guests are picky eaters and don't eat everything I cook.*	My children often refuse to eat healthier options especially if they see onion! (BF1)

			Total number of participants votes obtained for the above food waste driver were calculated for this code.	
FWD 5.2	Catering for special occasions	Serving food on holidays, special occasions such as wedding, family or friend gathering, and events in different cultures such as Christmas, Ramadan or Chinese New Year where people might provide extra food for guests or family than usual.	Participants comments on serving food for special occasions, and related to the following food waste drivers: *I tend to waste food on special occasions like Christmas.* *I want to serve ample food to myself/family/guests, but that ends with waste.* *I often cook for family members/guests who then don't turn up for the meal.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	Saudi biggest waste of food in Ramadan (SO5)
FWD 5.3	Cooking a lot, but not eating it	Cook or buy food but then get bored with eating it.	Participants comments on cooking or buying food but then not eat it, and related to the following food waste driver: *buy/cook food, but then don't feel like eating it.* Total number of participants votes obtained for the above food waste driver were calculated for this code.	The type of food is matter, for us our food is fatty/oily therefore, we will eat little when we cook more (AS6)
FWD 5.4	Impulse eating	Eating food that is seen immediately or feel like in the fridge or cupboards and not what needs to be used up.	Participants comments on impulse eating, and related to the following food waste drivers: *I eat what I see immediately in the fridge/cupboards, not what needs using up.* *I want to eat what I feel like, not what I actually have in the fridge/cupboards.* Total number of participants votes obtained for the above food waste drivers were calculated for this code.	Appetite, I put food in the fridge, but I don't want to eat it again that's why I waste it (AS5)

Note: * The food waste driver (FWD1.6, Food is cheap) was just included in Study 2. Also, this Codebook includes examples of participants comments from Study 1 and Study 2.

A.1.8. Analysis of Comments and Votes in Study 1

Table A.4 Comments provided by students for each driver (Number of comments, percentage of comments for that group)

Food waste driver	Chinese students	Rank	British students	Rank	Arab students	Rank	All students	Rank
FWD1. Overbuying food	**19**		**21**		**12**		**52**	
FWD1.1 Packages too big	8 (42.11)	1	9 (42.86)	1	0 (0.00)		17 (32.69)	1
FWD 1.2 Over optimistic buying	1 (5.26)		6 (28.57)	2	8 (66.67)	1	15 (11.53)	2
FWD 1.3 Influenced by offers	5 (26.32)	2	3 (14.29)	3	1 (8.33)	3.5	9 (6.92)	3
FWD 1.4 Impulse buying	3 (15.79)	3	2 (9.52)		2 (16.67)	2	7 (5.38)	
FWD 1.5 Advertising (on TV, in store)	2 (10.53)		1 (4.76)		1 (8.33)	3.5	4 (3.07)	
FWD 2. Shopping and meal planning	**10**		**11**		**1**		**22**	
FWD 2.1 Failure to make a plan	7 (70.00)	1	7 (63.64)	1	1 (50.00)	1.5	15 (68.18)	1
FWD 2.2 Failure to stick to a plan	3 (30.00)	2	4 (36.36)	2	0 (0.00)		7 (5.38)	2
FWD 2.3 Communication about meal/shopping/planning	N/A		N/A		1 (50.00)	1.5	1 (0.76)	3
FWD 3. Food storage and management	**20**		**16**		**13**		**49**	
FWD 3.1 Confusion about food labels	7 (35.00)	1.5	0 (0.00)		1 (7.69)		8 (16.32)	3
FWD 3.2 Lack of information about what food is in the fridge/pantry	4 (20.00)	3	8 (50.00)	1	5 (38.46)	1	17 (13.07)	1.5
FWD 3.3 Lack of knowledge about storing food	7 (35.00)	1.5	6 (37.50)	2	4 (30.77)	2	17 (13.07)	1.5
FWD 3.4 Lack of space to store food	2 (10.00)		2 (12.50)	3	3 (23.08)	3	7 (5.38)	
FWD 4. Food preparation and cooking	**13**		**8**		**10**		**31**	
FWD 4.1 Lack of time/motivation to cook	4 (30.77)	1.5	4 (50.00)	1	5 (50.00)	1	13 (41.93)	1
FWD 4.2 Lack of knowledge of how to use leftovers	3 (23.08)	3	2 (25.00)	2.5	1 (10.00)	3	6 (4.61)	3
FWD 4.3 Using leftover food is too much effort	0 (0.00)		0 (0.00)		0 (0.00)		0 (0.00)	
FWD 4.4 Belief that leftovers are not healthy	4 (30.77)	1.5	2 (25.00)	2.5	4 (40.00)	2	10 (7.69)	2
FWD 4.5 Lack of cooking skills	2 (15.38)		0 (0.00)		0 (0.00)		2 (1.53)	
FWD 5. Eating and socialising	**13**		**10**		**16**		**39**	
FWD 5.1 Catering for "picky" eaters	3 (23.08)	2	1 (10.00)		1 (6.25)		5 (12.82)	
FWD 5.2 Catering for special occasions	6 (46.15)	1	4 (40.00)	1	3 (18.75)	3	13 (10.00)	1.5
FWD 5.3 Cooking a lot, but not eating it	2 (15.38)		2 (20.00)	3	4 (25.00)	2	8 (6.15)	3
FWD 5.4 Impulse eating	2 (15.38)		3 (30.00)	2	8 (50.00)	1	13 (10.00)	1.5

Notes: Rank 1 = range from 1.000 to 1.999, Rank 2 = range from 2.000 to 2.999, Rank 3 = range from 3.000 to 3.999

Table A.5 Votes given to each main food waste driver and sub-driver (Number of votes, percentage of votes for that group)

Food waste driver	Chinese students	Rank	British students	Rank	Arab students	Rank	All students	rank
FWD1. Overbuying food	**100[1]**		**17**		**13**		**130**	
FWD1.1 Packages too big	48 (48.0)	1	8 (47.05)	1	0 (0.00)		56 (43.07)	1
FWD 1.2 Over optimistic buying	25 (25.0)	2	5 (29.40)	2	10 (76.90)	1	40 (30.76)	2
FWD 1.3 Influenced by offers	12 (12.00)	3	4 (23.50)	3	1 (7.69)	3	17 (13.07)	3
FWD 1.4 Impulse buying	4 (4.00)		0 (0.00)		2 (15.30)	2	6 (4.61)	
FWD 1.5 Advertising (on TV, in store)	11 (11.00)		0 (0.00)		0 (0.00)		11(8.46)	
FWD 2. Shopping and meal planning	**31**		**13**		**1**		**45**	
FWD 2.1 Failure to make a plan	22 (70.96)	1	11 (84.60)	1	1 (100.00)	1	34 (75.55)	1
FWD 2.2 Failure to stick to a plan	9 (29.03)	2	2 (15.38)	2	0 (0.00)		11 (8.46)	2
FWD 2.3 Communication about meal/shopping/planning	N/A		N/A		0 (0.00)		0 (0.00)	
FWD 3. Food storage and management	**78**		**8**		**14**		**100**	
FWD 3.1 Confusion about food labels	21 (26.90)	2	0 (0.00)		0 (0.00)		23 (23.00)	3
FWD 3.2 Lack of information about what food is in the fridge/pantry	16 (20.50)	3	5 (62.50)	1	6 (42.85)	1	27 (20.76)	2
FWD 3.3 Lack of knowledge about storing food	35 (44.87)	1	1 (12.50)	3	3 (21.40)	3	39 (30.00)	1
FWD 3.4 Lack of space to store food	6 (7.69)		2 (25.00)	2	5 (35.70)	2	13 (10.00)	
FWD 4. Food preparation and cooking	**61**		**6**		**23**		**90**	
FWD 4.1 Lack of time/motivation to cook	11(18.03)	2	5 (83.30)	1	5 (21.70)	2	21 (23.33)	3
FWD 4.2 Lack of knowledge of how to use leftovers	34 (55.7)	1	1 (16.66)	2	4 (17.39)	3	39 (30.00)	1
FWD 4.3 Using leftover food is too much effort	0 (0.00)		0 (0.00)		0 (0.00)		0 (0.00)	
FWD 4.4 Belief that leftovers are not healthy	9 (14.75)	3	0 (0.00)		14 (60.86)	1	23 (17.69)	2
FWD 4.5 Lack of cooking skills	7 (11.47)		0 (0.00)		0 (0.00)		7 (5.38)	
FWD 5. Eating and socialising	**98**		**5**		**9**		**112**	
FWD 5.1 Catering for "picky" eaters	7 (7.14)		3 (60.00)	1	0 (0.00)		10 (8.92)	
FWD 5.2 Catering for special occasions	72 (73.46)	1	1 (20.00)	2.5[2]	1(11.10)	3	74 (56.92)	1
FWD 5.3 Cooking a lot, but not eating it	11 (11.20)	2	0 (0.00)		3 (33.30)	2	14 (10.76)	2.5
FWD 5.4 Impulse eating	8 (8.16)	3	1 (20.00)	2.5	5 (55.55)	1	14 (10.76)	2.5

Notes: 1= Chinese students were given a whole sheet of dots, with different amounts of dots, by mistake. **2=** Rank 1 = range from 1.000 to 1.999, Rank 2 = range from 2.000 to 2.999, Rank 3 = range from 3.000 to 3.999

A.1.9. Detailed Results of Food practices and attitudes to food waste

Table A.6 Details of food shopping and cooking practices (Number and percentage of responses)

	Chinese Students N=10	British Students N=5	Arab Students N=6	All Students N=21
Who does most of the food shopping for your household? (Q12)				
Myself	10 (100.0)	2 (40.0)	4 (66.7)	15 (71.4)
My spouse/ partner	0 (0.0)	1 (20.0)	0 (0.0)	1 (4.7)
Housemates	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other (e.g., shop separately or together)	0 (0.0)	2 (40.0)	2 (33.3)	4 (19.0)
How often does the main shopper in the household shop for food? (Q13)				
Everyday	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Once a week	3 (30.0)	2 (40.0)	3 (50.0)	8 (38.0)
Several times a week	4 (40.0)	2 (40.0)	2 (33.3)	8 (38.0)
Only when they need to	2 (20.0)	1 (20.0)	1 (16.7)	6 (28.5)
Only when they have time	1 (10.0)	0 (0.0)	0(0.0)	1 (4.7)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Can the main shopper do the shopping when it is convenient for them? (Q14)				
Yes	9 (90.0)	3 (60.0)	4 (66.7)	16 (76.1)
Usually	1 (10.0)	1 (20.0)	2 (33.3)	4 (19.0)
No	0 (0.0)	1 (20.0)	0 (0.0)	1 (4.7)
How is the shopping for your household usually done? (Q15)				
Online	3 (30.0)	0 (0.0)	2 (33.3)	5 (23.8)
In supermarket	10 (100.0)	5 (100.0)	6 (100.0)	21 (100.0)
In specific shops and market (e.g., bakery, in open air markets or farm shops)	2 (20.0)	0 (0.0)	0 (0.0)	2 (9.5)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
What types of food do you prefer to buy? (Q16)				
Pre-cooked foods (such as ready meals)	2 (20.0)	1(20.0)	1 (16.7)	4 (19.0)
Fresh foods	10 (100.0)	5 (100.0)	6 (100.0)	21 (100.0)
Frozen food	3 (30.0)	1 (20.0)	4 (66.7)	8 (38.0)
Canned food	2 (20.0)	3 (60.0)	2 (33.3)	7 (33.3)
Other (e.g., pasta, rice)	0 (0.0)	1 (20.0)	0 (0.0)	1 (4.7)
Who does most of the food cooking for your household?[13](Q20)				
Myself	N/A	2 (40.0)	6 (100.0)	8 (72.7)
My spouse/ partner		1 (20.0)	0 (0.0)	1 (9.0)
Housemaid		0 (0.0)	0 (0.0)	0 (0.0)
Other (e.g., cook separately)		2 (40.0)	0 (0.0)	2 (18.1)
Typically, how often does the main cook prepare a meal in your household? (e.g., cooking at least one dish such as breakfast, dinner, snack) (Q21)				
Several times a day	8 (80.0)	2 (40.0)	3 (50.0)	13 (61.9)
Once a day	1 (10.0)	3 (60.0)	3 (50.0)	7 (33.3)
Several times a week	1 (10.0)	0 (0.0)	0 (0.0)	1 (4.7)
Less than once a week	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Does the main cook normally use recipes when cooking? (Q22)				

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[13] This question was included for Arab focus group and interview with British students. However, it was accidently omitted in the focus group with Chinese students. Therefore, the percentage calculated in the All Student was out of the total number of only Arab and British student groups.

Hardly ever	0 (0.0)	2 (40.0)	2 (33.3)	4 (19.0)
Rarely	2 (20.0)	1 (20.0)	2 (33.3)	5 (23.8)
Sometimes	7 (70.0)	1 (20.0)	1 (16.7)	9 (42.8)
Frequently	1 (10.0)	1 (20.0)	1 (16.7)	3 (14.2)
Regularly	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Table A.7 Details of participants' diet type and eating habits (Number of responses, percentage for each group)

	Chinese Students N=10	British Students N=6	Arab Students N=5	All Students N=21
Typically, how often do you eat out in the student cafeteria? (Q17)				
Less than once a week	8 (80.0)	3 (60.0)	4 (66.7)	15 (71.4)
Once a week	1 (10.0)	1 (20.0)	1 (16.7)	3 (14.2)
Several times a week	1 (10.0)	0 (0.0)	1 (16.7)	2 (9.5)
Most days	0 (0.0)	1 (20.0)	0 (0.0)	1 (4.7)
Typically, how often do you eat out in a restaurant or café (not on campus)? (Q18)				
Less than once a week	6 (60.0)	3 (60.0)	5 (83.3)	14 (66.6)
Once a week	2 (20.0)	2 (40.0)	0 (0.0)	4 (19.0)
Several times a week	2 (20.0)	0 (0.0)	1 (16.7)	3 (14.2)
Most days	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Typically, how often do you get take aways (that you collect or have delivered)? (Q19)				
Less than once a week	9 (90.0)	5 (100.0)	3 (50.0)	18 (85.7)
Once a week	0 (0.0)	0 (0.0)	2 (33.3)	2 (9.5)
Several times a week	1 (10.0)	0 (0.0)	1 (16.7)	2 (9.5)
Most days	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Are you… (Q25)				
Vegetarian	0 (0.0)	1 (20.0)	0 (0.0)	1 (4.7)
Vegan	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Halal	0 (0.0)	0 (0.0)	6 (100.0)	6 (28.5)
Currently in process of becoming or trying to be vegetarian	0 (0.0)	2 (40.0)	0 (0.0)	2 (9.5)
Currently in process of becoming or trying to be vegan	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Pescatarian (eat fish but not meat)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
No restriction (eat everything)	10 (100.0)	2 (40.0)	0 (0.0)	12 (57.1)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Table A.8 Details of food waste practices and attitudes (Number, percentage of responses)

Food waste practice	Chines Students N=10	British Students N=5	Arab Students N=6	All Students N=21
How do you decide whether food is still good to eat? (Q23)				
Labelling	7 (70.0)	2 (40.0)	2 (33.3)	10 (47.6)
Appearance	5 (50.0)	5 (100.0)	2 (33.3)	12 (57.1)
Smell	2 (20.0)	4 (80.0)	3 (50.0)	9 (42.8)
Taste	0 (0.0)	3 (60.0)	2 (33.3)	5 (23.8)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Do you throw away food which you have not opened the packaging? (Q24)				
Hardly ever	2 (20.0)	4 (80.0)	3 (50.0)	9 (42.8)
Rarely	5 (50.0)	0 (0.0)	2 (33.3)	7 (33.3)
Sometime	3 (30.0)	1 (20.0)	1 (16.7)	5 (23.8)
Frequently	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Regularly	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
What are the three most thrown away food items in your household? (Q27)				
Vegetables	1st 1 (10.0) 2nd 6 (60.0) 3rd 2 (20.0)	1st 2 (40.0) 2nd 1 (20.0) 3rd 2 (40.0)	1st 2 (33.3) 2nd 4 (66.7) 3rd 0 (0.0)	1st 5 (23.8) 2nd 11 (52.3) 3rd 4 (19.0)
Dairy (milk, yoghurt, cheese)	1st 1 (10.0) 2nd 1 (10.0) 3rd 1 (10.0)	1st 1 (20.0) 2nd 1 (20.0) 3rd 1 (20.0)	1st 1 (16.7) 2nd 2 (33.3) 3rd 1 (16.7)	1st 3 (14.2) 2nd 4 (19.0) 3rd 3 (14.2)
Bread and other baked goods (e.g., muffins, cake or biscuits)	1st 4 (40.0) 2nd 0 (0.0) 3rd 1 (10.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 2 (40.0)	1st 1 (16.7) 2nd 0 (0.0) 3rd 3 (50.0)	1st 5 (23.8) 2nd 0 (0.0) 3rd 6 (28.5)
Fruit	1st 1 (10.0) 2nd 0 (0.0) 3rd 3 (30.0)	1st 1 (20.0) 2nd 3 (60.0) 3rd 0 (0.0)	1st 2 (33.3) 2nd 1 (16.7) 3rd 0 (0.0)	1st 4 (19.0) 2nd 4 (19.0) 3rd 3 (14.2)
Rice, pasta, other starches	1st 1 (10.0) 2nd 1 (10.0) 3rd 1 (10.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 1 (16.7)	1st 1 (4.7) 2nd 1 (4.7) 3rd 2 (9.5)
Meat/fish	1st 2 (20.0) 2nd 2 (20.0) 3rd 1 (10.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 2 (9.5) 2nd 2 (9.5) 3rd 1 (4.7)
Other (e.g., snack, meal leftover)	1st 0 (0.0) 2nd 0 (0.0) 3rd 1 (10.0)	1st 1 (20.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 1 (4.7) 2nd 0 (0.0) 3rd 1 (4.7)
If you were to try to reduce your food waste, what would be the most important reason? (Q26)				
To minimise environmental impact	4 (40.0)	2 (40.0)	1 (16.7)	7 (33.3)
To reduce the amount spend on food	6 (60.0)	2 (40.0)	1 (16.7)	9 (42.8)
Both (minimise environmental impact & reduce the amount spend on food) *	0 (0.0)	1 (20.0)	0 (0.0)	1 (4.7)
Other (related to their religious beliefs or moral principles)	0 (0.0)	0 (0.0)	4 (66.7)	4 (19.0)
Have you used [these apps]? (Q29)				
No	9 (90.0)	5 (100.0)	6 (100.0)	20 (95.2)
Yes	1 (10.0)	0 (0.0)	0 (0.0)	1 (4.7)

Appendix B

Chapter 4

B.1. Study 2

B.1.1 Demographic Information of Participants

Table B.1 Demographic information of British family members

PC	Age	Gender	Marital status	Housing type	living with	N0. of people living with (except participant)		Employment status	Country of origin
						Adults	children		
BF1	42	Female	Married/ living with partner	House	Spouse and children	3	2	Employee	UK
BF2	39	Female	Married/ living with partner	House	Spouse and children	1	2	Employee	UK
BF3	46	Female	Married/ living with partner	House	Spouse and children	1	2	Employee	UK
BF4	49	Female	Married/ living with partner	House	Spouse and children	1	1	Employee	UK
BF5	32	Male	Separated	House	Other (with daughter on set days)	0	1	Employee	UK
BF6	49	Female	Married/ living with partner	House	Spouse and children	1	2	Employee	UK

Table B.2 Demographic information of Arab family members

PC	Age	Gender	Marital status	Housing type	living with	N0. of people living with (except participant)		Employment status	Country of origin
						Adults	children		
AF1	30	Female	Married	Apartment	Spouse and children	1	1	Employee	Saudi Arabia
AF2	32	Female	Married	Apartment	Spouse and children	1	3	Employee	Saudi Arabia
AF3	N/A	Female	Married	Apartment	Spouse and children	1	1	Employee	Saudi Arabia
AF4	33	Female	Married	Apartment	Spouse and children	2	2	Employee	Saudi Arabia
AF5	35	Female	Married	Apartment	Husband and children	2	3	Employee	Saudi Arabia

Note: N/A means information was not provided by a participant

Table B.3 Demographic information of British older people

PC	Age	Gender	Marital status	Housing type	living with	N0. of people living with (except participant)		Employment status	Country of origin
						Adults	children		
BO1	70	Female	Married/ living with partner	House	Spouse/ partner	1	0	Retired	UK
BO2	71	Female	Married/ living with partner	House	Spouse/ partner	1	0	Retired	UK
BO3	73	Female	Single	House	Alone	0	0	Retired	UK
BO4	69	Female	Single	House	Alone	0	0	Retired	UK
BO5	69	Male	Married/ living with partner	House	Spouse/ partner	1	0	Retired	UK
BO6	73	Male	Married/ living with partner	House	Spouse/ partner	1	0	Retired	UK
BO7	70	Female	Single	House	Alone	0	0	Retired	UK
BO8	78	Male	Married/ living with partner	House	Spouse/ partner	1	0	Retired	UK
BO9	70	Male	Married/ living with partner	House	Spouse/ partner	1	0	Retired	UK
BO10	75	Male	Married/ living with partner	House	Spouse/ partner	1	0	Retired	UK

Table B.4 Demographic information of Arab older people

PC	Age	Gender	Marital status	Housing type	living with	N0. of people living with (except participant)		Employment status	Country of origin
						Adults	children		
AO1	52	Male	Married	House	Wife and sons and daughters	4	0	Retired	Saudi Arabia
AO2	60	Male	Married	House	Wife and sons and daughters	6	0	Retired	Saudi Arabia
AO3	50	Male	Married	House	Wife and sons and daughters	4	0	N/A	Saudi Arabia
AO4	Approx. 64	Male	Married	House	Wife and sons and daughters	5	0	Retired	Saudi Arabia
AO5	52	Female	Married	House	Husband and sons and daughters	4	0	Housewife	Saudi Arabia
AO6	60	Male	Married	House	Wife and sons and daughters	4	0	Retired	Saudi Arabia
AO7	65	Female	Married	House	Husband and sons and daughters	6	0	Housewife	Saudi Arabia

Note: N/A means information was not provided by the participant

B.1.2. Analysis of Comments and Votes in Study 2

Table B. 5 Comments provided by participants for each driver (Number of comments, percentage of comments for that group)

Food waste driver	Arab family members	Rank	British family members	Rank	Arab older people	Rank	British older people	Rank	All	Rank
FWD1. Overbuying food	**12**		**15**		**23**		**27**		**77**	
FWD1.1 Packages too big	3 (25.00)	2	1 (6.67)		3 (13.04)	3.5	10 (37.04)	1	17	3
FWD 1.2 Over optimistic buying	4 (33.33)	1	4 (26.67)	2	7 (30.43)	1.5	6 (22.22)	3	21	1.5
FWD 1.3 Influenced by offers	1 (8.33)		6 (40.00)	1	7 (30.43)	1.5	7 (25.93)	2	21	1.5
FWD 1.4 Impulse buying	1 (8.33)		1 (6.67)		2 (8.70)		3 (11.11)		7	
FWD 1.5 Advertising (on TV, in store)	1 (8.33)		3 (20.00)	3	1 (4.35)		1 (3.70)		6	
FWD 1.6 Food is cheap	2 (16.67)	3	N/A		3 (13.04)	3.5	N/A		5	
FWD 2. Shopping and meal planning	**6**		**9**		**7**		**2**		**24**	
FWD 2.1 Failure to make a plan	5 (83.33)	1	4 (44.44)	2	4 (57.14)	1	0 (0.00)		13	1
FWD 2.2 Failure to stick to a plan	0 (0.00)		5 (55.56)	1	1 (14.29)	3	2 (100.00)	1	8	2
FWD 2.3 Communication about meal/shopping/planning	1 (16.67)	2	N/A		2 (28.57)	2	N/A		3	3
FWD 3. Food storage and management	**6**		**8**		**19**		**13**		**46**	
FWD 3.1 Confusion about food labels	0 (0.00)		0 (0.00)		0 (0.00)		1 (7.69)	3.5	1	
FWD 3.2 Lack of information about what food is in the fridge/pantry	5 (83.33)	1	6 (75.00)	1	11 (57.89)	1	9 (69.23)	1	31	1
FWD 3.3 Lack of knowledge about storing food	1 (16.67)	2	0 (0.00)		7 (36.84)	2	2 (15.38)	2	10	2
FWD 3.4 Lack of space to store food	0 (0.00)		2 (25.00)	2	1 (5.26)	3	1 (7.69)	3.5	4	3
FWD 4. Food preparation and cooking	**9**		**5**		**13**		**2**		**29**	
FWD 4.1 Lack of time/motivation to cook	3 (33.33)	2	4 (80.00)	1	0 (0.00)		0 (0.00)		7	2.5
FWD 4.2 Lack of knowledge of how to use leftovers	4 (44.44)	1	1 (20.00)	2	4 (30.77)	2	0 (0.00)		9	1
FWD 4.3 Using leftover food is too much effort	0 (0.00)		0 (0.00)		2 (15.38)	3.5	0 (0.00)		2	
FWD 4.4 Belief that leftovers are not healthy	1 (11.11)	3.5	0 (0.00)		5 (38.46)	1	1 (50.00)	1.5	7	2.5
FWD 4.5 Lack of cooking skills	1 (11.11)	3.5	0 (0.00)		2 (15.38)	3.5	1 (50.00)	1.5	4	
FWD 5. Eating and socialising	**14**		**10**		**22**		**12**		**58**	

Food waste driver	Arab family members	Rank	British family members	Rank	Arab older people	Rank	British older people	Rank	All	Rank
FWD 5.1 Catering for "picky" eaters	2 (14.29)	3	5 (50.00)	1	1 (4.55)		2 (16.67)	3	10	3
FWD 5.2 Catering for special occasions	7 (50.00)	1	2 (20.00)	3	11(50.00)	1	6 (50.00)	1	26	1
FWD 5.3 Cooking a lot, but not eating it	0 (0.00)		0 (0.00)		3 (13.64)	3	2 (16.67)	3	5	
FWD 5.4 Impulse eating	5 (35.71)	2	3 (30.00)	2	7 (31.82)	2	2 (16.67)	3	17	2

Notes: Rank 1 = range from 1.000 to 1.999, Rank 2 = range from 2.000 to 2.999, Rank 3 = range from 3.000 to 3.999

Table B.6 Votes provided by participants for each driver (Number of comments, percentage of comments for that group)

Food waste driver	Arab family members	Rank	British family members	Rank	Arab older people	Rank	British older people	Rank	All	Rank
FWD1. Overbuying food	**15**		**4**		**26**		**35**		**80**	
FWD1.1 Packages too big	1 (6.66)		1 (25.00)	2.5	4 (15.38)	2.5	14 (40.00)	1.5	20	2
FWD 1.2 Over optimistic buying	9 (60.00)	1	1 (25.00)	2.5	13 (50.00)	1	14 (40.00)	1.5	37	1
FWD 1.3 Influenced by offers	3 (20.00)	2	2 (50.00)	1	3 (11.50)		3 (8.57)		11	3
FWD 1.4 Impulse buying	0 (0.00)		0 (0.00)		0 (0.00)		4 (11.40)	3	4	
FWD 1.5 Advertising (on TV, in store)	1 (6.66)		0 (0.00)		2 (7.69)		0 (0.00)		3	
FWD 1.6 Food is cheap	1 (6.66)		N/A		4 (15.38)	2.5	N/A		5	
FWD 2. Shopping and meal planning	**7**		**13**		**8**		**7**		**35**	
FWD 2.1 Failure to make a plan	3 (42.85)	1.5	9 (69.20)	1	2 (25.00)	2.5	2 (28.57)	2	16	1
FWD 2.2 Failure to stick to a plan	1 (14.28)	3	4 (30.76)	2	2 (25.00)	2.5	5 (71.40)	1	12	2
FWD 2.3 Communication about meal/shopping/planning	3 (42.85)	1.5	N/A		4 (50.00)	1	N/A		7	3
FWD 3. Food storage and management	**10**		**7**		**9**		**22**		**48**	
FWD 3.1 Confusion about food labels	0 (0.00)		0 (0.00)		0 (0.00)		1 (4.50)		1	
FWD 3.2 Lack of information about what food is in the fridge/pantry	7 (70.00)	1	5 (71.40)	1	3 (33.33)	2	11 (50.00)	1	26	1
FWD 3.3 Lack of knowledge about storing food	3 (30.00)	2	0 (0.00)		5 (55.55)	1	5 (22.70)	2.5	13	2
FWD 3.4 Lack of space to store food	0 (0.00)		2 (28.57)	2	1 (11.11)	3	5 (22.70)	2.5	8	3
FWD 4. Food preparation and cooking	**6**		**8**		**7**		**7**		**28**	

FWD 4.1 Lack of time/motivation to cook	1 (16.66)	2	7 (87.50)	1	1 (14.28)	3.5	0 (0.00)		9	1
FWD 4.2 Lack of knowledge of how to use leftovers	5 (83.30)	1	1 (12.50)	2	0 (0.00)		2 (28.57)	2	8	2
FWD 4.3 Using leftover food is too much effort	0 (0.00)		0 (0.00)		2 (28.57)	2	1 (14.28)		3	
FWD 4.4 Belief that leftovers are not healthy	0 (0.00)		0 (0.00)		3 (42.85)	1	3 (42.85)	1	6	3
FWD 4.5 Lack of cooking skills	0 (0.00)		0 (0.00)		1 (14.28)	3.5	1 (14.28)		2	
FWD 5. Eating and socialising	**15**		**28**		**12**		**29**		**84**	
FWD 5.1 Catering for "picky" eaters	2 (13.30)		17 (60.70)	1	2 (16.66)	2.5	2 (6.89)	3	23	2
FWD 5.2 Catering for special occasions	6 (40.00)	1	4 (14.28)	3	8 (66.66)	1	23 (79.30)	1	41	1
FWD 5.3 Cooking a lot, but not eating it	3 (20.00)	3	1 (3.57)		0 (0.00)		1 (3.40)		5	
FWD 5.4 Impulse eating	4 (26.66)	2	6 (21.4)	2	2 (16.66)	2.5	3 (10.30)	2	15	3

Notes: Rank 1 = range from 1.000 to 1.999, Rank 2 = range from 2.000 to 2.999, Rank 3 = range from 3.000 to 3.999

B.1.3. Detailed Results of Food practices and attitudes to food waste

Table B.7 Details of food shopping and cooking practices (Number and percentage of responses)

	Arab Family members N=5	British Family members N=6	Arab Older People N=7	British Older People N=10	All N=28
Who does most of the food shopping for your household? (Q12)					
Myself	1 (20.0)	4 (66.7)	5 (71.4)	7 (70.0)	17 (60.7)
My spouse/partner	3 (60.0)	0 (0.0)	2 (28.6)	2 (20.0)	7 (25.0)
Other (e.g., shop separately or together)	1 (20.0)	2 (33.3)	0 (0.0)	1 (10.0)	4 (14.3)
How often does the main shopper in the household shop for food? (Q13)					
Everyday	0 (0.0)	0 (0.0)	2 (28.6)	0 (0.0)	2 (7.1)
Once a week	1 (20.0)	4 (66.7)	1 (14.2)	5 (50.0)	11 (39.3)
Several times a week	3 (60.0)	2 (33.3)	2 (28.6)	4 (40.0)	11 (39.3)
Only when they need to	1 (20.0)	0 (0.0)	2 (28.6)	1 (10.0)	4 (14.3)
Only when they have time	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Can the main shopper do the shopping when it is convenient for them? (Q14)					
Yes	2 (40.0)	1 (16.7)	5 (71.4)	10 (100.0)	18 (64.3)
Usually	2 (40.0)	4 (66.7)	2 (28.6)	0 (0.0)	8 (28.6)
No	1 (20.0)	1 (16.7)	0 (0.0)	0 (0.0)	2 (7.1)
How is the shopping for your household usually done? (Q15)					
Online	0 (0.0)	2 (33.3)	1 (14.2)	0 (0.0)	3 (10.7)
In supermarket	5 (100.0)	6 (100.0)	5 (71.4)	10 (100.0)	26 (92.9)
In specific shops and market (e.g., bakery, in open air markets or farm shops)	1 (20.0)	1 (16.7)	3 (42.9)	5 (50.0)	10 (35.7)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
What types of food do you prefer to buy? (Q16)					
Pre-cooked foods (such as ready meals)	0 (0.0)	1 (16.7)	1 (14.2)	1 (10.0)	3 (10.7)
Fresh foods	5 (100.0)	6 (100.0)	7 (100.0)	10 (100.0)	28 (100.0)
Frozen food	2 (40.0)	3 (50.0)	2 (28.6)	6 (60.0)	13 (46.4)
Canned food	2 (40.0)	4 (66.7)	2 (28.6)	4 (40.0)	12 (42.9)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Who does most of the food cooking for your household? (Q20)					
Myself	3 (60.0)	5 (83.3)	2 (28.6)	7 (70.0)	17 (60.7)
My spouse/partner	0 (0.0)	1 (16.7)	4 (57.1)	3 (30.0)	8 (28.6)
Housemaid	2 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (7.1)
Other (e.g., cook separately)	0 (0.0)	0 (0.0)	1 (14.2)	0 (0.0)	1 (3.6)
Typically, how often does the main cook prepare a meal in your household? (e.g., cooking at least one dish such as breakfast, dinner, snack) (Q21)					
Several times a day	0 (0.0)	3 (50.0)	0 (0.0)	7 (70.0)	10 (35.7)
Once a day	0 (0.0)	3 (50.0)	0 (0.0)	3 (30.0)	6 (21.4)
Several times a week*	3 (60.0)	0 (0.0)	3 (42.9)	0 (0.0)	6 (21.4)
Once a week*	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Less than once a week*	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Most days*	2 (40.0)	0 (0.0)	4 (57.1)	0 (0.0)	6 (21.4)
Does the main cook normally use recipes when cooking? (Q22)					

Hardly ever	0 (0.0)	0 (0.0)	1 (14.2)	2 (20.0)	3 (10.7)
Rarely	3 (60.0)	0 (0.0)	1 (14.2)	3 (30.0)	7 (25.0)
Sometimes	1 (20.0)	4 (66.7)	4 (57.1)	4 (40.0)	13 (46.4)
Frequently	0 (0.0)	2 (33.3)	1 (14.2)	1 (10.0)	4 (14.3)
Regularly	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.6)

Note: * In Q14, there was a mistake that Arab participants were provided with different options than British participants for this question. So, options: once a week, and most days were just provided to Arab participants. However, options: less than once a week, and several times a week were provided for both Arab and British participants.

Table B.8 Details of participants' diet type and eating habits (Number of responses, percentage for each group)

	Arab Family members N=5	British Family members N=6	Arab Older People N=7	British Older People N=10	All N=28
Typically, how often do you eat out in a restaurant or café (not on campus)? (Q18)					
Less than once a week	4 (80.0)	3 (50.0)	5 (71.4)	8 (80.0)	20 (71.4)
Once a week	0 (0.0)	3 (50.0)	1 (14.2)	1 (10.0)	5 (17.9)
Several times a week	1 (20.0)	0 (0.0)	1 (14.2)	1 (10.0)	3 (10.7)
Most days	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Typically, how often do you get take aways (that you collect or have delivered)? (Q19)					
Less than once a week	2 (40.0)	6 (100)	4 (57.1)	10(100.0)	22 (78.6)
Once a week	1 (20.0)	0 (0.0)	2 (28.6)	0 (0.0)	3 (10.7)
Several times a week	2 (40.0)	0 (0.0)	1 (14.2)	0 (0.0)	3 (10.7)
Most days	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Are you… (Q25) *					
Vegetarian	0 (0.0)	1 (16.7)	0 (0.0)	1 (10.0)	2 (7.1)
Vegan	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Halal	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Currently in the process of becoming or trying to be vegetarian	0 (0.0)	0 (0.0)	0 (0.0)	1 (10.0)	1 (3.6)
Currently in the process of becoming or trying to be vegan	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Pescatarian (eat fish but not meat)	0 (0.0)	0 (0.0)	1 (14.2)	0 (0.0)	1 (3.6)
No restriction (eat everything)	5 (100)	5 (83.3)	6 (85.7)	8 (80.0)	24 (85.7)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Note: * Assumption was made for Arab participants who were living in Saudi Arabia that they were already Halal eater. Thus, Halal as an option was not provided for them.

Table B.9 Details of food waste practices and attitudes (Number, percentage of responses)

	Arab Family members N=5	British Family members N=6	Arab Older People N=7	British Older People N=10	All N=28
How do you decide whether food is still good to eat? (Q23)					
Labelling	2 (40.0)	4 (66.7)	0 (0.0)	6 (60.0)	12 (42.9)
Appearance	3 (60.0)	5 (83.3)	0 (0.0)	8(80.0)	16 (57.1)
Smell	5(100.0)	4 (66.7)	1 (14.2)	7(70.0)	17 (60.7)
Taste	3 (60.0)	1 (16.7)	0 (0.0)	3 (30.0)	7 (25.0)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Do you throw away food which you have not opened the packaging? (Q24)					
Hardly ever	2 (40.0)	2 (33.3)	4 (57.1)	6 (60.0)	14 (50.0)
Rarely	2 (40.0)	0 (0.0)	2 (28.6)	2 (20.0)	6 (21.4)
Sometime	1 (20.0)	4 (66.7)	1 (14.2)	2 (20.0)	8 (28.6)
Frequently	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Regularly	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
What are the three most thrown away food items in your household? (Q27)					
Vegetables	1st 1(20.0) 2nd 2(40.0) 3rd 1(20.0)	1st 1(16.7) 2nd 2(33.3) 3rd 2(33.3)	1st 3(42.9) 2nd 0 (0.0) 3rd 1(14.2)	1st 5(50.0) 2nd 2(20.0) 3rd 1(10.0)	1st 10(35.7) 2nd 6 (21.4) 3rd 5 (17.9)
Dairy (milk, yoghurt, cheese)	1st 1(20.0) 2nd 1(20.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 1(16.7)	1st 0 (0.0) 2nd 0 (0.0) 3rd 3(42.9)	1st 2 (20.0) 2nd 1(10.0) 3rd 3(30.0)	1st 3 (10.7) 2nd 2 (7.1) 3rd 7 (25.0)
Bread and other baked goods (e.g., muffins, cake or biscuits)	1st 1(20.0) 2nd 0 (0.0) 3rd 2(40.0)	1st 1(16.7) 2nd 3(33.3) 3rd 1(16.7)	1st 3(42.9) 2nd 3(42.9) 3rd 0 (0.0)	1st 1(10.0) 2nd 2(20.0) 3rd 4(40.0)	1st 6 (21.4) 2nd 8 (28.6) 3rd 7 (25.0)
Fruit	1st 1(20.0) 2nd 1(20.0) 3rd 2(40.0)	1st 3(50.0) 2nd 1(16.7) 3rd 1(16.7)	1st 0 (0.0) 2nd 1(14.2) 3rd 2(28.6)	1st 2(20.0) 2nd 4(40.0) 3rd 1(10.0)	1st 6 (21.4) 2nd 7 (25.0) 3rd 6 (21.4)
Rice, pasta, other starches	1st 1(20.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0(0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 1(14.2) 2nd 3(42.9) 3rd 1(14.2)	1st 0 (0.0) 2nd 1(10.0) 3rd 0 (0.0)	1st 2 (7.1) 2nd 4 (14.3) 3rd 1 (3.6)
Meat/fish	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 1(16.7) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 1(10.0)	1st 1 (3.6) 2nd 0 (0.0) 3rd 1 (3.6)
Other	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)	1st 0 (0.0) 2nd 0 (0.0) 3rd 0 (0.0)

Appendix C

Chapter 5

C.1. Study 3

C.1.1 Demographic Information of Participants

Table C.1 Demographic information of British students

PC	Age-range	Gender	Marital status	Living with	No. of people living with (Except participant)		Occupation	Studying degree	Main area of study	Highest qualification
					Adults	Children				
S1	18 - 29	Male	Single	Parents and/or relatives	5	0	Student	Bachelors	Accounting & Finance	High School
S2	18 - 29	Female	Single	Housemate/s	2	0	Student	Masters	Translation	Bachelor's Degree
S3	18 - 29	Female	Single	Housemate/s	7	0	Student	Bachelors	Biomedical Engineering	High School
S4	18 - 29	Female	Single	Alone	0	0	Student	Bachelors	Psychology	High School
S5	18 - 29	Female	Single	Parents and/or relatives	3	0	Student	Masters	History	Master's Degree
S6	18 - 29	Male	Single	Parents and/or relatives	2	0	Student	Bachelors	History	High School
S7	18 - 29	Female	Single	Only spouse/partner	1	0	Student	Bachelors	Neuroscience	Bachelor's Degree
S8	18 - 29	Male	Single	Parents and/or relatives	4	0	Student	Bachelors	Economics	High School
S9	18 - 29	Male	Single	Parents and/or relatives	3	1	Student	Bachelors	Home	High School
S10	18 - 29	Female	Single	Parents and/or relatives	2	0	Student	Bachelors	Home	High School
S11	18 - 29	Female	Single	Parents and/or relatives	4	1	Student	Bachelors	Accounting and Finance	High School
S12	18 - 29	Male	Single	Parents and/or relatives	1	0	Student	Bachelors	Cyber Security	High School
S13	18 - 29	Female	Single	Housemate/s	6	0	Student	Bachelors	Sociology and Criminology	High School
S14	18 - 29	Female	Single	Housemate/s	7	0	Student	Bachelors	Psychology	Other (A-levels)
S15	18 - 29	Male	Married/living with partner	Parents and/or relatives	3	0	Student	Bachelors	Economics	Bachelor's Degree

S16	18 - 29	Female	Single	Housemate/s	6	0	Student	Bachelors	History and Politics	High School
S17	18 - 29	Female	Single	Housemate/s	3	0	Student	Bachelors	Biomedical Science	High School
S18	18 - 29	Female	Single	Parents and/or relatives	2	2	Student	Bachelors	Engineering	High School
S19	18 - 29	Male	Single	Parents and/or relatives	2	0	Student	Bachelors	Business	Bachelor's Degree

Table C.2 Demographic information of British adults living with children

| PC | Age-range | Gender | Marital status | Living with | No. of people living with (Except participant) | | Occupation | Job-title | Highest qualification |
					adults	children			
ALC1	30 - 39	Female	Married/living with partner	Spouse/partner and children	1	2	Employed or self-employed	Emergency service worker	High School
ALC2	30 - 39	Female	Married/living with partner	Spouse/partner and children	1	2	Employed or self-employed	Retail Administrator	Bachelor's Degree
ALC3	40 - 49	Female	Divorced	Only children	0	2	Employed or self-employed	Photographer	Bachelor's Degree
ALC4	30 - 39	Female	Married/living with partner	Spouse/partner and children	1	1	Employed or self-employed	Teacher	Master's Degree
ALC5	50 - 59	Male	Married/living with partner	Spouse/partner and children	2	1	Employed or self-employed	Wedding photographer	Bachelor's Degree
ALC6	18 - 29	Female	Married/living with partner	Spouse/partner and children	1	2	Employed or self-employed	Project manager	Bachelor's Degree
ALC7	30 - 39	Male	Married/living with partner	Spouse/partner and children	1	1	Employed or self-employed	IT Manager	Bachelor's Degree
ALC8	40 - 49	Male	Single	Only children	0	1	Employed or self-employed	Guttering fitter (construction)	High School
ALC9	40 - 49	Male	Married/living with partner	Spouse/partner and children	1	2	Employed or self-employed	Data Admin	Other (Apprenticeship)
ALC10	50 - 59	Female	Married/living with partner	Spouse/partner and children	1	1	Employed or self-employed	Solicitor	Other (Law Society finals)
ALC11	30 - 39	Male	Married/living with partner	Spouse/partner and children	1	1	Employed or self-employed	Bar Supervisor	High School
ALC12	50 - 59	Female	Married/living with partner	Spouse/partner and children	1	1	Employed or self-employed	HR Manager	Bachelor's Degree

ALC13	18 - 29	Female	Married/living with partner	Spouse/partner and children	1	2	Employed or self-employed	Children health and development practitioner	Master's Degree
ALC14	40 - 49	Female	Married/living with partner	Spouse/partner and children	2	1	Employed or self-employed	Teacher	Bachelor's Degree
ALC15	30 - 39	Male	Married/living with partner	Spouse/partner and children	1	1	Employed or self-employed	Clinical Research Coordinator	Bachelor's Degree
ALC16	40 - 49	Female	Married/living with partner	Spouse/partner and children	1	3	Employed or self-employed	Administrator	Bachelor's Degree
ALC17	30 - 39	Female	Married/living with partner	Spouse/partner and children	1	4	Employed or self-employed	Senior Manager	Bachelor's Degree
ALC18	40 - 49	Female	Widowed	Only children	0	2	Employed or self-employed	Web designer	Bachelor's Degree
ALC19	40 - 49	Female	Married/living with partner	Spouse/partner and children	1	2	Employed or self-employed	Commercial Director	Bachelor's Degree
ALC20	50 - 59	Female	Married/living with partner	Spouse/partner and children	2	0	Employed or self-employed	Nurse	High School
ALC21	40 - 49	Male	Married/living with partner	Spouse/partner and children	1	2	Employed or self-employed	Manager Financer	Master's Degree
ALC22	50 - 59	Female	Married/living with partner	Spouse/partner and children	1	0	Employed or self-employed	Recycling officer	High School
ALC23	30 - 39	Male	Married/living with partner	Spouse/partner and children	1	2	Employed or self-employed	Firefighter	High School
ALC24	18 - 29	Male	Married/living with partner	Spouse/partner and children	1	1	Employed or self-employed	Teacher	Master's Degree
ALC25	30 - 39	Female	Married/living with partner	Spouse/partner and children	2	5	Employed or self-employed	Director of IT	PhD
ALC26	40 - 49	Male	Married/living with partner	Spouse/partner and children	1	1	Employed or self-employed	Accountant	High School
ALC27	40 - 49	Male	Married/living with partner	Spouse/partner and children	1	3	Employed or self-employed	Office manager	Bachelor's Degree
ALC28	30 - 39	Female	Married/living with partner	Spouse/partner and children	1	2	Unemployed		Bachelor's Degree
ALC29	40 - 49	Female	Married/living with partner	Spouse/partner and children	2	1	Unemployed		High School
ALC30	30 - 39	Female	Single	Only children	0	1	Unemployed		High School
ALC31	50 - 59	Female	Divorced	Only children	1	0	Other (please specify)	Full time mum	High School

ALC32	40 - 49	Female	Married/living with partner	Spouse/partner and children	1	2	Other (please specify)	Housewife	Master's Degree
ALC33	40 - 49	Female	Married/living with partner	Spouse/partner and children	1	2	Other (please specify)	Full time mum	Bachelor's Degree
ALC34	18 - 29	Male	Single	Parents and/or relatives	4	1	Employed or self-employed	Financial Analyst	Master's Degree
ALC35	18 - 29	Female	Single	Parents and/or relatives	3	1	Employed or self-employed	Office Admin/Accounts	High School
ALC36	18 - 29	Non-binary	Married/living with partner	Housemate/s	2	1	Unemployed		Bachelor's Degree

Table C.3 Demographic information of British adults living without children

PC	Age-range	Gender	Marital status	Living with	No. of people living with (Except participant)		Occupation	Job-title	Highest qualification
					Adults	Children			
ALW1	18 - 29	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Civil servant	High School
ALW2	40 - 49	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Project manager	Bachelor's Degree
ALW3	18 - 29	Female	Single	Parents and/or relatives	2	0	Employed or self-employed	Research Assistant	Master's Degree
ALW4	40 - 49	Female	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Creative Director	Bachelor's Degree
ALW5	30 - 39	Male	Married/living with partner	Parents and/or relatives	4	0	Employed or self-employed	Manager	High School
ALW6	18 - 29	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Teacher	Master's Degree
ALW7	18 - 29	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Data analyst	Master's Degree
ALW8	50 - 59	Female	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Civil Servant	High School
ALW9	50 - 59	Female	Single	Alone	1	0	Employed or self-employed	Advocate	Bachelor's Degree
ALW10	30 - 39	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Network Engineer	High School
ALW11	50 - 59	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Musician	High School

ALW12	18 - 29	Male	Single	Alone	0	0	Employed or self-employed	Finance	Bachelor's Degree
ALW13	18 - 29	Female	Single	Parents and/or relatives	1	0	Employed or self-employed	Telecommunications agent	Bachelor's Degree
ALW14	18 - 29	Female	Single	Housemate/s	5	0	Employed or self-employed	HR & Talent Acquisition	Bachelor's Degree
ALW15	30 - 39	Female	Single	Alone	0	0	Employed or self-employed	Glass makers assistant	Bachelor's Degree
ALW16	18 - 29	Female	Single	Parents and/or relatives	4	0	Employed or self-employed	Admin Assistant	High School
ALW17	30 - 39	Female	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Learning Specialist	Bachelor's Degree
ALW18	18 - 29	Male	Single	Parents and/or relatives	1	0	Employed or self-employed	Administrator	Bachelor's Degree
ALW19	30 - 39	Female	Single	Parents and/or relatives	2	0	Employed or self-employed	Editor	Bachelor's Degree
ALW20	30 - 39	Male	Single	Parents and/or relatives	2	0	Employed or self-employed	Admin assistant	Bachelor's Degree
ALW21	18 - 29	Female	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Call centre agent	Other (PGCE)
ALW22	30 - 39	Male	Single	Alone	0	0	Employed or self-employed	Quality Assurance	Bachelor's Degree
ALW23	40 - 49	Male	Divorced	Housemate/s	2	0	Employed or self-employed	Self-employed IT	Bachelor's Degree
ALW24	40 - 49	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Tiler	High School
ALW25	18 - 29	Female	Single	Housemate/s	3	0	Employed or self-employed	Clinical scientist	Master's Degree
ALW26	18 - 29	Female	Single	Parents and/or relatives	2	0	Employed or self-employed	Tutor	Master's Degree
ALW27	18 - 29	Female	Single	Parents and/or relatives	4	0	Employed or self-employed	Freelance marketing and administration	Bachelor's Degree
ALW28	30 - 39	Female	Single	Alone	0	0	Employed or self-employed	Academic Librarian	Bachelor's Degree
ALW 29	30 - 39	Female	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Data Analyst	Bachelor's Degree
ALW30	50 - 59	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Prison officer supervisor	High School
ALW31	18 - 29	Female	Single	Parents and/or relatives	2	0	Employed or self-employed	Care Assistant	High School
ALW32	40 - 49	Male	Single	Parents and/or relatives	2	0	Employed or self-employed	Retail, Customer Adviser	High School

ALW33	30 - 39	Female	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Project manager	Master's Degree
ALW34	30 - 39	Male	Single	Parents and/or relatives	2	0	Employed or self-employed	Carpenter	Other (NVQ 3)
ALW35	30 - 39	Male	Single	Alone	0	0	Employed or self-employed	Joiner	Other (HND)
ALW36	50 - 59	Female	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Principal Officer	Master's Degree
ALW37	30 - 39	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Research Associate	PhD
ALW38	40 - 49	Female	Single	Alone	0	0	Employed or self-employed	Accountant	High School
ALW39	18 - 29	Male	Single	Parents and/or relatives	3	0	Employed or self-employed	Retail Assistant	Bachelor's Degree
ALW40	18 - 29	Female	Single	Housemate/s	1	0	Employed or self-employed	Retail Supervisor	Bachelor's Degree
ALW41	40 - 49	Male	Single	Alone	0	0	Employed or self-employed	Joiner	High School
ALW42	40 - 49	Male	Single	Alone	0	0	Employed or self-employed	Engineer	High School
ALW43	30 - 39	Male	Single	Parents and/or relatives	1	0	Employed or self-employed	Copywriter	Bachelor's Degree
ALW44	18 - 29	Male	Single	Only spouse/partner	1	0	Employed or self-employed	Civil servant	Bachelor's Degree
ALW45	50 - 59	Male	Single	Alone	0	0	Employed or self-employed	Military	High School
ALW46	50 - 59	Male	Single	Alone	0	0	Employed or self-employed	Software Tester	PhD
ALW47	18 - 29	Female	Single	Parents and/or relatives	2	0	Employed or self-employed	Designer	Bachelor's Degree
ALW48	40 - 49	Female	Single	Alone	0	0	Employed or self-employed	Teacher	Bachelor's Degree
ALW49	18 - 29	Male	Single	Parents and/or relatives	5	0	Employed or self-employed	IT helpdesk analyst	Bachelor's Degree
ALW50	40 - 49	Female	Single	Only spouse/partner	1	0	Employed or self-employed	Events Management	High School
ALW51	30 - 39	Male	Single	Parents and/or relatives	1	0	Employed or self-employed	Audio Engineer	Bachelor's Degree
ALW52	30 - 39	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Bar Manager	Bachelor's Degree
ALW53	40 - 49	Male	Widowed	Only spouse/partner	N/A	0	Employed or self-employed		PhD
ALW54	40 - 49	Male	Widowed	Only spouse/partner	1	0	Employed or self-employed		PhD
ALW55	18 - 29	Male	Single	Parents and/or relatives	3	0	Unemployed		Bachelor's Degree

ALW56	50 - 59	Male	Single	Parents and/or relatives	3	0	Unemployed		Bachelor's Degree
ALW57	50 - 59	Male	Divorced	Alone	0	0	Unemployed		Bachelor's Degree
ALW58	18 - 29	Female	Single	Parents and/or relatives	5	0	Unemployed		High School
ALW59	18 - 29	Male	Single	Parents and/or relatives	1	0	Unemployed		High School
ALW60	50 - 59	Female	Single	Alone	0	0	Unemployed		High School
ALW61	18 - 29	Male	Single	Parents and/or relatives	2	0	Unemployed		Bachelor's Degree
ALW62	18 - 29	Non-binary	Single	Parents and/or relatives	1	0	Unemployed		High School
ALW63	18 - 29	Male	Single	Parents and/or relatives	1	0	Unemployed		High School
ALW64	30 - 39	Male	Single	Parents and/or relatives	2	0	Unemployed		Master's Degree
ALW65	18 - 29	Male	Single	Parents and/or relatives	3	0	Unemployed		Bachelor's Degree
ALW66	30 - 39	Non-binary	Single	Alone	0	0	Unemployed		Bachelor's Degree
ALW67	18 - 29	Non-binary	Single	Parents and/or relatives	1	0	Unemployed		Bachelor's Degree
ALW 68	50 - 59	Male	Single	Parents and/or relatives	1	0	Other (disabled)		High School
ALW69	18 - 29	Female	Single	Parents and/or relatives	2	0	Other (Looking for work)		Other (BTEC Media)

Table C.4 Demographic information of British retired people

PC	Age-range	Gender	Marital status	Living with	No. of people living with (Except participant)		Occupation	Job-title	Highest qualification
					Adults	Children			
RP1	60 - 69	Male	Married/living with partner	Only spouse/partner	1	0	Retired		Bachelor's Degree
RP2	70+	Male	Married/living with partner	Only spouse/partner	1	0	Retired		Bachelor's Degree
RP3	60 - 69	Female	Married/living with partner	Spouse/partner and children	1	1	Retired		High School
RP4	60 - 69	Male	Married/living with partner	Only spouse/partner	1	0	Retired		Bachelor's Degree
RP5	60 - 69	Male	Married/living with partner	Only spouse/partner	1	0	Retired		Master's Degree
RP6	70+	Male	Married/living with partner	Only spouse/partner	1	0	Retired		High School
RP7	70+	Male	Married/living with partner	Only spouse/partner	1	0	Retired		Bachelor's Degree
RP8	60 - 69	Male	Divorced	Only children	1	0	Employed or self-employed	Forensic Social Worker	Master's Degree
RP9	60 - 69	Female	Married/living with partner	Spouse/partner and children	2	0	Employed or self-employed	Teaching assistant	PhD
RP10	60 - 69	Male	Married/living with partner	Spouse/partner and children	4	0	Employed or self-employed	Laboratory Technician	Bachelor's Degree
RP11	60 - 69	Male	Married/living with partner	Only spouse/partner	1	0	Employed or self-employed	Credit controller	High School

C.1.2 Questionnaire of Study 3

SURVEY ON FOOD SHOPPING AND WASTE

Thank you for volunteering to take part in this survey, which is part of my research for my PhD at the University of York.

I am interested in understanding your attitudes and behaviour in relation to food shopping, management and waste. This will help me in developing an app to guide people in wasting less food.

There are no right or wrong answers to the questions, just your own views.

The survey should take about 10 minutes to complete.

Your participation is completely voluntary, all your information will be completely confidential and anonymous and meet the standards of the General Data Protection Regulation (GDPR).

You are free to withdraw from this survey at any point. If during or after doing the survey you wish to withdraw, just email me with your prolific code and all your information will be deleted.

You are very welcome to ask any questions about this research, at any stage before, during or after the study. You can contact me Mashael Aljubairah at masa506@york.ac.uk or my supervisor Professor Helen Petrie at helen.petrie@york.ac.uk.

Please select the appropriate button below and continue to the next page

- o   I have understood the purpose of the study and am happy to participate

- o   If you do not wish to participate in this study, please return your submission on Prolific by selecting the 'Stop without completing' button.

Enter your prolific ID here: _____

The first set of questions is about you, just for statistical purposes

1. **What best describes your current situation?**
   - o   Student
   - o   Employed or self-employed
   - o   Unemployed
   - o   Retired
   - o   Other (please specify) _____

2. **What is the highest degree or level of education you have completed?**
   - o   High School
   - o   Bachelor's Degree
   - o   Master's Degree
   - o   PhD
   - o   Other (please specify _____

3. **What is your marital status?**
   - o   Single
   - o   Married/living with partner
   - o   Divorced
   - o   Widowed
   - o   Other (please specify) _____

4. Do you live …
- o Alone
- o With housemate/s
- o With parents and/or relatives
- o Only with spouse/partner
- o With spouse/partner and children
- o Only with children
- o Other (please specify) _____

5. What is your age?
- o Under 18
- o 18 - 29
- o 30 - 39
- o 40 - 49
- o 50 - 59
- o 60 - 69
- o 70 and over

6. What is your gender?
- o Female
- o Male
- o Non-binary
- o Prefer to self identify _____
- o Prefer not to say

7. Are you involved in any of these food related activities in your household (select all that apply)
- ☐ Food shopping
- ☐ Food storing and management
- ☐ Food cooking
- ☐ Food waste reduction
- ☐ None of the above

8. What qualification are you studying for?
- o Bachelors
- o Masters
- o PhD
- o Other (please specify) _____

9. Where do you live currently?
- o On campus, in student accommodation
- o Off campus in accommodation specifically for students
- o Off campus in accommodation in other accommodation
- o Other, please specify_____

10. What is your main area of study?_____

11. What is your occupation?_____

12. How many adults do you live with? (do not count yourself)_____

13. How many children do you live with?_____

The next set of questions are about how your household shops for food (if you are a student sharing accommodation, the household could be the group of students you share a kitchen/accommodation with)

14. Who typically shops for food in your household?
- o   Myself
- o   My housemate/s
- o   Myself and house-mate/s
- o   My parents or relatives
- o   My spouse/partner
- o   Myself and spouse/partner
- o   Myself and spouse/partner and children
- o   My spouse/partner and children
- o   Myself and children
- o   My children
- o   All members of the household
- o   Other (please specify) _____

15. How often does the main person who shops typically go shopping for food?
- o   One large shop per week
- o   A large shop per week and several smaller top up shops
- o   Only when they need to
- o   Only when they have time to go shopping
- o   Other (please specify) _____

16. Where is the shopping for food your household most often done?
- ☐   Online
- ☐   In a supermarket
- ☐   In specific shops and markets (e.g. bakery, in open air markets or farm shops)
- ☐   Other (please specify) _____

The next set of questions is about food waste

17. Would you say your household wastes much food?

None or almost none						A lot
1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

18. What kinds of food tend to get wasted in your household?

----

19. What are the main reasons for food waste in your household?

----

20. Please rate your agreement with the following statements about what leads to wasting food in your household

	Strongly Disagree						Strongly Agree
I often buy food in packages that contain more than I need because big packages seem better value	○	○	○	○	○	○	○

I often buy food in packages that contain more than I need because smaller packages are not available	○	○	○	○	○	○	○
I am often overly optimistic that I will consume all the food I buy (e.g. I buy fresh food but then don't eat it)	○	○	○	○	○	○	○
I am often influenced by offers in the shops (e.g. buy one get one free)	○	○	○	○	○	○	○
I often do not make a shopping list	○	○	○	○	○	○	○
I often make a shopping list, but don't stick to it	○	○	○	○	○	○	○
I rarely make a meal/cooking plan	○	○	○	○	○	○	○
I often make a meal/cooking plan, but don't stick to it	○	○	○	○	○	○	○
I am often confused about the meanings of food labels such as "use by", "best before", "sell by" "expiry date"	○	○	○	○	○	○	○
I often forget about what is in the fridge and/or pantry, so items become too old to eat	○	○	○	○	○	○	○
I often forget about what is in the fridge and/or pantry, and buy more of the same items	○	○	○	○	○	○	○
I do not know about storing food so it will last as long as possible	○	○	○	○	○	○	○
I do not know what food is better kept in the fridge and what food is better not kept there	○	○	○	○	○	○	○
I do not know about freezing food (e.g. what can be frozen, how long things can be kept)	○	○	○	○	○	○	○
I often do not have time to cook	○	○	○	○	○	○	○
I am often not motivated to cook	○	○	○	○	○	○	○
I do not know how to use up leftover food	○	○	○	○	○	○	○
Eating leftovers is not healthy	○	○	○	○	○	○	○

	Strongly Disagree						Strongly Agree
I am not a good cook, the things I cook do not taste good, which leads to waste	○	○	○	○	○	○	○
In my household I need to prepare different meals for different people, which leads to waste	○	○	○	○	○	○	○
I often prepare too much food when I have guests, which leads to waste	○	○	○	○	○	○	○
I often prepare too much food on special occasions, which leads to waste	○	○	○	○	○	○	○
I often eat what I feel like, not what needs using up	○	○	○	○	○	○	○
There is often not enough communication between household members about what food needs to be bought (If you live alone, rate as "strongly disagree")	○	○	○	○	○	○	○

21. Please rate your agreement with the following statements about your attitudes to food waste

		Strongly Disagree						Strongly Agree
(A)	I am concerned about food waste in my household	○	○	○	○	○	○	○
(B)	My household wastes too much food	○	○	○	○	○	○	○
(C)	I am concerned about food waste in our society	○	○	○	○	○	○	○
(D)	I try to minimise the amount of food waste in my household	○	○	○	○	○	○	○
(E)	I intend to waste less food in the future	○	○	○	○	○	○	○
(F)	I feel guilty when I throw food away	○	○	○	○	○	○	○

Thank you for taking the time to answer this survey. Your answers will be a great help in my research.
You will now be directed back to prolific to log your participation.

C.1.3 Detailed Results of Food practices and attitudes to food waste

Table C.5 Details of participant involvement in food-related activities (Number and percentage of responses)

	Students N= 19	Adults living with children N=36	Adults living without children N= 69	Retired people N= 11	All N= 135
Are you involved in any of these food related activities in your household? (Q7) *					
Food shopping	16(84.2)	35(97.2)	65(94.2)	11(100.0)	127(94.1)
Food storing and management	13(68.4)	33(91.7)	52(75.4)	7(63.6)	105(77.8)
Food cooking	16(84.2)	35(97.2)	57(82.6)	10(90.9)	118(87.4)
Food waste reduction	7(36.8)	32(88.9)	44(63.8)	8(72.7)	91(67.4)
None of the above	1 (5.3)	0(0.0)	1(1.4)	0(0.0)	2(1.5)

Note: * = multiple answers possible.

Table C.6 Details of food shopping practice (Number and percentage of responses)

	Students N= 19	Adults living with children N=36	Adults living without children N= 69	Retired people N= 11	All N= 135
Who typically shops for food in your household? (Q14)					
Myself	3(15.8)	19(52.8)	27(39.1)	4(36.4)	53(39.3)
My housemate/s	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Myself and house-mate/s	5(26.3)	1(2.8)	4(5.8)	0 (0.0)	10(7.4)
My parents or relatives	7(36.8)	0 (0.0)	10(14.5)	0 (0.0)	17(12.6)
My spouse/partner	0 (0.0)	2(5.6)	0 (0.0)	2(18.2)	4(3.0)
Myself and spouse/partner	1(5.3)	11(30.6)	13 (18.8)	5(45.5)	30(22.2)
Myself and spouse/partner and children	0 (0.0)	1(2.8)	0 (0.0)	0 (0.0)	1(0.7)
My spouse/partner and children	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Myself and children	0 (0.0)	1(2.8)	0 (0.0)	0 (0.0)	1(0.7)
My children	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
All members of the household	3(15.8)	1(2.8)	15(21.7)	0 (0.0)	19(14.1)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
How often does the main person who shops typically go shopping for food? (Q15)					
One large shop per week	6(31.6)	10(27.8)	16(23.2)	5(45.5)	37(27.4)
A large shop per week and several smaller top up shops	9(47.4)	22(61.1)	30(43.5)	4(36.4)	65(48.1)
Only when they need to	3(15.8)	4(11.1)	16(23.2)	2(18.2)	25(18.5)
Only when they have time to go shopping	0 (0.0)	0 (0.0)	1(1.4)	0 (0.0)	1(0.7)
Other	1(5.3)	0 (0.0)	6(8.7)	0 (0.0)	7(5.2)
Where is the shopping for food your household most often done? (Q16) *					
Online	4(21.1)	16(44.4)	18(26.1)	5(45.5)	43(31.9)
In a supermarket	15(78.9)	29(80.6)	59(85.5)	7(63.6)	110(81.5)
In specific shops and markets (e.g., bakery, in open air markets or farm shops)	0 (0.0)	4(11.1)	10(14.5)	2(18.2)	16(11.9)
Other	0 (0.0)	1(2.8)	0 (0.0)	2(18.2)	3(2.2)

Note: * = multiple answers possible.

Table C.7 Details of content analysis of kinds of foods wasted

	Students N= 19	Adults living with children N=36	Adults living without children N= 69	Retired people N= 11	All N= 135
What kinds of foods tend to get wasted in your household? (Q18)					
Vegetables	5 (26.3)	19 (52.7)	29 (42.0)	6 (54.5)	59 (43.7)
Bread and baked goods (e.g., Biscuits, crackers, and croissants)	5 (26.3)	11 (30.5)	21 (30.4)	3 (27.2)	40 (29.6)
Fruits	1 (5.2)	9 (25.0)	21 (30.4)	4 (36.3)	35 (25.9)
Dairy products (e.g., such as milk, yogurt and cheese)	1 (5.2)	9 (25.0)	13 (18.8)	2 (18.1)	25 (18.5)
Leftover	2 (10.5)	7 (19.4)	6 (8.7)	1 (9.0)	16 (11.8)
Chicken and Meat	2 (10.5)	3 (8.3)	5 (7.2)	1 (9.0)	11 (8.1)
Salads	0 (0.0)	2 (5.5)	8 (11.5)	2 (18.1)	12 (8.8)
Dips and sauces	0 (0.0)	2 (5.5)	7 (10.1)	0 (0.0)	9 (6.6)
Expired foods	1 (5.2)	1 (2.7)	0 (0.0)	1 (9.0)	2 (1.4)
Rice/pasta	0 (0.0)	0 (0.0)	2 (2.9)	0 (0.0)	3 (2.2)
Sausages	0 (0.0)	0 (0.0)	1 (1.4)	2 (18.1)	3 (2.2)
Hams/ bacon	0 (0.0)	1 (2.7)	0 (0.0)	1 (9.0)	2 (1.4)
Junk/Sugary food	1 (5.2)	1 (2.7)	0 (0.0)		2 (1.4)
Tinned food	0 (0.0)	0 (0.0)	0 (0.0)	1 (9.0)	1 (0.7)
Eggs	1 (5.2)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)
Pickles	0 (0.0)	1 (2.7)	0 (0.0)	0 (0.0)	1 (0.7)
Herbs	0 (0.0)	1 (2.7)	1 (1.4)	0 (0.0)	2 (1.4)
Fish	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)

Table C.8 Details of quantitative content analysis of main reasons for food waste in the household

	Students N=19	Adults living with children N=36	Adults living without children N=69	Retired people N=11	All N=135
What are the main reasons for food waste in their household? (Q19)					
Over optimistic buying	6 (31.5)	8 (22.2)	14 (20.2)	1 (9.0)	29 (21.4)
Lack of information about what food is in the fridge/pantry	6 (31.5)	2 (5.5)	5 (7.2)	2 (18.1)	15 (11.1)
Cooking a lot, but not eating it	1 (5.2)	2 (5.5)	8 (11.5)	1 (9.0)	12 (8.8)
Packages too big	0 (0.0)	2 (5.5)	3 (4.3)	1 (9.0)	6 (4.4)
Lack of time/motivation to cook	1 (5.2)	2 (5.5)	4 (5.8)	0 (0.0)	7 (5.1)
Impulse eating	2 (10.5)	1 (2.7)	4 (5.8)	1 (9.0)	8 (5.9)
Failure to stick to a plan	0 (0.0)	1 (2.7)	2 (2.9)	0 (0.0)	2 (1.4)
Confusion about food labels	0 (0.0)	1 (2.7)	0 (0.0)	0 (0.0)	1 (0.7)
Catering for 'picky' eaters	0 (0.0)	1 (2.7)	1 (1.4)	0 (0.0)	1 (0.7)
Lack of space to store food	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	1 (0.7)
Influenced by offers	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	1 (0.7)

C.1.4 Overview of participants' thoughts about food waste drivers

This is the results of the ratings on the individual statements of food waste drivers, made by all participants and each participant groups (Table C.9). This is in addition to the RQs investigated in this study.

Table C.9 Medians (and semi-interquartile ranges) of the 24 statements of food waste drivers for all and each participant group

Statement	S	Adult with child	Adult w/o child	Ret	All
I often buy food in packages that contain more than I need because big packages seem better value	5.0 (1.0)	5.0 (1.5)	4.0 (1.5)	2.0 (2.0)	4.0 (1.5)
I often buy food in packages that contain more than I need because smaller packages are not available	4.0 (1.0)	5.0 (1.5)	4.0 (1.5)	5.0 (2.0)	4.0 (1.5)
I am often overly optimistic that I will consume all the food I buy (e.g., I buy fresh food but then don't eat it)	6.0 (1.0)	5.0 (1.5)	5.0 (1.0)	4.0 (0.5)	5.0 (1.0)
I am often influenced by offers in the shops (e.g., buy one get one free)	5.0 (1.0)	5.0 (1.5)	5.0 (1.5)	2.0 (2.0)	5.0 (1.5)
I often do not make a shopping list	5.0 (2.5)	4.0 (2.0)	4.0 (2.5)	4.0 (1.5)	4.0 (2.0)
I often make a shopping list, but don't stick to it	3.0 (2.0)	3.0 (1.5)	3.0 (1.5)	4.0 (2.0)	3.0 (2.0)
I rarely make a meal/cooking plan	3.0 (2.0)	4.0 (2.0)	4.0 (1.5)	3.0 (2.0)	4.0 (1.5)
I often make a meal/cooking plan, but don't stick to	3.0 (1.0)	3.0 (1.5)	2.0 (1.5)	2.0 (1.5)	3.0 (1.0)
I am often confused about the meanings of food labels such as "use by", "best before", "sell by" "expiry date"	2.0 (2.0)	1.0 (1.0)	1.0 (1.0)	1.0 (0.5)	1.0 (1.0)
I often forget about what is in the fridge and/or pantry, so items become too old to eat	5.0 (1.5)	5.0 (1.5)	4.0 (2.0)	6.0 (2.0)	5.0 (1.5)
I often forget about what is in the fridge and/or pantry, and buy more of the same items	4.0 (1.0)	3.0 (2.0)	3.0 (1.0)	4.0 (2.5)	3.0 (1.5)
I do not know about storing food so it will last as long as possible	3.0 (2.0)	2.0 (1.5)	2.0 (1.5)	1.0 (0.5)	2.0 (1.5)
I do not know what food is better kept in the fridge and what food is better not kept there	2.0 (0.5)	2.0 (1.5)	2.0 (1.5)	1.0 (1.5)	2.0 (1.5)
I do not know about freezing food (e.g., what can be frozen, how long things can be kept)	3.0 (2.0)	2.0 (1.5)	2.0 (1.5)	1.0 (0.5)	2.0 (1.5)
I often do not have time to cook	4.0 (1.0)	3.0 (1.5)	3.0 (1.5)	1.0 (0.5)	3.0 (1.5)
I am often not motivated to cook	5.0 (0.5)	4.0 (2.0)	4.0 (2.0)	4.0 (2.5)	4.0 (2.0)
I do not know how to use up leftover food	4.0 (2.5)	4.0 (2.0)	3.0 (2.0)	1.0 (0.0)	3.0 (2.0)
Eating leftovers is not healthy	2.0 (1.0)	1.0 (1.0)	1.0 (1.0)	1.0 (0.5)	1.0 (1.0)
I am not a good cook, the things I cook do not taste good, which leads to waste	2.0 (0.5)	2.0 (1.0)	2.0 (1.0)	1.0 (0.5)	2.0 (1.0)
In my household I need to prepare different meals for different people, which leads to waste	1.0 (1.5)	3.0 (2.0)	1.0 (1.0)	3.0 (1.5)	2.0 (1.5)
I often prepare too much food when I have guests, which leads to waste	4.0 (2.5)	3.0 (1.5)	2.0 (1.5)	2.0 (2.0)	2.0 (2.0)
I often prepare too much food on special occasions, which leads to waste	4.0 (2.0)	3.0 (1.5)	2.0 (1.5)	3.0 (2.0)	3.0 (2.0)
I often eat what I feel like, not what needs using up	5.0 (5.0)	5.0 (1.0)	5.0 (1.5)	3.0 (1.5)	5.0 (1.5)
There is often not enough communication between household members about what food needs to be bought	5.0 (0.5)	3.0 (1.5)	2.0 (1.5)	3.0 (2.0)	3.0 (2.0)

For all participants, they gave high ratings (i.e., median rating of 5-7) on the following statements that led to wasting food in their households:

- I am often overly optimistic that I will consume all the food I buy (e.g., I buy fresh food but then don't eat it)

- I am often influenced by offers in the shops (e.g., buy one get one free);

- I often forget about what is in the fridge and/or pantry, so items become too old to eat;

- I often eat what I feel like, not what needs using up.

For Statement "I am often influenced by offers in the shops e.g., buy one get one free", there was agreement between all participant groups, with a median score was 5.0, except retired people, for whom the median was 2.0, which indicated that they did not agree on this statement. This was similar for Statement "I often eat what I feel like, not what needs using up", where the median score of all participant groups was 5.0, except retired people for whom the median was 3.0.

For Statement "I often forget about what is in the fridge and/or pantry, so items become too old to eat", there was agreement between students and adults living with children, with median score was 5.0. However, for retired people the median score was 6.0, while for adults living without children it was 4.0.

For Statement "I am often overly optimistic that I will consume all the food I buy e.g., I buy fresh food but then don't eat it", there was agreement between adults living with children and adults living without children, with median score was 5.0. However, for students the median score was 6.0, and for retied people it was 4.0.

The study therefore found that the only food waste driver that was identified as *High importance* in Study 1 and 2 which was then confirmed as an important driver in this study was "Lack of information about what food is in the fridge/pantry". The issue of not knowing what was already in stock was also found by Ganglbauer et al. (2015) in their research. However, this study found other important food waste drivers ("Impulse eating", "Influenced by offers", "Over optimistic buying") which were only of *Moderate importance* for British individuals in Studies 1 and 2 (see Chapter 4, Section 4.3.3.2). The method by which importance was calculated in the different studies might account for different results.

Appendix D

Chapter 6

D.1. Development of WasteLess app

D.1.1 Heuristics

Table D.1 Heuristics proposed by Petrie and Power (2012)

Heuristic
Physical presentation
1.   Make text and interactive elements large and clear enough
Default and typically rendered sizes of text and interactive elements should be large enough to be easy to read and manipulate.
2.   Make page layout clear
Make sure that the layout of information on the page is clear, easy to read and reflects the organization of the material.
3.   Avoid short time-outs and display times
Provide time-outs that are long enough for users to complete the task comfortably, and if information is displayed for a limited time, make sure it is long enough for users to read comfortably.
4.   Make key content and elements and changes to them salient
Make sure the key content and interactive elements are clearly visible on the page and that changes to the page are clearly indicated.
Content
5.   Provide relevant and appropriate content
Ensure that content is relevant to users' task and that it is appropriately and respectfully worded.
6.   Provide sufficient but not excessive content
Provide sufficient content (including Help) so that users can complete their task but not excessive amounts of content that they are overwhelmed.
7.   Provide clear terms, abbreviations, avoid jargon
Define all complex terms, jargon and explain abbreviations.
Information architecture
8.   Provide clear, well-organized information structures
Provide clear information structures that organize the content on the page and help users complete their task.
Interactivity
9.   How and why
Provide users with clear explanations of how the interactivity works and why things are happening.
10. Clear labels and instructions
Provide clear labels and instructions for all interactive elements. Follow web conventions for labels and instructions (e.g. use of asterisk for mandatory elements).
11. Avoid duplication/excessive effort by users
Do not ask users to provide the same information more than once and do not ask for excessive effort when this could be achieved more efficiently by the system.
12. Make input formats clear and easy
Make clear in advance what format of information is required from users. Use input formats that are easy for users, such as words for months rather than numbers.

13. Provide feedback on user actions and system progress Provide feedback to users on their actions and if a system process will take time, on its progress.
14. Make the sequence of interaction logical Make the sequence of interaction logical for users (e.g. users who are native speakers of European languages typically work down a page from top left to bottom right, so provide the Next button at the bottom right).
15. Provide a logical and complete set of options Ensure that any set of options includes all the options users might need and that the set of options will be logical to users.
16. Follow conventions for interaction Unless there is a very particular reason not to, follow web and logical conventions in the interaction (e.g. follow a logical tab order between interactive elements).
17. Provide the interactive functionality users will need and expect Provide all the interactive functionality that users will need to complete their task and that they would expect in the situation (e.g. is a search needed or provided?).
18. Indicate if links go to an external site or to another webpage If a link goes to another website or opens a different type of resource (e.g. PDF document) indicate this in advance.
19. Interactive and non-interactive elements should be clearly distinguished Elements which are interactive should be clearly indicated as such, and element which are not interactive should not look interactive.
20. Group interactive elements clearly and logically Group interactive elements and the labels and text associated with them in ways that make their functions clear.
21. Provide informative error messages and error recovery Provide error messages that explain the problem in the users' language and ways to recover from errors.

D.1.2 Introduction to the WasteLess app

WasteLess is an app I am designing to help manage household food. It will not only help you reduce the amount of food you waste, but also help you save money on food, plan your shopping and cooking, and give you tips on food management and cooking.

You can assume that WasteLess will know what food you have in your fridge and pantry – very soon this will be possible, through two routes. Firstly, food that you buy in a supermarket can be logged on your supermarket loyalty card. So, you will just have to wave your loyalty card over your smartphone, and food you have bought in your last shopping trip will be entered into WasteLess.

Secondly, for food that you don't buy in shops where you don't have a loyalty card, there are several routes which would be available to enter information about food you have bought. The easiest would be to use a virtual assistant like Alexa or Siri. You could tell the agent what you have bought and the assistant would have a database with nutritional information for each item. So, you might say "a pound of broccoli" and the virtual assistant would log that information into WasteLess and add nutritional information. An alternative would be to use the bar codes on packets, WasteLess will also have a barcode reader to make this easy to do.

A trickier issue is you would need to keep WasteLess informed about what food you are using and throwing away. Again, doing this via a virtual assistant would be the easiest route. You might say "I'm eating one of the apples". The assistant might ask for more information, with a question like "You have gala and golden delicious apples at the moment, which are you eating?". You would also tell the assistant what food items you are using when you are cooking.

D.1.3 Results of collaborative expert evaluation (CHE)

Application under evaluation: WasteLess

Date: 7/8/ 2020

Evaluators: E1, E2, E3

Heuristic set: Petrie and Power

Problem No.	Problem description	Screen/ Page	Individual ratings			
			E1	E2	E3	Mean
1	First sentence too long.	Instructions page	0.50	1	0	0.50
2	What is the Internet of Things	Instructions page	1	1	1	1.00
3	Confusion over where things are happening (scanning etc)	Instructions page	1	1	1	1.00
4	Shrink logo and de-clutter text	Login page	1	1	1	1.00
5	Terms and conditions needed	Login page	1.50	1	2	1.50
6	Gestalts of headings not working	Set Up	2.50	2	3	2.50
7	Eating habits needs changing as a heading	Set Up	1.50	1	2	1.50
8	Eating habits should be about the individual, looks like it's about the household	Set Up	2.50	3	2	2.50
9	Alignment of icons	Home	1	1	1	1.00
10	Waste should be Food Waste	Home	1	1	1	1.00
11	2 icons have white background, 2 don't	Home	2	2	2	2.00
12	Too much ink, remove lines	across screens	1.50	1	2	1.50
13	Checking Waste should be Check Waste	Home	1	1	1	1.00
14	Home icon should be on the top panel	Home	1	2	0	1.00
15	Check waste icon should go down not up	Home	1	1	1	1.00
16	Icon too big	Food shopping land page	3	2	4	3.00
17	Food Shelf Life	Food shopping land page	2.50	3	2	2.50
18	"Last time" - ask whether they want the date	Food item waste	0	1	2	1.00
19	Need to add an "unused category"	Food item waste	3	4	1	2.66
20	Need to have the used/unused/wasted labels above the bars (if amount is very small the label won't show up)	Food item waste	3	2	2	2.33
21	Label on axis needs to be closer to the bar	Food item waste	3	2	1	2.00
22	Percentages as number or an axis?	Food item waste	0	1	0	0.33
23	Add year as well as week and month	Food item waste	3	1	2	2.00
24	Make red and green bars more representative of the amount used/wasted	Food item waste	3	3	1	2.33
25	Should scroll bar start at the breakdown of the foods?	Food item waste	0	3	1	1.33
26	Add search characteristics	food available	3	2	1	2.00
27	Organize by distance	food available	3	2	1	2.00
28	Make grammar consistent for each explanation	Food management land page	1	1	0	0.66

29	Make last two labels as clearly different as possible	Food management land page	1	2	1	1.33
30	Could number of days to expire be added to the icons?	Check food stock	2	2	1	1.66
31	Align items for better gestalt	Check food stock	2	2	2	2.00
32	Changed filter to sort	Check food stock	1	1	1	1.00
33	Use amber rather than yellow for better contrast	Check food stock	3	3	1	2.33
34	Add stronger line before chicken breast	Check food stock	1	1	3	1.66
35	Align items for better gestalt (check for a particular item)	Check Food Stock (by food item)	1	2	2	1.66
36	Add logo for source of info	Food Labels	2	2	2	2.00
37	Instruction, then place, then length (action first)	Extending Shelf Life	2	3	1	2.00
38	Indicate how many suggestions for keeping food longer	Extending Shelf Life	2	2	2	2.00
39	ToC/links - pantry, freezer, fridge	Extending Shelf Life	2	2	3	2.33
40	View -> "More ..." (drop this)	Extending Shelf Life	0	1	1	0.66
41	Consistent heading Store In/	Extending Shelf Life	2	2	2	2.00
42	Indicate that foods can be frozen with an icon	Extending Shelf Life	3	2.50	2	2.50
43	Make grammar consistent for each explanation	Extending Shelf Life	2	1.50	1	1.50
44	Add info that servings can be scaled (in text)	Recipe Details	2	1.50	1	1.50

D.1.4: Link of food waste drivers and proposed functions in WasteLess app

Table D.2: Links between food waste drivers and WasteLess functions that proposed according to the BCW, is indicated with an x

COM-B component	Food waste driver	Model of behaviour: source	WasteLess function	Description	BCW Intervention function: Designer point of view		
					E	P	B
Capability	FWD 4.2 Lack of knowledge of how to use leftovers	C-Ps	Use up food	Provide recipes to use up particular foods and leftovers.	x		
	FWD 3.1 Confusion about food labels	C-Ps	Food labels	Provide information to understand the meaning of different food labels.	x		
	FWD 3.3 Lack of knowledge about storing food (what food can be frozen, how/where to store food to conserve (fridge versus cupboard)	C-Ps	Extending shelf-life	Provide advice on how to extend food shelf life to last for longer	x		
			Food storage advice	Provide advice on where and how best to store user food	x		
	FWD 4.5 Lack of cooking skills	C-Ps	Recipes	Provide different recipes to cook food, including a "step by step video" feature to provide step by step video for a recipe to help learning how to cook a particular dish.	x		
Opportunity	FWD 2.3 (Lack of) Communication about meal/shopping/planning	O-Ph	Shopping list: share feature	Share the list with other members of the household.			x
			Meal plan: share feature	Share the meal plan with other members of the household.			x
	FWD 5.1 Catering for "picky" eaters	O-So	Set up [14]	Facilitate finding recipes based on the users' preferences.			x
	FWD 2.2 Failure to stick to a plan (shopping plan or meal plan)[15]	O-So	Meal plan	Allow making flexible meal plan: according to specific duration as well as ability to editing.			x
	FWD1.1 Packages too big (e.g., because smaller packages are not available)[16]	O-Ph	Food sharing	Facilitate Sharing extra food with others.			x
			Longer lasting food	Facilitate finding longer lasting substitutions for foods.			x

	FWD 3.2 Lack of information about what food is in the fridge/pantry[17]	O-Ph	Check at home food	Check if users have a particular food item at home while shopping for food.			x
			Check food stock	Check what food users have at home that stored at different areas			x
	FWD 4.1 Lack of time to cook	O-Ph	Recipe: filtering feature[18]	Allow to filter recipes according to suitable time.			x
Motivation	FWD 5.2 Catering for special occasions/ holidays[19]	M-Au	Event plans	Easy planning of upcoming event, as well as providing information of previous similar event details.		*r, t*	x
	FWD1.1 Packages too big (e.g., big package seems better value)	M-Re	Food buying advice	Provide advice on food shelf-life, if it is worth to buy and the sufficient amount to buy	x	*t*	
	FWD 4.4 Belief that leftovers are not healthy	M-Re	Food safety advice	Provides advice about safety of eating leftover food, re-heating food and other safety advice	x		
	FWD 5.4 Impulse eating (e.g., eat what seen/ feel like)	M-Au	Check food stock	Provide easy and delicious recipes to use up available food, and provide information of remaining amount of food available at home and its expiry date		*r, t*	
	FWD 2.1 Failure to make a plan (not motivated to make a shopping list)	M-Au	Shopping list	Provides easy way to create a shopping list.		*r*	

[14] Set up can help with this food waste driver via facilitating accessing to personalised recipes according to their household requirements. However, the main support provided by Set up function is personalization.

[15] This might be due to of working time or other member requirements.

[16] Extending Shelf Life and Recipes can also help with this food waste driver. Extending Shelf Life can facilitate accessing to ways of extending shelf life of their available food at households. Recipes also can facilitate accessing to recipes in order to use food/ingredients users have at households.

[17] This can lead to items become too old to eat or buy more of the same items.

[18] This feature can enable users filtering recipes that suitable to their time. However, the main support provided by Recipe function is education.

[19] This food waste driver (FWD5.2) could be due to the desire of providing too much food for family or guests, which could be because of the social or culture factors, for example as a gesture of welcome in some countries. Thus, this driver can be also categorised under O-So, which have ultimate effect on individual motivation. The WasteLess app provides support for users via Event Plans function to enable them as well as promote their motivation by easily planning and monitoring of their food events details.

				E	P	B
FWD 2.1 Failure to make a plan (a meal/cooking plan)	M-Au	Meal plan	Provides easy way to create meal plan and generate its shopping list.		*r*	
FWD 1.3 Influenced by offers	M-Re	Food buying advice	Provide advice on food shelf-life, if it is worth to buy and the sufficient amount to buy	x	*t*	
FWD 1.2 Over optimistic buying[20]	M-Au	Food buying advice	Provide information about if it is worth to buy and the sufficient amount to buy		*t*	
FWD 4.1 Lack of motivation to cook	M-Au	Extending shelf-life[21]	Facilitate finding ways to extend food shelf-life.			x
Additional motivating functions for food waste reduction		Overall Waste	Check user overall food waste and for each item.		*t*	
		Item Waste	Check user waste of a particular food item.		*t*	
		Goal setting	Set a goal to reduce user food waste and monitor it.		*t*	
		Compete with friends	Join a competition for food waste reduction with user friends		*ct*	
		Food Sharing	Share user food with others to reduce food waste		*co*	
General feature		Set up	Personalise the app according to user preferences.		*p*	

Note*: C-Ps refers to psychological capability, O-Ph refers to physical opportunity, O-So refers to social opportunity, M-Au refers to automatic motivation, and M-Re refers to Reflective motivation. **E** refers to Education, **P** Persuasion and **B** Enablement. *p* refers to personalization support, *r* reduction support, *t* tracking support, *n* reminder support, *co* cooperation support, and *ct* competition support.

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[20] This can include how much / what type of food will be consumed (e.g., fresh food)
[21] Extending shelf-life can also help with this food waste driver via facilitating accessing to ways of extending the shelf life of their available food at households. However, the main support provided by Extending shelf-life function is education.

Appendix E

Chapter 7

E.1. Study 4

E.1.1 Demographic Information of Participants

Table E.1 Demographic information of British students in the UK

PC	Age-range	Gender	Marital status	Living with	No. of people living with (Except participant)		Occupation	Studying degree	Main area of study	Highest qualification
					Adults	Children				
BS1	18-29	Male	Married/Living with partner	Housemate/s	8	0	Student	PhD	Computer science	Bachelors degree
BS2	18-29	Male	Single	Only spouse/partner	1	0	Student	PhD	Computer Science	Masters degree
BS3	18-29	Female	Married/Living with partner	Only spouse/partner	1	0	Student	Other (PGCE)	Primary education	Bachelors degree
BS4	18-29	Female	Single	Parents and/or relatives	4	0	Student	Masters	Pharmacy	High school
BS5	18-29	Female	Single	Housemate/s	5	0	Student	Bachelors	Architecture	Bachelors degree
BS6	18-29	Male	Single	Housemate/s	6	0	Student	Masters	Engineering	High school
BS7	18-29	Female	Single	Parents and/or relatives	4	0	Student	Bachelors	Physical education	Bachelors degree
BS8	18-29	Female	Single	Housemate/s	6	0	Student	Bachelors	Psychology	High school
BS9	18-29	Male	Single	Housemate/s	2	0	Student	Bachelors	Mechanical engineering	High school
BS10	30-39	Female	Married/Living with partner	Only spouse/partner	1	0	Student	PhD	Health research	Masters degree
BS11	18-29	Female	Single	Parents and/or relatives	3	0	Student	Bachelors	Languages	High school
BS12	18-29	Male	Single	Parents and/or relatives	3	0	Student	Bachelors	engineering	Bachelors degree
BS13	18-29	Female	Single	Alone	0	0	Student	PhD	Psychology	Masters degree
BS14	18-29	Female	Single	Alone	0	0	Student	Bachelors	Mathematics	High school
BS15	18-29	Female	Single	Parents and/or relatives	2	0	Student	Bachelors	Psychology	High school
BS16	18-29	Female	Single	Housemate/s	4	0	Student	Bachelors	Physics	High school
BS17	18-29	Female	Single	Alone	0	0	Student	Bachelors	Accounting and Finance	Bachelors degree
BS18	18-29	Female	Single	Parents and/or relatives	2	0	Student	Masters	Computer science	High school

BS19	18-29	Female	Single	Housemate/s	5	0	Student	Bachelors	English Literature	High school
BS20	18-29	Male	Single	Housemate/s	2	0	Student	Bachelors	Software Engineering	High school
BS21	18-29	Male	Single	Alone	0	0	Student	Bachelors	Economics	Bachelors degree
BS22	18-29	Female	Single	Alone	0	0	Student	Bachelors	biological sciences	High school
BS23	18-29	Female	Single	Housemate/s	2	0	Student	Bachelors	Finance	High school
BS24	18-29	Male	Other (in a relationship but living separately)	Parents and/or relatives	4	0	Student	Masters	Politics & Contemporary History	Bachelors degree
BS25	18-29	Male	Single	Alone	0	0	Student	Bachelors	Economics	High school
BS26	30-39	Female	Single	Only spouse/partner	1	0	Student	PhD	Psychology	Masters degree
BS27	18-29	Male	Single	Housemate/s	1	0	Student	Bachelors	Computer science	Bachelors degree
BS28	18-29	Female	Single	Housemate/s	2	0	Student	Bachelors	Population health	High school
BS29	18-29	Female	Single	Housemate/s	1	0	Student	Bachelors	Accounting	Bachelors degree
BS30	18-29	Male	Single	Housemate/s	2	0	Student	Masters	Information Technology	Bachelors degree
BS31	18-29	Female	Single	Alone	0	0	Student	Bachelors	Nursing - mental health	Bachelors degree
BS32	18-29	Male	Single	Alone	0	0	Student	PhD	Medicine	Bachelors degree
BS33	18-29	Female	Single	Housemate/s	1	0	Student	Bachelors	Criminology	High school
BS34	18-29	Male	Single	Alone	0	0	Student	Bachelors	IT	High school
BS35	18-29	Male	Single	Parents and/or relatives	3	0	Student	Bachelors	Nutritionist	High school
BS36	18-29	Female	Single	Parents and/or relatives	2	0	Student	Bachelors	Computing	High school
BS37	18-29	Female	Single	Parents and/or relatives	3	0	Student	Bachelors	Psychology	Other qualification (A-levels)
BS38	18-29	Female	Single	Parents and/or relatives	2	0	Student	Masters	Languages and Cultures	Bachelors degree
BS39	18-29	Male	Single	Parents and/or relatives	2	0	Student	Bachelors	Digital Games	High school
BS40	18-29	Female	Married/Living with partner	Only spouse/partner	1	0	Student	PhD	Pain in autistic children	Masters degree
BS41	18-29	Male	Single	Alone	0	0	Student	Bachelors	Food and nutrition	Bachelors degree
BS42	18-29	Female	Single	Parents and/or relatives	2	0	Student	Other (A-levels)	Classical Civilisation, English Literature, Psychology	High school
BS43	18-29	Male	Single	Housemate/s	2	0	Student	Bachelors	Computer Science	High school
BS44	18-29	Female	Married/Living with partner	Only spouse/partner	1	0	Student	PhD	Social sciences	Masters degree
BS45	18-29	Male	Married/Living with partner	Housemate/s	5	0	Student	Bachelors	Physics	High school
BS46	18-29	Female	Single	Parents and/or relatives	2	0	Student	Bachelors	Music	High school
BS47	18-29	Male	Single	Parents and/or relatives	3	0	Student	Bachelors	Electronics and Instrumentation Engineering	High school
BS48	18-29	Female	Single	Housemate/s	2	0	Student	Bachelors	Economics	High school
BS49	18-29	Female	Single	Housemate/s	1	0	Student	Masters	Technology	Bachelors degree

BS50	18-29	Female	Single	Housemate/s	5	0	Student	Bachelors	Psychology	High school
BS51	18-29	Female	Single	Alone	0	0	Student	Bachelors	Information technology	Bachelors degree
BS52	18-29	Male	Single	Housemate/s	1	0	Student	Bachelors	Engineering	High school
BS53	18-29	Male	Single	Housemate/s	1	0	Student	Masters	Agriculture	Bachelors degree
BS54	18-29	Female	Single	Parents and/or relatives	2	0	Student	Bachelors	Nursing	High school
BS55	18-29	Male	Single	Parents and/or relatives	2	0	Student	Bachelors	Software engineering	Bachelors degree
BS56	18-29	Female	Single	Housemate/s	3	0	Student	Bachelors	Law	High school
BS57	18-29	Female	Single	Parents and/or relatives	4	0	Student	Bachelors	Natural History Photography	High school
BS58	18-29	Female	Single	Parents and/or relatives	2	0	Student	Bachelors	Psychology	High school
BS59	18-29	Male	Single	Housemate/s	1	0	Student	Bachelors	International Relations	High school
BS60	18-29	Female	Single	Parents and/or relatives	2	0	Student	Other (Level 2)	Accounting	Bachelors degree
BS61	18-29	Male	Single	Housemate/s	5	0	Student	Bachelors	Visual Communication	High school
BS62	18-29	Male	Married/Living with partner	Only spouse/partner	1	0	Student	Bachelors	Statistics	High school
BS63	18-29	Female	Single	Parents and/or relatives	3	0	Student	Bachelors	neuroscience	Bachelors degree

Table E.2 Demographic information of British family members in the UK

PC	Age-range	Gender	Marital status	Living	No. of people living with (Except participant)		Occupation	Job-title/ Main area of study	Highest qualification
					Adults	Children			
BF1	30-39	Female	Married/Living with partner	with spouse/partner and children	1	3	Employed or self-employed	Retail supervisor	High school
BF2	40-49	Male	Divorced	Only with children	1	1	Employed or self-employed	Free Lancer	Bachelors degree
BF3	40-49	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Bid writer charity	Masters degree
BF4	30-39	Female	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Veterinary nurse	Other (Nvq3)
BF5	40-49	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Security Manager	Masters degree
BF6	30-39	Female	Single	Only with children	0	2	Employed or self-employed	Waitress	High school
BF7	30-39	Male	Married/Living with partner	with spouse/partner and children	3	2	Employed or self-employed	IT	Masters degree
BF8	30-39	Female	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Museum Learning Manager	Masters degree
BF9	40-49	Female	Married/Living with partner	with spouse/partner and children	3	2	Employed or self-employed	Sales assistant	Bachelors degree
BF10	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	search engine evaluator	Bachelors degree

BF11	30-39	Male	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Outsourcing professional	Other (Diploma)
BF12	30-39	Female	Single	Only with children	0	1	Employed or self-employed	Art therapy support worker	Bachelors degree
BF13	40-49	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Doctor	Bachelors degree
BF14	30-39	Female	Married/Living with partner	with spouse/partner and children	2	2	Employed or self-employed	Nutritionist	Bachelors degree
BF15	30-39	Male	Married/Living with partner	with spouse/partner and children	3	1	Employed or self-employed	Operations manager	Bachelors degree
BF16	30-39	Female	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Solicitor	Bachelors degree
BF17	40-49	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	IT Consultant	Masters degree
BF18	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Unemployed	NA	Masters degree
BF19	40-49	Male	Married/Living with partner	with spouse/partner and children	3	2	Employed or self-employed	Professor	PhD
BF20	40-49	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Property consultant	PhD
BF21	30-39	Female	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Assistant manager	Bachelors degree
BF22	30-39	Male	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Customers service agent	Bachelors degree
BF23	30-39	Female	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Behaviour Support	High school
BF24	40-49	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Security Systems Manager	Bachelors degree
BF25	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Transport Consultant, Engineering	Masters degree
BF26	30-39	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	accountant	Bachelors degree
BF27	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Midwife	Bachelors degree
BF28	30-39	Female	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Clerk	Other
BF29	40-49	Male	Divorced	with spouse/partner and children	1	3	Employed or self-employed	Estate Manager	Bachelors degree
BF30	30-39	Female	Married/Living with partner	with spouse/partner and children	3	3	Employed or self-employed	Technical director	Masters degree
BF31	30-39	Female	Married/Living with partner	with spouse/partner and children	4	2	Employed or self-employed	manager	Masters degree
BF32	40-49	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Security Systems Manager	Bachelors degree
BF33	40-49	Male	Married/Living with partner	with spouse/partner and children	4	2	Employed or self-employed	Fitness trainer	Bachelors degree
BF34	30-39	Female	Married/Living with partner	with spouse/partner and children	2	2	Employed or self-employed	Yoga instructor	Masters degree
BF35	40-49	Female	Married/Living with partner	with spouse/partner and children	1	3	Employed or self-employed	High School Teacher	Bachelors degree

BF36	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Veterinary officer	Bachelors degree
BF37	30-39	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Accountant	Masters degree
BF38	30-39	Female	Married/Living with partner	with spouse/partner and children	3	2	Employed or self-employed	Math teacher	Masters degree
BF39	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Nurse	Masters degree
BF40	40-49	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Lawyer	Bachelors degree
BF41	40-49	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Self employed	Bachelors degree
BF42	40-49	Female	Married/Living with partner	with spouse/partner and children	1	3	Unemployed	NA	Bachelors degree
BF43	30-39	Male	Married/Living with partner	with spouse/partner and children	2	1	Unemployed	NA	Masters degree
BF44	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Engineer	Bachelors degree
BF45	40-49	Female	Married/Living with partner	with spouse/partner and children	1	3	Unemployed	NA	Bachelors degree
BF46	30-39	Female	Married/Living with partner	with spouse/partner and children	2	1	Employed or self-employed	associate director administration	Masters degree
BF47	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	PA	Masters degree
BF48	30-39	Male	Married/Living with partner	with spouse/partner and children	2	3	Unemployed	NA	Bachelors degree
BF49	40-49	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Free lancer	Bachelors degree
BF50	30-39	Male	Married/Living with partner	Only with children	0	2	Unemployed	NA	Bachelors degree
BF51	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Unemployed	NA	Bachelors degree
BF52	30-39	Female	Married/Living with partner	with spouse/partner and children	1	3	Employed or self-employed	Procurement Officer	Bachelors degree
BF53	40-49	Female	Divorced	with spouse/partner and children	1	3	Employed or self-employed	Primary Teacher	Bachelors degree
BF54	40-49	Female	Married/Living with partner	with spouse/partner and children	2	2	Employed or self-employed	Nurse	Bachelors degree
BF55	30-39	Female	Married/Living with partner	with spouse/partner and children	2	2	Employed or self-employed	Teacher	Bachelors degree
BF56	40-49	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Administrator	Masters degree
BF57	30-39	Female	Single	Only with children	0	3	Unemployed	NA	Other (Foundation degree)
BF58	30-39	Male	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Banker	Bachelors degree
BF59	30-39	Male	Single	Only with children	0	2	Employed or self-employed	Unemployed	High school
BF60	30-39	Female	Single	Only with children	0	2	Unemployed	NA	Bachelors degree
BF61	40-49	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Consultant	Bachelors degree
BF62	30-39	Male	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Lecturer (higher education)	PhD

BF63	40-49	Male	Divorced	Only with children	0	2	Employed or self-employed	Welfare Rights Officer	Bachelors degree
BF64	40-49	Female	Married/Living with partner	with spouse/partner and children	2	4	Employed or self-employed	Finance clerk credit control	Bachelors degree
BF65	30-39	Male	Divorced	Only with children	0	2	Employed or self-employed	Chef	High school
BF66	40-49	Male	Married/Living with partner	with spouse/partner and children	3	2	Unemployed	NA	High school
BF67	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Pharmacy technician	Bachelors degree
BF68	30-39	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Bar Manager	High school
BF69	30-39	Female	Single	Only with children	0	2	Employed or self-employed	Human Resources and Payroll Manager	Other (NVQ)
BF70	30-39	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	PSV Technician	Other (SVQ/City and Guilds level3)
BF71	40-49	Female	Married/Living with partner	with spouse/partner and children	2	2	Unemployed	NA	High school
BF72	40-49	Male	Married/Living with partner	with spouse/partner and children	2	1	Employed or self-employed	Logistics manager	High school
BF73	30-39	Male	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Teacher	Masters degree
BF74	30-39	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	customer service assistant	Bachelors degree
BF75	30-39	Female	Married/Living with partner	with spouse/partner and children	1	3	Employed or self-employed	H&S Manager	Bachelors degree
BF76	30-39	Female	Married/Living with partner	with spouse/partner and children	1	1	Employed or self-employed	Hospitality manager	High school
BF77	40-49	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Company secretary	Bachelors degree
BF78	40-49	Female	Married/Living with partner	with spouse/partner and children	1	2	Other (Homemaker)	NA	Bachelors degree
BF79	30-39	Female	Married/Living with partner	with spouse/partner and children	1	3	Employed or self-employed	Writer	Masters degree
BF80	40-49	Female	Married/Living with partner	with spouse/partner and children	1	2	Employed or self-employed	Finance management	Masters degree
BF81	30-39	Female	Single	Only with children	0	2	Student	PhD in Dentistry	PhD
BF82	18-29	Female	Single	Only with children	0	1	Student	Level3: Mental health	Other (College)
BF83	18-29	Male	Married/Living with partner	With parents and/or relatives	4	2	Student	BSc in Food Science	High school
BF84	18-29	Female	Married/Living with partner	With parents and/or relatives	4	1	Student	BS in Psychology	High school
BF85	18-29	Male	Married/Living with partner	With parents and/or relatives	4	1	Student	BSc in Computer Science	High school
BF86	18-29	Male	Married/Living with partner	With parents and/or relatives	3	1	Student	BSc in Technology	High school

BF87	30-39	Female	Married/Living with partner	with spouse/partner and children	1	1	Student	BSc in Commerce	High school
BF88	18-29	Female	Single	With parents and/or relatives	3	1	Student	BSc in Law	High school
BF89	18-29	Male	Single	With parents and/or relatives	2	1	Student	BSc in Chemistry	High school

Note: Participants BF81, BF82, BF83, BF84, BF85 and BF88 seem that they put the highest qualification is their current degree of study. Further, participant BF59 seems that he misunderstood one of the questions about employment. As this information is not very crucial in this study, this participant was accepted.

Table E.3 Demographic information of British older people in the UK

PC	Age-range	Gender	Marital status	Living	No. of people living with (Except participant)		Occupation	Job-title	Highest qualification
					Adults	Children			
BE1	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Employed or self-employed	care manager	Bachelors degree
BE2	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Masters degree
BE3	60-69	Female	Divorced	Alone	0	0	Unemployed		Bachelors degree
BE4	70+	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE5	60-69	Female	Married/Living with partner	Other (with spouse and adult daughter)	2	0	Retired		Masters degree
BE6	70+	Female	Divorced	Alone	0	0	Retired		High school
BE7	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Employed or self-employed	teacher in a TEI	PhD
BE8	60-69	Male	Single	Alone	0	0	Retired		Masters degree
BE9	60-69	Female	Divorced	Alone	0	0	Retired		High school
BE10	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		PhD
BE11	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE12	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Employed or self-employed	nurse	Bachelors degree
BE13	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		PhD
BE14	70+	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Other (Diploma of Occupational therapy)
BE15	70+	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Masters degree
BE16	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		PhD
BE17	60-69	Female	Married/Living with partner	With housemate/s	3	0	Retired		PhD
BE18	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Masters degree

BE19	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE20	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Employed or self-employed	customer services adviser	Masters degree
BE21	70+	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE22	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE23	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE24	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE25	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Employed or self-employed	Learning support tutor	Masters degree
BE26	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE27	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE28	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE29	70+	Female	Widowed	Alone	0	0	Retired		Other (Nvq)
BE30	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE31	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE32	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE33	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE34	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE35	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE36	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE37	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE38	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE39	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE40	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE41	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE42	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE43	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE44	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE45	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE46	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree

BE47	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE48	60-69	Male	Widowed	Alone	1	0	Retired		Masters degree
BE49	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE50	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE51	60-69	Male	Married/Living with partner	Alone	0	0)	Retired		High school
BE52	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE53	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE54	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE55	60-69	Male	Married/Living with partner	Only with spouse/partner	2	0	Retired		Bachelors degree
BE56	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE57	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE58	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE59	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE60	60-69	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		Bachelors degree
BE61	60-69	Male	Divorced	Alone	0	0	Employed or self-employed	postman	High school
BE62	70+	Female	Married/Living with partner	Only with spouse/partner	1	0	Retired		High school
BE63	60-69	Male	Married/Living with partner	Only with spouse/partner	1	0	Employed or self-employed	cleaner	Other (0 level)

Note: Participants BE48 and BE55 seems they counted themselves as adults in the household.

Table E.4 Demographic information of Arab students

PC	Age-range	Gender	Marital status	Living with	No. of people living with (Except participant)		Occupation	Studying degree	Main area of study	Highest qualification	Country of origin	Country of currently living	Length of being in the UK (in years)
					Adults	Children							
AS1	30-39	Male	Single	Alone	0	0	Student	PhD	Computer science	Masters degree	Arab country (Saudi Arabia)	United Kingdom	5
AS2	30-39	Male	Single	Alone	0	0	Student	PhD	Physics	Masters degree	Arab country (Saudi Arabia)	United Kingdom	5
AS3	18-29	Male	Single	Alone	0	0	Student	BSc	Mechanical Engineering	High school	Arab country (Egypt)	United Kingdom	3
AS4	18-29	Male	Single	Housemate/s	5	0	Student	MSc	Aerospace engineering	High school	Arab country (Syria)	United Kingdom	9
AS5	18-29	Female	Single	Housemate/s	4	0	Student	BSc	Pharmacology	High school	Arab country (Egypt)	United Kingdom	(Less than) 1
AS6	18-29	Female	Single	Alone	0	0	Student	BSc	Finance	High school	Arab country (Jordan)	United Kingdom	2
AS7	18-29	Female	Single	Parents and/or relatives	1	0	Student	BSc	Marketing with management	High school	Arab country (Palestine)	United Kingdom	3
AS8	18-29	Female	Single	Alone	9	0	Student	BSc	Sociology and social policy	High school	Arab country (Tunisia)	United Kingdom	1
AS9	18-29	Female	Single	Alone	0	0	Student	BSc	Marketing with Management	High school	Arab country (Jordan)	United Kingdom	2
AS10	18-29	Male	Single	Alone	0	0	Student	BSc	Mechanical Engineering	High school	Arab country (Egypt)	United Kingdom	1
AS11	18-29	Female	Single	Alone	0	0	Student	MSc	architecture	Bachelors degree	Arab country (Morocco)	United Kingdom	5
AS12	18-29	Female	Single	Housemate/s	9	0	Student	BSc	Mathematics	High school	Arab country (United Arab Emirates)	United Kingdom	17

Table E.5 Demographic information of Arab family members

PC	Age range	Gender	Marital status	Living with	No. of people living with (Except participant)		Occupation	Job-title/ Main area of study	Highest qualification	Country of origin	Country of currently living	Length of being in the UK (in years)
					Adults	Children						
AF1	18-29	Female	Married/Living with partner	Spouse/partner and children	1	3	Student	PhD in Computer Science	Masters degree	Arab country (Saudi Arabia)	United Kingdom	(Less than) 1
AF2	30-39	Female	Married/Living with partner	Only children	0	4	Student	PhD in Computer Science	Masters degree	Arab country (Saudi Arabia)	United Kingdom	3
AF3	30-39	Male	Married/Living with partner	Spouse/partner and children	1	2	Student	PhD in Chemistry	Masters degree	Arab country (Saudi Arabia)	United Kingdom	(Less than) 1
AF4	30-39	Male	Married/Living with partner	Spouse/partner and children	1	2	Student	PhD in Chemistry	Masters degree	Arab country (NA)	United Kingdom	1
AF5	30-39	Female	Married/Living with partner	Only children	0	1	Student	Masters in MBA	Bachelors degree	Arab country (Iraq)	United Kingdom	(Less than) 1
AF6	18-29	Female	Single	Parents and/or relatives	3	1	Student	Bachelors in Psychology	High school	Arab country (Sudan)	United Kingdom	1
AF7	30-39	Female	Married/Living with partner	Spouse/partner and children	2	2	Employed or self-employed	Lecturer	Masters degree	Arab country (Saudi Arabia)	Arab country (Saudi Arabia)	NA
AF8	30-39	Female	Married/Living with partner	Spouse/partner and children	2	3	Employed or self-employed	Lecturer	Masters degree	Arab country (Saudi Arabia)	Arab country (Saudi Arabia)	NA
AF9	30-39	Female	Married/Living with partner	Spouse/partner and children	2	3	Employed or self-employed	Employee	Masters degree	Arab country (Saudi Arabia)	Arab country (Saudi Arabia)	NA
AF10	30-39	Female	Married/Living with partner	Spouse/partner and children	2	3	Employed or self-employed	Lecturer	Masters degree	Arab country (Saudi Arabia)	Arab country (Saudi Arabia)	NA
AF11	40-49	Female	Married/Living with partner	Only children	1	3	Employed or self-employed	Lecturer	PhD	Arab country (Saudi Arabia)	Arab country (Saudi Arabia)	NA
AF12	30-39	Female	Married/Living with partner	Spouse/partner and children	3	3	Employed or self-employed	Lecturer	Masters degree	Arab country (Saudi Arabia)	Arab country (Saudi Arabia)	NA

E.1.2 Screening survey for participants in Study 4

<div align="center">Screening survey</div>

Thank you for volunteering to take part in this study about an app I am developing to help people with food management and waste, which is part of my f PhD at the University of York.

This first short questionnaire is to create a balanced panel of people for the main study. So it will just ask some questions about yourself and your living situation. It should take about 5 minutes to complete.

Your participation is completely voluntary, all your information will be completely confidential and anonymous and meet the standards of the General Data Protection Regulation (GDPR). You are free to withdraw from this survey at any point. if during or after doing the survey you wish to withdraw, just email me your prolific ID and all your data will be deleted.

You are very welcome to ask any questions about this research, at any stage before, during or after the study. You can contact me Mashael Aljubairah at masa506@york.ac.uk or my supervisor Professor Helen Petrie at helen.petrie@york.ac.uk. If you are suitable to form part of the panel for the main study, you will receive another invitation in a few days.

If you are happy to proceed, please give consent below. If you do not wish to participate in this study, choose that option, "otherwise choose I do not wish to participate" option.

- o   I have read and understood this information and am happy to take this short questionnaire.
- o   I do not wish to participate

Enter your prolific ID here: _____

1. **What best describes your current situation?**
- o   Student
- o   Employed or self-employed
- o   Unemployed
- o   Retired
- o   Other (please specify)_____
2. **What is the highest degree or level of education you have completed?**
- o   High School
- o   Bachelor's Degree
- o   Master's Degree
- o   PhD
- o   Other (please specify)_____

3. **What qualification are you studying for?**
- o   Bachelors
- o   Masters
- o   PhD
- o   Other (please specify) _____
4. **What is your main area of study?_____**
5. **What is your occupation?_____**
6. **What is your marital status?**

- Single
- Married/Living with partner
- Divorced
- Widowed
- Other (please specify) _____

7. Do you live …

- Alone
- With housemate/s
- With parents and/or relatives
- Only with spouse/partner
- With spouse/partner and children
- Only with children
- Other (please specify) _____

8. How many adults do you live with? (do not count yourself)_____

9. How many children do you live with?_____

10. What is your country of origin?

- Arab country, please specify which _____
- China
- United Kingdom
- Other (please specify) _____

11. What country do you live in currently?

- Arab country, please specify which _____
- China
- United Kingdom
- Other (Please specify) _____

12. If you are currently living in the UK, how long have you been in the UK? (to nearest year)_____

13. What is your age?

- Under 18
- 18 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 - 69
- 70 and over

14. What is your gender?

- Female
- Male
- Non-binary
- Prefer to self identify _____
- Prefer not to say

15. Are you involved in any of these food related activities in your household (select all that apply)?

- Food shopping
- Food storage and management
- Food preparation and cooking
- Food waste reduction
- None of the above

Thank you for taking this short questionnaire.
We will be in touch soon if the main study is suitable for you to take.
You will now be directed back to Prolific.

E.1.3 Codebook of the Study Analysis for Study 4

No.	Code label	Definition	Description	Examples
1	Intervention functions			
1.1	Education	Education is increasing user knowledge and understanding of food-related practice and consumption. This definition is inspired by (Michie *et al*, 2011)	This sub-theme was initially proposed by the designer, following the Behaviour Change Wheel (BCW) of proposing intervention for behaviour change issue. So, participant comments about enhancing their knowledge and information towards managing and consuming their foods were categorised under this sub-theme. Note, any function that has education-related comments mentioned by participants within any user group, was then classified by the researcher under education.	I get to know best option on where and how to store food (BS35)
1.2	Enablement	Enablement is increasing means or reducing barriers to increase capability or opportunity. This definition is inspired by (Michie *et al*, 2011)	This sub-theme was initially proposed by the designer, following the Behaviour Change Wheel (BCW) of proposing intervention for behaviour change issue. So, participant comments about increasing their ability to manage and check their food were categorised under this sub-theme. Note, any function that has enablement-related comments mentioned by participants within any user group, was then classified by the researcher under enablement.	Very helpful when you are away from home...you can manage yourself while far away (BS21)
1.3	Persuasion codes			
1.3.1	Personalization	Personalization is providing users with personalized features or contents (Oinas-Kukkonen & Harjumaa, 2008, 2009).	This lower-level sub-theme was derived from the data collection question (Are there any things related to shopping, preparing food and eating that you think would be helpful to personalise in the app). So, it was proposed by the designer, following the persuasive techniques provided by Oinas-Kukkonen and Harjumaa (2008, 2009). Participant comments about	I am not vegetarian but mainly eat a vegetarian diet. Setting a goal or intention to only eat meat a certain number of days a week that one could track could be useful (AS8)

			personal preferences of food-related practices and activities were categorised under this sub-theme.	
1.3.2	Tracking	Tracking is providing information to users about their past behaviour regarding food consumption and waste.	This lower-level sub-theme was initially proposed by the designer, following the tracking as persuasive technique. So, participant comments related to tracking and providing information of their past consumption and waste behaviour were categorised under this sub-theme. Note, any function that has tracking-related comments mentioned by participants within any user group, was then classified by the researcher under tracking.	It would help to tell me when foods I commonly use and need to stock up on is running out and needs added to the shopping list (BF82)
1.3.3	Competition	Competition is providing ways for users to compete with each other (Oinas-Kukkonen & Harjumaa, 2008, 2009) towards performing the target behaviour.	This lower-level sub-theme was derived from the data collection question (How likely or not would you be to join a competition with friends (or others) to compare food waste reduction). So, it was proposed by the designer, following the persuasive techniques provided by Oinas-Kukkonen and Harjumaa (2008, 2009). Participants comments about competition were categorised under this sub-theme. Note, any function that has competition-related comments mentioned by participants within any user group, was then classified by the researcher under competition.	Competing with waste reduction can become competitive with family members or friends and this will encourage you wanting to reduce waste reduction (BF56)
1.3.4	Cooperation	Cooperation is providing a way for users to cooperate with each other towards performing the target behaviour (Oinas-Kukkonen & Harjumaa, 2008, 2009).	This lower-level sub-theme was initially proposed by the designer, following the persuasive techniques provided by Oinas-Kukkonen and Harjumaa (2008, 2009). So, participant comments related to cooperation and helping each other were categorised under this sub-theme. Note, any function that has cooperation-related comments mentioned by participants within any user group, was then classified by the researcher under cooperation.	To help people who are hungry (BE52)
1.3.5	Reduction	Reduction is simplifying the target behaviour by reducing the complexities of a task to a single or few easy steps (Fogg,	This lower-level sub-theme was initially proposed by the designer, following the persuasive techniques provided by (Fogg, 2003). So, participant comments	It would cut down on the time required on planning so it seems like a great idea (BS12)

		2003). So, it can be performed with less time and effort.	related to reduction were categorised under this sub-theme. Note, any function that has reduction -related comments mentioned by participants within any user group, was then classified by the researcher under reduction.	
1.3.6	Reminding	Reminding users to perform the target behaviour (Oinas-Kukkonen & Harjumaa, 2008, 2009). So, supporting users by reminding them towards reducing food waste. For example, what food they got at home or needs to buy from supermarkets.	This lower-level sub-theme was emerged from the data, and it was not initially proposed by the designer. Participants comments related to reminding were categorised under this sub-theme. Note, any function that has reminding -related comments mentioned by participants within any user group, was then classified by the researcher under reminding.	Its a good reminder and helps not to forget things you need on your shopping trip (BF69)

E.1.4 Interceding reliability data and results

Function	Group	HP codes	MA codes	Agreement	Comment
Cooking: Using Up Food	British older people	Enablement	Enablement	1	To maximize use on leftovers
	British older people	Enablement	Enablement	1	Be able to reuse food
	British older people	Education	Education	1	As I am mostly unaware of how to use up left over food to be edible
	British family member	Education	Education	1	To tell the best conditions to store the foods
	British family member	Education	Education	1	Great for inspiration
	British students	Education	Education	1	Its great to know how to use the leftovers with different taste
	British students	Enablement, Education	Education	1/2	Helps me use leftover
	British students	Enablement, Education	Education	1/2	To tell the right amount of recipe to apply
Food Shopping: Event Plans function	British older people	Reduction	Reduction	1	Save on planning time
	British older people	Tracking	Tracking	1	Great to know what and how much we ate on previous occasions
	British older people	Enablement	Enablement	1	Allows me plan for foods to be eaten in an event without wastages
	British family member	Reduction	Reduction	1	Makes events planning easier
	British family member	Reminder	Reminder	1	Remind you to prep and what you need for it
	British family member	Enablement	Enablement	1	Enables proper planning
	British family member	Enablement	Enablement	1	I will be able to avoid food wastage
	British students	Tracking	Tracking	1	For one to know on what to add and what to reduce
	British students	Tracking, enablement	Tracking	1/2	I like the idea that the app will adjust the servings based on how much food was wasted last time
	British students	Reduction	Reduction	1	It would cut down on time
	British students	Reduction	Reduction	1	It becomes easy to budget for an event

Food Management : Food Storage Advice function	British older people	Education	Education	1	To know the right conditions to store some foods
	British older people	Reduction	Reduction	1	Saves on time, since it extends the food life
	British older people	Reduction	Reduction	1	To save on shopping time
	British family member	Education	Education	1	It's a topic I'm not that knowledgeable on
	British family member	Education	Education	1	Educate me on food storage to minimize wastage
	British family member	Education	Education	1	Informs me where and how to store food
	British students	Education	Education	1	This will be new information to me so I would be interested
	British family member	Education	Education	1	Helps you expand your knowledge on safe handling of food
	British students	Reduction, Education	Reduction	1/2	Would save me a lot of time researching
	British students	Reduction, Education	Reduction	1/2	It saves time googling the best way to store things, especially potatoes
Food Waste: Item Waste function	British older people	Tracking	Tracking	1	Probably good way to monitor how much food is wasted
	British older people	Tracking	Tracking	1	Its hard to keep track of those foods
	British family member	Tracking	Tracking	1	To know the amount of food I used
	British family member	Tracking	Tracking	1	I know what we are more susceptible to wasting. This would help me show my husband!
	British family member	Tracking	Tracking	1	There are certain products I know we should track more
	British students	Tracking	Tracking	1	Shows me a particular food that I have wasted
	British students	Tracking, Education	Tracking	1/2	I'd like to know more information about my food waste management and this aspect does exactly that
Food Waste: Food Sharing as donor function	British older people	Cooperation	Cooperation	1	I love to give to the community
	British older people	Enablement	Enablement	1	Be able to help the needy.
	British family member	Enablement	Enablement	1	Allows me to share foods
	British family member	Cooperation	Cooperation	1	Sharing resources to help people in need
	British family member	Enablement	Enablement	1	I will be able to help the needy

	British family member	Reduction	Reduction	1	Makes donating easy
	British students	Cooperation, Enablement	Cooperation	1/2	This is a really good initiative to help unfortunates get food on their tables which might have gone to waste
	British students	Cooperation, Enablement	Cooperation	1/2	Am willing to help those with less at hand
	British students	Enablement	Enablement	1	So as I can donate the amounts excess food
Total number of codes used					53
Total number of agreements					45
Total percentage of agreements					84.9%
Agreements on particular categories					
Category		Total number	Disagreements	Agreements	Agreements (%)
Cooperation		3	0	3	100%
Enablement		12	3	9	64.2%
Education		15	3	13	80%
Reduction		9	0	9	100%
Reminder		1	0	1	100%
Tracking		10	0	10	100%

E.1.5 Questionnaire of WasteLess app evaluation study

EVALUATION OF THE WASTELESS APP TO HELP WITH FOOD WASTE

Thank you for volunteering to take part in this study, which is part of my research for my PhD at the University of York.

I am interested in your attitudes about food waste and your views about an app I am developing to help people waste less food. There are no right or wrong answers to the questions, just your own views.

The study should take about 45 minutes to complete. All participants who complete the study will be offered a voucher for Amazon or Marks and Spencer worth £5. Your participation is completely voluntary, all your information will be completely confidential and anonymous and meet the standards of the General Data Protection Regulation (GDPR). You are free to withdraw from this survey at any point. On the next screen you will be given a unique code, if during or after doing the study you wish to withdraw, just email me your code and all your information will be deleted. You are very welcome to ask any questions about this research, at any stage before, during or after the study. You can contact me Mashael Aljubairah at masa506@york.ac.uk or my supervisor Professor Helen Petrie at helen.petrie@york.ac.uk.

If you are happy to participate, please confirm by select the statement below and continue to the next page. Otherwise just close this screen.

- o   I have understood the purpose of the study and am happy to participate

This first set of questions is to make sure this study is suitable for you to take part in. Questions 1, 2, 3,4, 5,6,7, 8, 9,10, 11, and 15 had been asked in the screening questionnaire but were repeated in this questionnaire to check the accuracy of participants answers.

[**Note:** Not all questions in this questionnaire were presented in this thesis]

12. Are you a ...
- o Full-time student
- o Part-time student

13. Are you a ...
- o Campus-based student
- o Distance learning student

14. Where do you live currently?
- o   On-campus
- o   In off-campus housing

Sorry, before you start, here are a few more questions about yourself and your household:

16. What degree are you studying for?
- o   High school
- o   Bachelors
- o   Masters
- o   PhD
- o   Other (please specify) _____

17. How many adults do you live with? (do not count yourself)_____

18. How many children do you live with?_____

19. Who typically shops for food in your household?
- ○ Myself
- ○ My housemate/s
- ○ Myself and housemate/s
- ○ My parents or relatives
- ○ My spouse/partner
- ○ Myself and spouse/partner
- ○ Myself and spouse/partner and children
- ○ My spouse/partner and children
- ○ Myself and children
- ○ My children
- ○ All members of the household
- ○ Other (please specify) _____

20. How often does your household shop for food?
- ○ Just only large shop per week
- ○ A large shop per week and several smaller top up shops
- ○ Only when we need to
- ○ Only when we have time to go shopping
- ○ Other (please specify) _____

21. How is the shopping for food your household most often done?
- ○ Online
- ○ In a supermarket
- ○ In specific shops and markets (e.g. bakery, in open air markets or farm shops)
- ○ Other (please specify) _____

The next set of questions is about cooking and eating habits, as well as food waste in your household:

22. To what extent do you consider yourself to be a skilled cook?

Not at all   Very
  skilled   skilled

○   ○   ○   ○   ○   ○   ○

23. In relation to diet, is your household ..
- ○ Not restricted (I/we eat everything)
- ○ Halal
- ○ Kosher
- ○ Vegetarian
- ○ Vegan
- ○ Pescatarian (I/we eat fish but not meat)
- ○ Currently in the process of becoming or trying to be vegetarian
- ○ Currently in the process of becoming or trying to be vegan
- ○ Other, including if different people in the household have different diets (please specify) _____

24. How concerned are you about reducing the amount of food waste in your household?

Not at all   Very
                                                                                                  much

○   ○   ○   ○   ○   ○   ○

25. How important are these reasons for your concern in reducing your household food waste

	Not at all important						Very important
To minimise environmental impact	○	○	○	○	○	○	○
To reduce the amount I/we spend on food	○	○	○	○	○	○	○
Religious or other ethical reasons (e.g., there are many people who are hungry)	○	○	○	○	○	○	○

If you selected religious or other ethical reasons, please describe briefly the reasons

_____

If you have other reasons, please describe briefly

_____

Introduction to the WasteLess app

WasteLess is an app I am designing to help manage household food. It will not only help you reduce the amount of food you waste, but also help you save money on food, plan your shopping and cooking, and give you tips on food management and cooking.

You can assume that WasteLess will know what food you have in your fridge and pantry – very soon this will be possible, through two routes. Firstly, food that you buy in a supermarket can be logged on your supermarket loyalty card. So, you will just have to wave your loyalty card over your smartphone, and food you have bought in your last shopping trip will be entered into WasteLess.

Secondly, for food that you don't buy in shops where you don't have a loyalty card, there are several routes which would be available to enter information about food you have bought. The easiest would be to use a virtual assistant like Alexa or Siri. You could tell the agent what you have bought and the assistant would have a database with nutritional information for each item. So, you might say "a pound of broccoli" and the virtual assistant would log that information into WasteLess and add nutritional information. An alternative would be to use the bar codes on packets, WasteLess will also have a barcode reader to make this easy to do.

A trickier issue is you would need to keep WasteLess informed about what food you are using and throwing away. Again, doing this via a virtual assistant would be the easiest route. You might say "I'm eating one of the apples". The assistant might ask for more information, with a question like "You have gala and golden delicious apples at the moment, which are you eating?". You would also tell the assistant what food items you are using when you are cooking.

You will now see a set of screenshots about how the WasteLess app might work and what features it could offer. We are interested in your feedback on what people would be most likely to use, so each screen is accompanied by some questions for you to answer. There are no right or wrong answers, just your opinions.

Login

The WasteLess app will start with a login screen, so you can have your own secure account. Imagine that you have already registered, so this would be your login screen.

Set Up: Personalising WasteLess
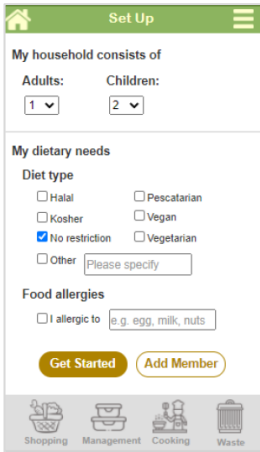
Before you start using the app, you will be able to set up your personal profile and other people in your profile could set up their profiles. A setup screen will allow you to personalise the app to provide you with features that are tailored to your needs and those of your household. This includes recommendations tailored to your dietary choices, and avoiding foods you are allergic to. As part of the set up you could choose, and avoiding foods you are allergic to. As part of the set up you could choose whether you want to see

measures in metric (kg, g, l, ml) or imperial (lb, oz, pint, fl oz) measures. For simplicity in this survey, metric measures will be used.

You will be able to complete a screen like this for each member of your household.

Would you be likely or unlikely to personalise the app?

Very
unlikely

Very
likely
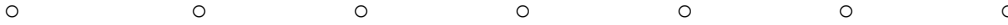
○ ○ ○ ○ ○ ○ ○

This screen currently shows tailoring for overall diet and allergies. Are there other things about shopping, preparing food and eating that you think would be helpful to be to personalise in the app (we will come back to this issue when you have seen the whole app, as you may have more then).

_____

Home screen

After you have set up the app, you will see the Home screen which you will always start with when you open the app. The Home screen will allow you to navigate to the different groups of options offered by WasteLess.

For each group of options, please answer the following questions

Food Shopping:
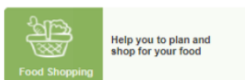
What do you think you would find in Food Shopping group?

_____

Food Management:
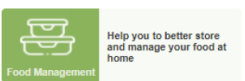
What do you think you would find in Food Management group?

_____

Cooking:
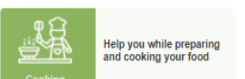
What do you think you would find in Cooking group?

_____

Food Waste:
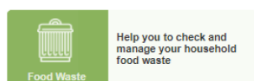
What do you think you would find in Food Waste group?

_____

Do you have any other comments about the Home screen?

_____

The next sets of questions will show you each group of options in WasteLess and ask for your feedback on each group.

Food Shopping group

The Food Shopping group allows you to create shopping lists, share those lists when you are planning your food shopping at home or when you are out shopping. It also advises you on buying food and finding substitutions for food which last longer. Finally, it helps you plan meals and food for special events. All of these options will help you reduce food waste. The landing screen of Food Shopping option could look like this.
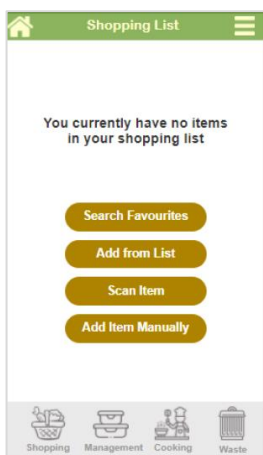
Food Shopping: Shopping List

The shopping list is the first option in the Food Shopping group. It allows you to create a shopping list by adding items by four different methods. The screen below shows the shopping list when it is empty.

Food Shopping: Shopping List (Adding items)
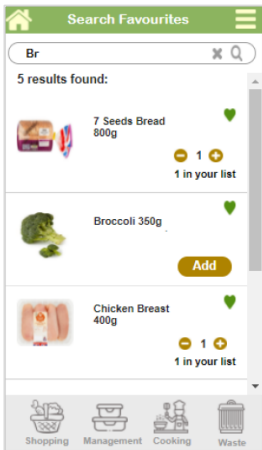
The first method for adding items to the Shopping List is Search Favourites. This allows you to search for an item you often buy and add it to the shopping list. Imagine you want to add broccoli to your shopping list. You type "br", WasteLess starts to find options. When broccoli appears you can add the item to the shopping list simply by selecting Add.

How likely or unlikely would you be to use the "Search Favourites" method to add items to shopping list?

Very   Very
unlikely   likely

○   ○   ○   ○   ○   ○   ○
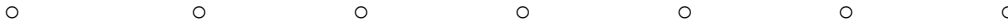
Please add any comments about why you chose this rating:
_____

Would you like have any of the following information about the items in the favourites list?
- ☐ Your average consumption of the food item
- ☐ Your average wastage of the food item
- ☐ Nutritional information about the food item
- ☐ Average price of the food item
- ☐ Other (please specify) _____
- ☐ None of these

Completely used   Nearly used up
up food items   food items
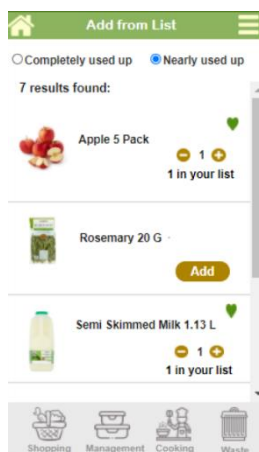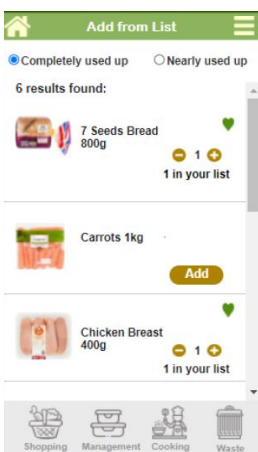
Food Shopping: Shopping List (Adding items)

The second method for adding items to the shopping list is Add from List. You can request a list of food items that you have run out of or a list of food items which are nearly used up. These two possibilities are illustrated in the screens below. Again, you can add items to the shopping list by tapping on Add.

How likely or unlikely would you be to use the "Completely used up" option to add food items to your shopping list?

Very   Very
unlikely   likely

○   ○   ○   ○   ○   ○   ○

398

Please add any comments about why you chose this rating:

_____

How likely or unlikely would you be to use the "nearly used up" option to add food items to your shopping list?

Very
unlikely

Very
likely

○   ○   ○   ○   ○   ○   ○   Please add any comments about why you chose this rating:

_____

Shopping: Shopping List (Add Items)

The third method of adding items to the shopping list is Scan Food Item This allows you to add the item by scanning the bar code on a food package. Again, you can then add it simply by selecting Add.

How likely or unlikely would you be to use the "Scan Food Item" option to add items to your shopping list?

Very
unlikely

Very
likely

○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating:

_____

Food Shopping: Shopping List (Add items)

The fourth method for adding items to the shopping list is Add Item Manually. This allows you to enter the name of the item, select the food category and the quantity from pull down lists. Again, you then select Add.

Very
unlikely

Very
likely

How likely or   ○   ○   ○   ○   ○   ○   ○
unlikely would you be to use the "Add item manually" option to add items to shopping list?

Please add any comments about why you chose this rating:
_____

Food Shopping: Shopping List (Viewing and sharing the list)

You can view your shopping list whenever you like, at home and when out shopping. You can also share the list with other members of the household using the Share option, for example if someone else is out shopping.

How likely or unlikely would you be to use the "Share" option to share a shopping list with other member/s in your household?

Very   Very
unlikely   likely
○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating:
_____

The current Share option allows you to share shopping list with other household members, would you be interested in sharing your shopping list with
- ☐   Online supermarket services
- ☐   Delivery apps which can do food shopping for you at supermarket
- ☐   Other (please specify) _____
- ☐   None of these
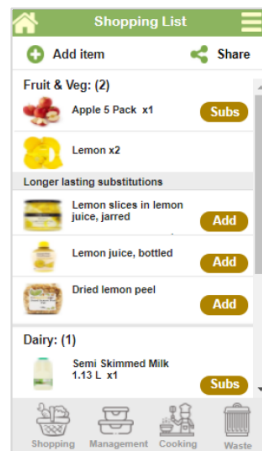
Food Shopping: Longer lasting food (Substitutions)

Longer Lasting Foods is a option which will help you find longer lasting substitutions for particular food items. This will avoid having food go bad and be wasted. Within a shopping list there is an option to check for longer lasting substitutions for each food item. For example, if you have lemons on your shopping list but you have learnt from using Wasteless that you often waste fresh lemons (you will see that feature later), you can check substitutes for lemons and it is showing a number of substations you can add.

How likely or unlikely would you be to use the Substitutions option to find longer lasting foods?

Very   Very
unlikely   likely

○   ○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating:

_____

Are there particular kinds of food you would want to be able to find substitutions for?

_____

The current option shows you longer lasting food substitutions, would you also be interested in:
- ☐ Nutritional information about the two foods (the original and the substitute)
- ☐ Price of the original food and any longer lasting substitutions
- ☐ How long the substitute will last
- ☐ Other (please specify) _____
- ☐ None of these

Food Shopping: Check at Home

Check at Home Food is an option to help you when you are out shopping. It will allow you to check whether you have a particular food item in stock at home. You enter the name of the food and WasteLess tells you whether you have it at home, how much and when it will expire.

How likely or unlikely would you be to use the "Check at home food" option?

Very
unlikely   Very
   likely
○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating:

_____

Food Shopping: Food Buying Advice

Food Buying Advice is a option to help you when you want to buy a food item you are not familiar with. It will provide you with information about its shelf life and advice on the amount of food you should buy depending on your likely consumption, so you will waste as little as possible. You can enter the food name in the search box or scan the item.

Very
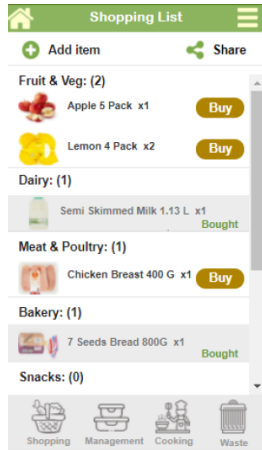unlikely   Very
                                                                                                             likely

How likely or
unlikely would you be to use the "Food buying advice" option?

          ○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating:
_____

Food Shopping: Meal Plans

Meal Plans is a option which will allow you to make a meal plan. You can select your plan details in the first screen, for example, start date, duration and which meals to plan for.
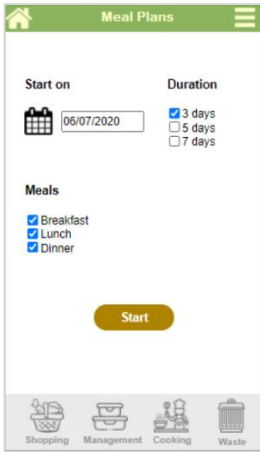
On the next screen, you will find recipe suggestions for each meal for the first day in the plan, and WasteLess will then take you through each day. Then it will show you the entire meal plan.

This screen shows an entire meal plan which you will be able to edit. Wasteless will also create a shopping list for the meal plan, and you can share the meal plan with others in your household and beyond.
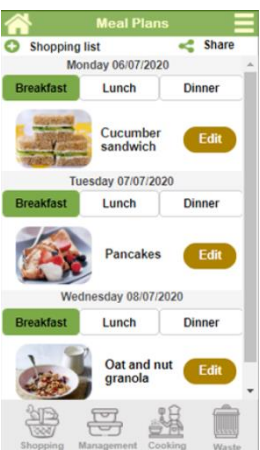
How likely or unlikely would you be to use the meal plan option?

Very   Very
unlikely   likely
  ○   ○   ○   ○   ○   ○   ○
Please add any comments about why you chose this rating:
_____

How likely or unlikely would you be to create a shopping list for your meal plan?

       Very   Very
     unlikely   likely

○   ○   ○   ○   ○   ○   ○

How likely or unlikely would you be to use the 'share plan' option to share meal plan with other members of your household ?

   Very   Very
     unlikely   likely

○   ○   ○   ○   ○   ○   ○
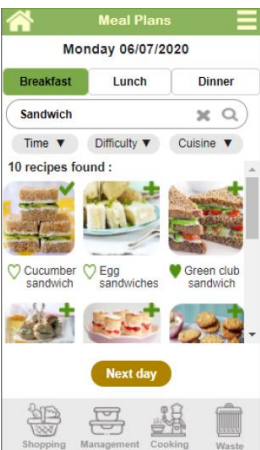
How likely or unlikely would you be to use 'share plan' option to share meal plan with family or friends outside your household ?

       Very   Very
     unlikely   likely

○   ○   ○   ○   ○   ○   ○
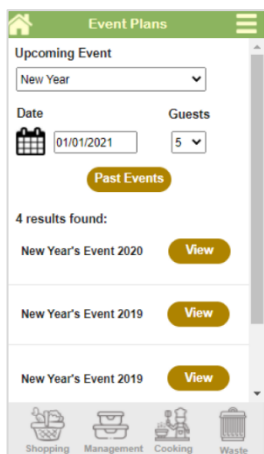
Food Shopping: Event Plans

Event Plans is a option which will allow you to plan for special events such as birthdays, Christmas and New Year. You provide information about your previous events particularly those planned through WasteLess.

You can enter your upcoming event details and via past events WasteLess will show results of the previous version of the same event.
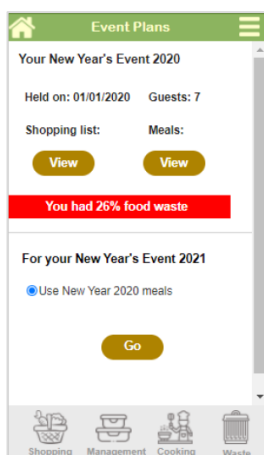
You can then select a previous event and see details of that event including when it was held, how many guests, dishes served and your shopping list. In addition, you can see how much food you wasted.

If you want to have the same meals for your upcoming event you can easily select that option.

WasteLess will then show the meals from the previous event. You can select the dishes you want to use again. In addition, you can create a shopping list, adjusting it to avoid wasting food (WasteLess will calculate how to do that based on your waste at the previous event).

How likely or unlikely would you be to use the "Event plans" option?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____

What events or occasions would you find it useful for WasteLess to record? _____

The current option provides the previous event name, date and number of guests, also the shopping list and meals and food waste, would you like any other information included?
- ○ Yes
- ○ No

What other information you would like to have included in the Events Plan option?_____

Home screen

Here again is the Home screen that you saw at the beginning of the introduction of WasteLess:

Food Shopping:

Now that you have had a chance to explore the Food Shopping group of options, how clear or not is it what is in the Food Shopping group?

Not at all clear						Very clear
○	○	○	○	○	○	○

Please add any comments about why you chose this rating and any other comments about the Food Shopping Group of options in WasteLess:
_____

404

The Food Management group

The Food Management group helps you check what food you have at home. In addition, it helps you understand food labels, and provides advice on food storage and extending food shelf-life.

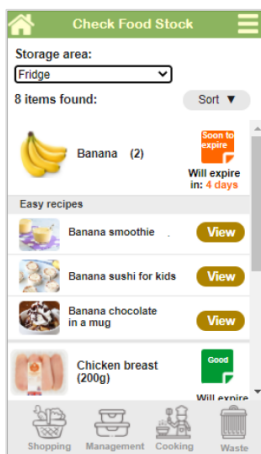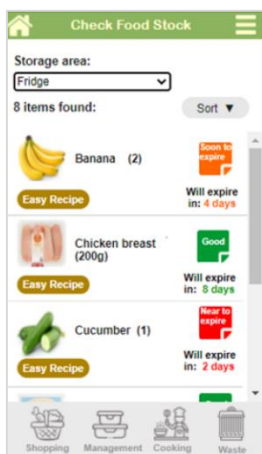Check food stock

After selecting Easy Recipe

Food Management: Check Food Stock (by storage area)

The Check Food Stock option allows you to check what food you have in stock. So, instead of searching in the fridge or pantry for what you have, you can easily check via WasteLess. This option can also be useful when you are out shopping and can't remember whether you have something at home or how much you have. WasteLess has two methods to help you check the food you have.

The first method is checking what is stored in different storage areas (for example the pantry, fridge or freezer). For each food item WasteLess will provide information about how much you have, and the expiry date. You can also link to recipes to use that food up via the Easy Recipe button.

How likely or unlikely would you be to use the Check Food Stock" by storage area option to check what food you have?

| Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____
How useful or not is the following information about the available food stock?

	Not at all						Very useful
Expiry date	○	○	○	○	○	○	○
Remaining amount of food	○	○	○	○	○	○	○

Would you like to include any of the following information for each food item?
- ☐ Cost of the remaining amount
- ☐ Nutritional information
- ☐ Other (please specify) _____
- ☐ None of the above
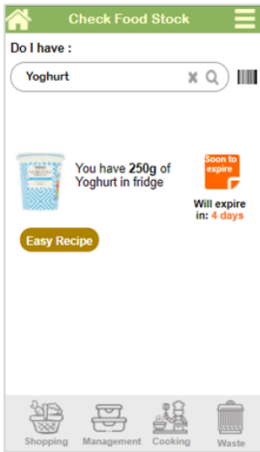
Food Management: Check Food Stock (by food item)

The second method for checking whether you have particular foods in stock, how much you have and where it is stored by using searching for the name of the food item. You can use the search box or scan the item from the package (useful when out shopping).

How likely or unlikely would you be to use the "Check food stock" by food item of checking your food stock?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____

Food Management: Food Labels

Food Labels is a option to help you understand what different food labels such as "use by" and "best before" mean.

How likely or unlikely would you be to use the "Food labels" option?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____

How important or not do you think the following food labels are:

	Not at all						Very important
Use by	○	○	○	○	○	○	○
Best before	○	○	○	○	○	○	○
Sell by	○	○	○	○	○	○	○

Please add any comments about why you chose these ratings:
_____

Are there any other food labels or related information you would like to know about?

- ○ Yes
- ○ No

Please explain briefly which labels or related information you would like to know about and why:
_____
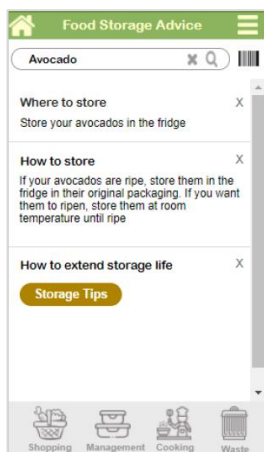
Food Management: Food Storage Advice

Food Storage Advice is an option to provide you with advice about how best to store your food to minimise waste. You can enter the name of the food item in the search box or scan the item.

In addition, this option will tell you how to extend the storage life of foods via the Storage Tips button.

How likely or unlikely would you be to use the "Food storage advice" option?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:

_____

Are there particular types of food you would like to have food storage advice on?

- ○ Yes
- ○ No

Please explain briefly what types of food you would like to have food storage advice on:

_____

The current option provides advice on where and how to store your food, do you have any other food storage issues you would like to know about?
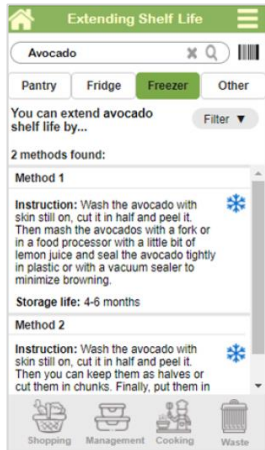
- o Yes
- o No

Please explain briefly what food storage issues you would like to know about:

_____

Management: Extending Shelf Life

The Extending Shelf Life option helps you with information about how to store food for longer so you are less likely to waste any. You can either enter the name of a food in the search box or scan the item. In addition, you can select any storage area (e.g. pantry, fridge or freezer) where you would like to keep your food, and WasteLess will provide you with information about how to store food in that storage area so it will last longer.

How likely or unlikely would you be to use the "Extending shelf life" option?

Very unlikely						Very likely
o	o	o	o	o	o	o

Please add any comments about why you chose this rating:
_____

Are there any particular foods you would like to know how to extend its shelf life?
- o Yes
- o No

Please explain briefly what foods you would like to know how to extend its shelf life:

_____

Would you like to include other information in the results from extending shelf life, for example:
- ☐ Preparation time for extending food shelf life
- ☐ Difficulty level of preparing food to extend its shelf life
- ☐ Other (please specify) _____
- ☐ None of the above

Would you like to filter the results about extending food shelf life according to any of the following?
- ☐ Shelf life
- ☐ Preparation time for extending food shelf life
- ☐ Difficulty level of preparing food to extend its shelf life
- ☐ Other (please specify) _____
- ☐ None of the above

Home screen

Here again is the Home screen you saw at the beginning of the Introduction to WasteLess:

Food Management:
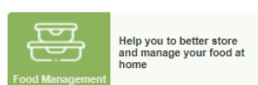
Now that you have had a chance to explore the Food Management group of options, how clear or not is it what is in the Food Management group:

Not at all   Very
clear   clear

○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating and any other comments about the Food Management Group of options in WasteLess:

_____

The Cooking group

The cooking group allows you to find recipes, including recipes to use up leftovers and safety advice about eating leftover food.

Finding recipes   Recipe details

Cooking: Recipes

The Recipes option helps you to search for recipes. You can search using the name of an ingredient or dish, and filter the recipes found based on preparation time, difficulty level, and cuisine.

When you tap on a recipe photo, you will get the recipe details screen. Here WasteLess will provide information about that recipe. You can change the amounts of the ingredients based on how many people you want to serve using the "Serves" pull down menu. You can also link to a step-by-step video of how to prepare the dish.

How likely or unlikely would you be to use the Recipes option?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____

How likely or unlikely would you be to filter recipes according to the following:

	Very unlikely						Very likely
Preparation time	○	○	○	○	○	○	○
Difficulty	○	○	○	○	○	○	○
Cuisine	○	○	○	○	○	○	○

How likely or unlikely would you be to watch a step by step video for a recipe to help you learn to cook a particular dish?

Very unlikely						Very likely
○	○	○	○	○	○	○

Are there any other ways you like to have instead to learn how to cook a particular dish?
○   Yes
○   No

Please explain briefly what ways you like to have instead to learn how to cook a particular dish:
_____

Would you like to filter the results of recipes according to any of the following?

- ☐ Recipes which include ingredients available at home
- ☐ Recipes for specific health conditions (e.g. low in sugar or salt)
- ☐ Recipes which do not include particular ingredients (e.g. without garlic)
- ☐ Recipes for a specific diet. (e.g. vegetarian diet)
- ☐ Recipe with a particular calorie value (e.g. maximum 350 kcal)
- ☐ Recipe type (for example, appetizer, main course, dessert)
- ☐ Recipes suitable for children
- ☐ Recipes for dishes that can be frozen
- ☐ Other (please specify) _____
- ☐ None of the above
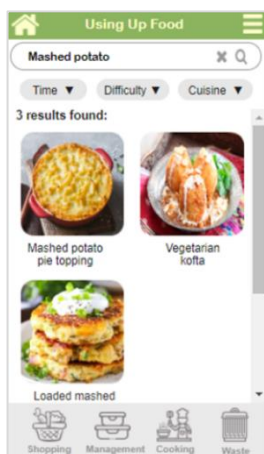
Cooking: Using Up Food

The Using Up Food option helps you to find recipes to use up particular foods and leftovers . You can search by ingredient or dish name, and filter the results based on preparation time, difficulty level, and cuisine.

How likely or unlikely would you be to use the Using Up food option?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____
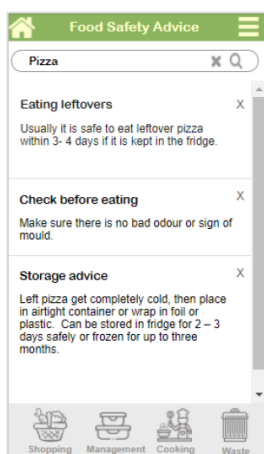
Cooking: Food Safety Advice

The Food Safety Advice option provides advice about food safety. For example, whether it is safe to eat particular leftover foods, to re-heat them and so on. You can search for safety advice on particular foods and dishes.

How likely or unlikely would you be to use the Food Safety Advice option?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:

_____

Are there particular types of food you would like to have food safety advice on?

- o   Yes

- o   No

Please describe briefly the types of food you would like to have food safety advice on:

_____

Home screen

Here again is the Home screen you saw at the beginning of the Introduction to WasteLess:

Cooking:
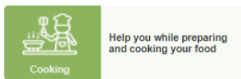
Now that you have had a chance to explore the Cooking group of options, how clear or not is it what is in the group:

Not at all clear						Very clear
o	o	o	o	o	o	o

Please add any comments about why you chose this rating and any other comments about the Cooking group of options in WasteLess:

_____

The Food Waste group

The Food Waste group allows you to check your overall food waste as well as waste for particular food items. In addition, it helps you to reduce your food waste by allowing you to set a food waste reduction goal and monitor your progress towards that goal. Finally, if you like you start a food waste reduction competition with friends, and also share food with others rather than waste it.

Food Waste: Overall Food Waste
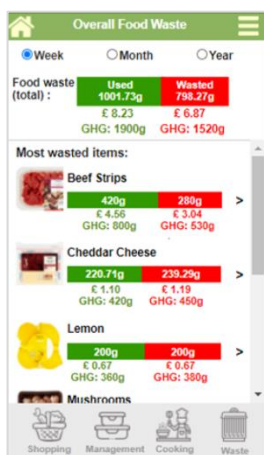
The Overall Waste option allows you monitor your overall food waste. It will show you how much food you used and how much you have wasted in total and for each food individually. You can monitor by the week, month or year.

It will also provide you with tips of how to waste less of particular food items by selecting the arrow next to the food item.

How likely or unlikely would you be to monitor your overall food waste?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____

Would you like or not to be able to select particular categories of food (e.g. meat, vegetables, bread) to monitor?

Not at all						A lot
○	○	○	○	○	○	○

How important or not are these aspects of the information about the overall amount of food wasted:

	Not at all important						Very important
Amount of food wasted	○	○	○	○	○	○	○
Amount of money wasted	○	○	○	○	○	○	○
GHG emissions of food wasted	○	○	○	○	○	○	○

Food Waste: Food Item Waste

The Food Item Waste option allows you to check how much of a particular food item you have used and how much you have wasted. You can search for a particular food item and the date you purchased it on.

How likely or not would you be to monitor waste of particular foods?

Very   Very
unlikely   likely

○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating:
_____
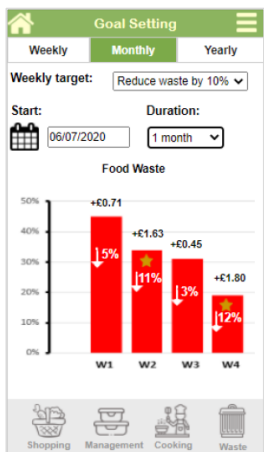
Food Waste: Goal Setting

The Goal Setting option allows you to set a goal to reduce your food waste over time and to track your progress towards meeting that goal. You can set a goal or a target to reduce your food waste by a certain amount (10% each week is shown here) and for a particular period of time (1 month is shown here). WasteLess will show you how much food waste you produced each week and the percentage of food waste reduction for each week compared with the previous week. WasteLess will put a star to indicate that you have met your weekly target, and it will also show you how much money you saved each week by reducing your food waste.

How likely or not would you be to set a goal for waste reduction?

Very   Very
unlikely   likely

○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating:
_____

How likely or not would you be to monitor that goal over time?

Very   Very
unlikely   likely

○   ○   ○   ○   ○   ○   ○

Please add any comments about why you chose this rating:
_____

What period would you like to set the goal for?
- o   One month
- o   3 months
- o   6 months
- o   a year
- o   More than a year
- o   Other (please specify) _____
- o   I'm not interested in setting a goal

What period do you want to monitor for?
- o   Every day
- o   Every week
- o   Every month
- o   Other (please specify) _____
- o   I'm not interested in monitoring food waste

What units do you want to see the reduction in?
- o   Amount of food
- o   percentage of food
- o   GHG
- o   Money saved
- o   Other (please specify) _____
- o   I'm not interested in monitoring food waste
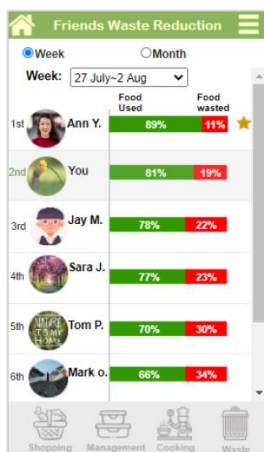
Food Waste: Compete with Friends

The Compete with Friends option allows you to compare your food waste reduction with your friends, setting up a competition. The competition could also be between different households in your local community or your children's classmates households. WasteLess will create a scoreboard, based on who has reduced their food waste the most. In this example, Ann Y gets a gold star for the week as she has wasted the least.

How likely or not would you be to join a competition with friends (or others) to compare food waste reduction?

Very
unlikely

Very
likely

o   o   o   o   o   o   o

Please add any comments about why you chose this rating:
_____

Would you like to be able to send a congratulation to the week's winner?

Very
unlikely

Very
likely

o   o   o   o   o   o   o

Would you like to be able to collect stars (or some other indicator of success) in a longer term leaderboard?

Very
unlikely

Very
likely

o   o   o   o   o   o   o

415

Would you want to do the competition with your...

- o Friends
- o Your local community
- o Your child's classmates and their households
- o Other (please specify) _____
- o I am not interested in a competition

How would you like WasteLess to reward you for reducing your food waste?

- ☐ Recognition amongst your friends/community/school
- ☐ Discount on your council/local government tax
- ☐ Vouchers from the supermarket you shop with
- ☐ Other (please specify) _____
- ☐ I am not interested in a competition

The current option allows you to see how much food you and other households use and waste, would you like to have in addition:

- ☐ How much money each one saves
- ☐ How much money each one wastes
- ☐ What GHG emissions each one produces from food waste
- ☐ Other (please specify) _____
- ☐ I am not interested in a competition

Food Waste: Food Sharing
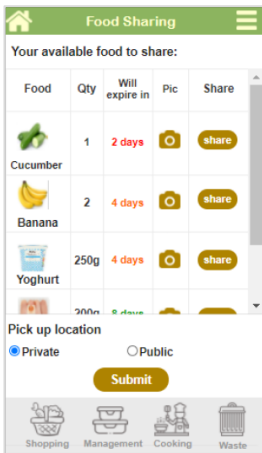
The Food Sharing option allows you to share food with others, so that food you might waste can be used by someone else. WasteLess will show you a list of your available food at home and allow you to easily share one or more items. In addition, you can take a photo of the item to show to people who might use it.

Programmes like this are being set up in many communities. This kind of programme can be set up in two ways: (a) direct person-to-person, a person can specify a private pickup location (e.g. their home) for the receiver to pick up the food; or (b) using a public location where the food can be available (e.g. some communities are setting up food sharing fridges in community centres).
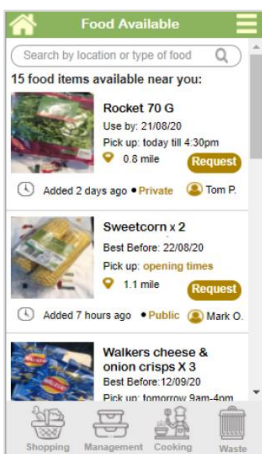
Also, you can see shared food items near you and request them:

How likely or not would you be to use food sharing as a donor?

Very
unlikely
                    Very
likely

o   o   o   o   o   o   o

Please add any comments about why you chose this rating:
_____

How likely or not would you be to use food sharing as a receiver?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____

How likely or not would you be to use public space food sharing (as either a donor or receiver)?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____

How likely or not would you be to use private space food sharing (as either a donor or receiver)?

Very unlikely						Very likely
○	○	○	○	○	○	○

Please add any comments about why you chose this rating:
_____

Would you like to share food with...
- ☐ People you know (i.e. family or friends)
- ☐ Anyone in the community
- ☐ Other (please specify) _____
- ☐ I am not interested in food sharing

Home screen

Here again is the Home screen you saw at the beginning of the Introduction to WasteLess:

Food Waste:
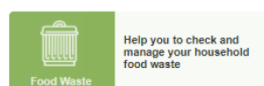
Now that you have had a chance to explore the Food Waste group of options, how clear is it what is in the Food Waste group?

Not at all clear						Very clear
○	○	○	○	○	○	○

Please add any comments about why you chose this rating and any other comments about the Food Waste group of options in WasteLess:

_____

Set Up: Personalising WasteLess

Now, after answering the all the questions about WasteLess, here is the Set Up screen you saw at the beginning of the survey:

This screen currently shows tailoring for overall diet and allergies. Are there other things about shopping, preparing food and eating that you think would be helpful to be to personalise in WasteLess?

_____

Thank you for taking the time to complete this evaluation of WasteLess app survey. We truly value the information you have provided. Your responses will contribute to our research of helping people to waste less food towards decreasing the unnecessary negative impacts on the environment.

To receive an Amazon or M&S gift voucher worth £5, please provide an email address below and I will contact you to arrange that. Your email address will not be used for any other purpose.

_____

E.1.6 Overview about food practices and food waste

Participants were asked a number of questions about their food shopping practices, their cooking practices and what diet they follow. They were also asked about their food waste practices and attitudes to food waste. The key results are summarized in Table E.6 (only answers with more than 10% of responses from any participant group).

Table E.6 Food shopping and cooking practices (Number and percentage of responses)

	British students N = 63	British family members N = 89	British older people N = 63	Arab students N=12	Arab family members N=12
Who typically shops for food in your household?					
Myself	20 (31.7)	37 (41.1)	36 (57.1)	11 (91.7)	3 (25.0)
Myself and spouse/partner	3 (4.8)	29 (32.2)	19 (30.2)	0 (0.0)	6 (50.0)
Myself and spouse/partner and children	0 (0.0)	12 (13.3)	0 (0.0)	0 (0.0)	0 (0.0)
All members of the household	16 (25.4)	2 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)
How often does your household shop for food? (Q20)					
Just only large shop per week	15 (23.8)	22 (24.4)	14 (22.2)	2 (16.7)	5 (41.7)
A large shop per week and several smaller top up shops	37 (58.7)	63 (70.0)	36 (57.1)	4 (33.3)	2 (16.7)
Only when we need to	10 (15.9)	4 (4.4)	10 (15.9)	5 (41.7)	4 (33.3)
How is the shopping for food your household most often done? (Q21)					
Online	7 (11.1)	18 (20.0)	9 (14.3)	3 (25.0)	2 (16.7)
In a supermarket	48 (76.2)	52 (57.8)	31 (49.2)	8 (66.7)	9 (75.0)
In specific shops and markets (e.g., bakery, in open air markets or farm shops)	8 (12.7)	18 (20.0)	22 (34.9)	1 (8.3)	0 (0.0)
You are a skilled cook (Q22) (rating: 1 = strongly disagree to 7 = strongly agree) (Median, Semi-Interquartile Range, SIQR)					
Median (SIQR)	5.0 (1.0)	5.0 (1.0)	5.0 (1.0)	5.5 (1.5)	6.0 (1.0)

Table E.7 Participants' diet type (Number of responses, percentage for each group)

	British students N = 63	British family members N = 89	British older people N = 63	Arab students N=12	Arab family members N=12
In relation to diet, is your household .. (Q23)					
Not restricted (I/we eat everything)	40 (63.5)	69 (76.7)	52 (82.5)	2 (16.7)	0 (0.0)
Halal	5 (7.9)	5 (5.6)	1 (1.6)	7 (58.3)	12(100.0)
Other (e.g., different diets, gluten free, particular food allergy such as Cow's milk protein allergy (CMPA), or mushroom)	8 (12.7)	5 (5.6)	3 (4.8)	3 (25.0)	0 (0.0)

Participants were asked to rate their agreement with a number of statements related to food waste issues (see Table E.8).

Table E.8 Ratings of food waste attitudes (Median, Semi Interquartile Range) (1 = strongly disagree to 7 = strongly agree)

British Students N = 63	British family members N= 89	British older people N= 63	Arab students N=12	Arab family members N=12
How concerned are you about reducing the amount of food waste in your household? (Q24)				
7.0 (1.0)	7.0 (1.0)	7.0 (1.0)	6.0 (2.0)	7.0 (0.0)
How important are these reasons for your concern in reducing your household food waste: To minimise environmental impact* (25.1)				
6.0 (1.0)	6.0 (1.0)	6.0 (1.0)	5.0 (1.0)	6.5 (1.0)
How important are these reasons for your concern in reducing your household food waste: To reduce the amount I/we spend on food* (25.2)				
6.0 (1.0)	6.0 (0.5)	6.0 (1.0)	6.0 (1.0)	6.0 (1.5)
How important are these reasons for your concern in reducing your household food waste: Religious or other ethical reasons (e.g., there are many people who are hungry)* (25.3)				
3.0 (2.5)	4.5 (2.5)	4.5 (2.0)	6.0 (2.0)	7.0 (0.5)

Note: In Q25.1, Q25.2, and Q25.3 there was one missing value for British family members, British older people, and Arab students

In relation to the reasons for reducing food waste (Q25), participants were asked to describe briefly any religious or other ethical reasons for reducing food waste. The reasons mentioned by participants included:

- They have to think about other people who dying of hunger, which is ethically and morally not right to them;
- In some religions, such as Islam, it is prohibited to waste food, and some mentioned a Christian belief that food should not go to waste;
- Food waste is not good and it could be a sin and ungodly;
- Giving is a virtue, and it is better to give food than to throw it away;
- Food wastage is not good for the world, and to save the environment by recycling food to be used for other purposes.

Participants were asked to provide other reasons if they have any and describe them briefly. Some participants mentioned that food waste is not a humanly nature and not in their cultures, and it makes them feel better not to throw food away.

E.1.7 Additional details of Participants' views on the intervention and persuasion supports the WasteLess app

Table E.9 Number of comments provided for personalization sub-theme

Function	Number of comments
Set Up	Total: 130 BS: 43 BF: 53 BO: 28 AS: 3 AF: 3

Table E.10 Comments relevant to the tracking sub-theme

Level 2 Sub-theme Description	Function	Number of comments	Examples
Comments on functions designed to provide tracking support			
All tracking functions		Total: 271 BS: 85 BF: 114 BO: 56 AS: 7 AF:9	
Help to track food consumption habits	Advice: Food Buying	Total: 16 BS: 6 BF: 6 BO: 2 AS: 2	Very helpful to know past usage and wastage to avoid wasting more food in future (BF16) So, I know what I've done in the past. And whether I know I wouldn't waste it this time around (AS4) **Negative opinions** I am confident in my own choices (BS36) Would be fun to try out, but may become irritating (BO15) I usually have a specific list and in hurry (AF11)
Provide details of what and how much food is wasted in the household	Overall Food Waste	Total: 42 BS: 16 BF: 23 BO: 2 AF: 1	I think this is particularly innovative and useful to understand where most food wastage is occurring (BS38) I know my household wastes too much food, but don't know how to track and change these habits, so a platform for tracking it would be very useful (BS44)
Provide details about previous special events to avoid potential waste in future events	Event Plan	Total: 11 BS: 7 BO: 3 AF: 1	I like the idea that the app will adjust the servings based on how much food was wasted last time (BS62) Great to know what and how much we ate on previous occasions (BO7) **Negative opinions** I prefer the traditional paper plan (BO41) I think big family events are meant to be extravagant, planning the meal would be

			great, but keeping track of waste might not be a good idea (BS6)
			I don't think I would use this. I would be less likely to repeat recipes from previous events/ different guests would have different requirements (BS26)
Provide information about what and where foods are stored, as well as how much food they have at home and for how long it will last	Check Food (By Storage Area, By Food Item)	Total: 49 BS: 16 BF: 16 BO: 14 AS: 1 AF: 2	I am very busy and sometime stuff get messy and cluttered so it would be great to know what is in a specific place (AF8) Seems intuitive since I more often wonder how much of X do I have left (BS2) **Negative opinions** I know where I keep my food, it is easy to locate & check. This system is way more complicated (BO4)
Monitor and track certain food items if they felt they need more focusing on these items.	Monitor Particular Foods	Total: 36 BS: 12 BF: 19 BO: 4 AF: 1	I can know when I purchased a product and how much I have wasted (BF36) Probably good way to monitor how much food is wasted (BE55)
Have information about how much money they could save by reducing their food waste. Watching their progress towards that goal	Set Goal	Total: 64 BS: 22 BF: 23 BO: 15 AS: 1 AF: 3	I personally prefer monitoring things over time because it shows how big the impact is and will persuade me to stop doing it or change my habits (BS58) I guess I would want to see how I've improved over time (AS12) **Negative opinions** I would not be interested in setting a goal (AS8)
Comments on other functions			
Assess their progress in food waste reduction by comparing with other people	Join a Competition*	Total: 8 BS: 6 BF: 2	To know where I am in community food wastage reduction (BS41)
Help to know how well they use food at their household, as well as what food have totally run out and need to be restocked Assess their preferred food	Shopping List	Total: 45 BF: 25 BO: 16 AS: 3 AF: 1	It would help to tell me when foods I commonly use and need to stock up on is running out and needs added to the shopping list (BF82) To know on which products, I need to add (BO37) Enables me assess my favourite list (BF35) I'll know the food about to be used up and those that need restocking (BF42) To know for how long the available food can run (BO47) It's good to know when something's almost running out compared to already gone completely (AF6)

Note: * function is not included in the main thesis due to the percentage of comments is not 10% and above of the tracking sub-theme from any participant group

Table E.11 Comments from participants on the competition sub-theme

Level 2 Sub-theme Description	Function	Number of comments	Examples
Comments on functions designed to provide competition support			
All competition functions		Total: 24 BS: 9 BF: 8 BO: 4 AS: 1 AF: 2	
Competition could motivate to do better for food waste reduction	Join a Competition	Total: 24 BS: 9 BF: 8 BO: 4 AS: 1 AF: 2	Competing with waste reduction can become competitive with family members or friends and this will encourage you wanting to reduce waste reduction (BF56) **Negative opinions** I'm little sceptical on this, I don't think I would want to compete as this is a personal goal (BS20) Not super interested in making it a competition, just want to reduce my own waste (AF6)

Table E.12 Comments relevant to the cooperation sub-theme

Level 2 Sub-theme Description	Function	Number of comments	Examples
Comments on functions designed to provide cooperation support			
All cooperation functions		Total: 69 BS: 18 BF: 26 BO: 21 AS: 1 AF: 3	
Help less fortunate people with food that might be not used by them and that they would end up wasting it	Food Sharing	Total: 69 BS: 18 BF: 26 BO: 21 AS: 1 AF: 3	I love the idea of community kitchens and collaborative communities (BF8) It seems a bit like food banks. We would be happy to contribute to them (BO21) I like privacy and helping people privately (BF44) I'd likely know the person I'd share food with so it would just make more sense (AF6) *[As a doner]* This is a really good initiative to help unfortunates get food on their tables which might have gone to waste (BS20) Because if it helps others, whilst reducing waste, then it is worthwhile (BF12) *[As a receiver]*

			This would help me too, particularly if on a tight budget (BF12)
			Could be helpful on certain occasions (BO55)
			Negative opinions
			Concerns over hygiene/theft (BS2)
			It is not safe with the covid19 situation (BO26)
			[As a doner]
			Just isn't something I would do particularly during COVID times (BS26)
			Don't like random strangers dropping by (BS2)
			[As a receiver]
			I like the idea but I am already signed up to Olio[22] and haven't actually used it yet - Covid makes it less likely I would at the moment (BS31)
			Concerns over food quality/hygiene (BS2)
			I'd be embarrassed to pick up food (BS8)

Table E.13 Comments relevant to the reduction sub-theme

Level 2 Sub-theme Description	Function	Number of comments	Examples
Comments on functions designed to provide reduction support			
All reduction functions		Total: 426 BS:99 BF:164 BO:136 AS:13 AF:14	
Easily add items that purchased regularly Save time as regularly buy same items Time saver and a convenient method of preparing a shopping list Scanning items by their bar codes is a quick and convenient way to add food items to shopping lists	Shopping List	Total: 253 BS: 66 BF: 106 BO: 59 AS: 10 AF: 12	I often buy the same things at the supermarket so this would save time rather than using a raw search (BS2) Easiest way of finding regular purchases (BF4) Hassle free way to make a shopping list, requires minimal effort (BS46) I love options that makes my life easier (AF8) It's easier for me to see what foods are nearly finished (BF84) This is much less time consuming (BO25) Easy way of adding item (AF1) It makes it easier for another member to pick up what is needed for the household without any mistakes (BF28) It makes it easy for everyone to add things to the list that they want/need (AF6) **Negative opinions**

---

[22]OLIO is a mobile app for food sharing, which connects neighbours with each other as well as with local food businesses, so that excess food can be shared with those who need, to reduce food waste.

			Hard to search for all food that I got. Imagine I bought 20 items! (AS1)
			Too time consuming to do for large shops (AS8)
Help to easily and efficiently search for what food items they have in stock	Check Food (By Storage Area, By Food Item)	Total: 47 BS: 9 BF: 17 BO: 20 AS: 1	Saves on time to check each place (BO34) This feature is great but a bit time consuming since I need to hold every item and scan it (AF8) It is a bit of a lengthy process I think I'd rather just do like the saying it out loud to Siri (AS12) This can be a very long process (BF2) I think that the other options are just much easier to use so I wouldn't use this much unless for some reason an item is not compatible with the other methods (AF6)
Cut down on the time required on planning, and they could organise the week's meals in a stress-free manner	Meal Plans	Total: 31 BS: 7 BF: 6 BO: 15 AS: 1 AF: 2	This would take a lot of headaches out of meal-planning when I am busy with college and out on placements (BS31) As student, it very easy so we don't lose time to thinks about what we should eat (AS5) **Negative opinions** I like to organize that on my own. Putting it into the app would be too time consuming for me (AS8)
Help to plan for events with less time and effort, as well as reducing the pressure required for deciding what to have at the event	Event Plan	Total: 32 BS: 7 BF: 5 BO: 20	Makes events planning easier (BF50) To save on time spent on planning what to have in the event" (BO47)
Comments on other functions			
Find good method to store food easily and efficiently	Advice: Food Storage*	Total: 11 BS: 4 BF: 2 BO: 5	It saves time googling the best way to store things, especially potatoes (BS13)
It could help them to easily find longer lasting substitutes which help them to save their time and money	Advice: Longer Lasting Food*	Total: 13 BS: 1 BF: 3 BO: 9	Makes it easier to buy longer lasting food to reduce food waste (BS45) This is inspired!! I would love this function. It would save me time and money (BF3)
Help to donate food easily	Food Sharing*	Total: 4 BF: 4	I can easily share my food (BF39)
Help to quickly and easily access the information related to food labels	Advice: Food labels*	Total: 4 BF: 4	To access them easily (BF24)
Save on time in extending shelf life of food	Extend Food shelf-life*	Total: 3 BO: 3	Save on time (BO44)

Provide them with quick ideas, as well as it could help them to save time in finding recipes and to cook more efficiently	Recipes*	Total: 13 BF: 10 BO: 2 AS: 1	I spend a lot of time sourcing recipes online. Having them on the app would be great (BF8)
Find information and advice quickly related to food safety	Advice: Food Safety*	Total: 2 BS: 2	It would save me having to google this information. It would be great having all this information in one app (BS12)
It is an efficient and coinvented function which could help them to manage and check whether there is a particular food item in their household or not	Check Food: Home*	Total: 13 BS: 3 BF: 7 BO: 3	Checking the house for certain foods is quick and easy (BF33)

Note: * function is not included in the main thesis due to the percentage of comments is not 10% and above of the reduction sub-theme from any participant group

Table E.14 Comments relevant to the reminder sub-theme

Level 2 Sub-theme Description	Function	Number of comments	Examples
Comments on other functions			
All reminder functions		Total: 97 BS:23 BF:47 BO:20 AS:3 AF:4	
Reminding of what food do they not have a sufficient amount at home, so that they can remember to buy them when they go shopping	Shopping List	Total: 63 BS: 23 BF: 31 BO: 6 AS: 3	It will help for the avoidance of missing anything out/forgetting anything! (BF47)
Reminding of what foods, they often bought and needed to be purchased			It will help me remember my favourites in order not to forget anything I normally by as most times it's very easy to do (BF28)
Reminding of what food was running out at home, to help them preparing a shopping list to purchase needed food items on the next shopping trip			It's a good reminder and helps not to forget things you need on your shopping trip (BF69)
			I always forget that I ran out of a certain food and notice halfway through cooking (AS10)
Create food lists which would be used as a reminder when they go shopping for food at supermarkets			Reminds me the foods to buy while in the market (BS27)
			Easy reminder of what to buy (BS45)
It could be used as a reminder of what needs to be purchased.			To remind my wife if she was shopping (BF62)

It could help them to remember what food they have at home, especially in some situations.	Check Food: Home	Total: 21 BF: 12 BO: 8 AF: 1	Because I usually buy exactly the same items, all my shopping trips "run in" to each other so it's hard to remember if I bought x y or z on the last trip or 3 trips ago. This would be brilliant (BF27) Very useful way to remember what is exactly needed (AF1)
Remind about whether they like food or not	Advice: Food Buying	Total: 1 AF: 1	Would be a big help with reducing waste and can remind me of whether I liked something or not (AF6)
Help to remembers the details of the previous events	Event Plan	Total: 3 BF: 2 AF: 1	Remind you to prep and what you need for it (BF82) Remember the amount of wasted food and ensure to make meal that suitable and finished by guests (AF1)
Remind of what food they have at home to avoid buying the same items	Check Food (By Storage Area, By Food Item)	Total: 7 BF: 2 BO: 5	Reminds me of the foods I have back at home (BF36) It would save duplication and offer a reminder to replenish (BO21)
Help to remember the ingredients of a particular dish, and the meals which were planned	Meal Plans	Total: 2 BO: 1 AF: 1	It's usually easy to remember main ingredients so this would be more detailed so unlikely to miss buying rest of ingredients (BO9) Remembering the planned meals (AF1)

Table E.15 Comments relevant to the education sub-theme

Level 1 Sub-theme Description	Function	Number of comments	Examples
Comments on functions designed to provide education support			
All education functions		Total: 339 BS:118 BF: 141 BO: 58 AS: 12 AF: 10	
Educating people who do not really know or understand the meaning of different food labels, so that they would know what to consume first. It could reduce anxiety that arises from not knowing if they can use food after dates on specific food labels such as "best before"	Advice: Food labels	Total: 62 BS: 19 BF: 23 BO: 15 AS: 3 AF: 2	Useful info if unsure about food labels (BO55) It is quite helpful and informative, and you might not think about it but if its provided I would pay attention to it (AS9) **Negative opinions** I already know what they mean, plus I could just google it if I didn't (BS2)
Giving some tips and information especially in some situations	Extend Food Shelf Life	Total: 42 BS: 12 BF: 24 BO: 4	Educate me on storing food for longer (BF39) very important features helping to know the best way of storing food longer (AF1) **Negative opinions**

		AS: 1 AF: 1	It is sometimes hard to extend shelf life of some products (BS30)
Educate them by providing advice about how long they can keep unfamiliar food items in different storage areas, which would help them to store food in the right place to have it last for longer and avoid food waste	Advice: Food Buying	Total: 25 BS: 8 BF: 10 BO: 6 AS: 1	Good to know the freezer dates in comparison to fridge as you never know how long it can be stored (BS10) Educate me on foods I'm unfamiliar with" (BF37)
Educate them on how to store certain foods properly	Advice: Food Storage	Total: 49 BS: 20 BF: 15 BO: 11 AS: 2 AF: 1	Educate me on best ways to store food" (BS51) To know the right conditions to store some foods (BO33) **Negative opinions** I would look online rather than an app (BO3) Usually, they tell you on the packaging so I don't think I would use this much (AF6)
Provide new ideas for cooking and preparing meals, as well as other cooking styles. It could also inform them of the ingredients they need for preparing food	Recipes	Total: 60 BS: 22 BF: 26 BO: 11 AF: 1	I love cooking and learning new recipes and always keen on meal ideas (BF4) I don't cook often since I live with my family but when I go to university, I'm planning to use videos and stuff to learn so this would be helpful to me (AF6) **Negative opinions** I like to create my own recipes and do not tend to follow others. I am also more interested in reading recipes from a book rather than online (AS9) There is so many recipes on YouTube, with a wide variety of variations. I don't think this would be my go-to (AS10)
Know how to make new dishes from their leftovers	Using Up Food	Total: 18 BS: 9 BF: 6 BO: 1 AS: 1 AF: 1	Never knew you could this - it's brilliant! Would definitely use it (BS17) As I am mostly unaware of how to use up left over food to be edible (BO60) **Negative opinions** I would still more likely do it on my own (AS9)
Give them knowledge about how to store leftover food, re-heating it and eating it.	Advice: Food Safety	Total: 60 BS: 28 BF: 20 BO: 8 AS: 2 AF: 2	To tell if I should warm the left over before eating it or some other conditions to be met before eating it (BO39) Good for prompting if am not sure. Good as a tool or educating the kids (BF64) **Negative opinions** [I] would search online (BO3) I feel like I already know this information because it's common sense (BS8) Wouldn't really use as I would eat it next day and no longer (BS33)
Comments on other functions			

	Meal Plans*	Total: 7 BF: 7	My son is a picky eater so this would help with ideas on meals for him (BF57)
Provide ideas about what suitable meals they could serve for picky children, or meals for special occasions by providing variety of options of what they can eat and serve			
Provide them with information and ideas about other available options of food which could last longer when they are struggling to think about last longer options, or they might not be thought about it	Advice: Longer Lasting Food	Total: 16 BF: 10 BO: 2 AS: 2 AF: 2	This is a good idea as it helps awareness of other options that I may not know about (BO9) Good to have an idea about other choices (AF11)

Note: * function is not included in the main thesis due to the percentage of comments is not 10% and above of the education sub-theme from any participant group

Table E.16 Comments relevant to the enablement sub-theme

Level 1 Sub-theme Description	Function	Number of comments	Examples
Comments on functions designed to provide enablement support			
All enablement functions		Total: 139 BS: 57 BF: 52 BO: 23 AS: 6 AF: 1	
Enable household members to communicate, share thoughts and update their shopping lists. Enable to search for their favourite food and check it any time as well as add it to the shopping list	Shopping List	Total: 36 BS: 17 BF: 14 BO: 2 AS: 3	My mum always asks me what I need from the shop and if this share option was available, then she could just share it with me and she would be able to see instantly the items I would like. (BS58) I can check the information anytime (BE57) It would allow me to search and add ingredients for my frequently bought ingredients (AS4) **Negative opinions** Usually the driver prefer simpler method (AF11) I live alone (AS9)
Enable them to have access and know if they have food at home or not when they are out shopping, to prevent buying more food than they need.	Check Food: Home	Total: 42 BS: 19 BF: 14 BO: 8 AS: 1	I am able to know the foods I have in stock (BS51) **Negative opinions** I would probably know and am already a frugal shopper (BF62) This is something I would have done before the shop (BS26)
It could enable them to find longer lasting substitutions of food	Advice: Longer Lasting Food*	Total: 1 BO: 1	Help find options that have long lasting shelf life (BO48) **Negative opinions**

			It depends on what I'm buying like lemons I would want them to be fresh rather than in a jar (AF6)
It could enable them to make meal plans by providing them with guidance and the ability to make a plan for a particular time period	Meal Plans	Total: 9 BF: 8 AS: 1	This will enable one to plan meals well and reduce wastages (BF54) Helps me organise my food plan and ingredients I need to buy (AS4)
It could enable them to plan for their special events properly by checking and comparing with their previous events in order to avoid food waste	Event Plan	Total: 10 BF: 8 BO: 1 AS: 1	This will enable one to benchmark from previous events and reduce wastages (BF14) Allows me plan for foods to be eaten in an event without wastages (BO17)
Enable them to check what foods they have in stock, where they are stored and how much they have left, when they are away from home. Allow them to search for a particular food item when they are in a shop to purchase	Check Food (By Storage Area, By Food Item)	Total: 24 BS: 17 BF: 6 BO: 1	I can check the food I have in stock (BS51) Enable check Food on Stock (BF87) Obviously if you were already in the shop and needed to check this would be great (BO25)
Enable them to donate/obtain excess food at a convenient time to the people receiving it or share it the with family members or friends	Food Sharing	Total: 15 BS: 4 BF: 2 BO: 8 AF: 1	Be able to help the needy (BO44) To send food any time for others who may need it (AF1) I would be able to get what I do not have (BS23) It can host larger population (BO33)
Comments on other functions			
Enable to re-use and maximise usage of leftovers	Using Up Food*	Total: 2 BO: 2	Be able to reuse food (BO46)

Note: * function is not included in the main thesis due to the percentage of comments is not 10% and above of the enablement sub-theme from any participant group

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.

Aktas, E., Sahin, H., Topaloglu, Z., Oledinma, A., Huda, A. K. S., Irani, Z., Kamrava, M. (2018). A consumer behavioural approach to food waste. *Journal of Enterprise Information Management*, *31*(5), 658–673.

Al-Buainain, Fadal, (2015). Need to reduce food waste: Experts. Article *Arab News*. http://www.arabnews.com/saudi-arabia/news/722026. Accessed: 30 June 2023.

Aljamal, A., & Bagnied, M. (2021). Food consumption and waste in Kuwait: the prospects for demand-side approach to food security. Int. Rev. Business Res. Papers 8 (6), 15–26.

Al-Matary, A., & AlJohani, E. (2021). Effect of housemaids on adolescents in Saudi Arabia. *Hamdan Medical Journal*, *14*(2), 82.

Alshabanat, Z., Alkhorayef, A., Ben Haddad, H., Mezghani, I., Gouider, A., Tlili, A., Allouche, M., & Gannouni, K. A. (2021). Quantifying food loss and waste in Saudi Arabia. *Sustainability*, *13*(16), 9444.

Armitage, C. J. (2009). Is there utility in the transtheoretical model?. British journal of health psychology, 14(2), 195-210.

Aschemann-Witzel, J., De Hooge, I., Amani, P., Bech-Larsen, T., & Oostindjer, M. (2015). Consumer-related food waste: Causes and potential for action. *Sustainability*, 7(6), 6457-6477.

Baig, M. B., Al-Zahrani, K. H., Schneider, F., Straquadine, G. S., & Mourad, M. (2018). Food waste posing a serious threat to sustainability in the Kingdom of Saudi Arabia – A systematic review. *Saudi Journal of Biological Sciences*, 26 (7), 1743-1752

Baig, M. B., Gorski, I., & Neff, R. A. (2018). Understanding and addressing waste of food in the Kingdom of Saudi Arabia. *Saudi Journal of Biological Sciences*, 26, 1633–1648.

Bandura, A. (1997). The anatomy of stages of change. *American journal of health promotion: AJHP,* 12(1), 8-10.

Bartholomew, L. K., & Mullen, P. D. (2011). Five roles for using theory and evidence in the design and testing of behavior change interventions. *Journal of Public Health Dentistry*, 71, S20-S33.

Bassanelli, S., Vasta, N., Bucchiarone, A., & Marconi, A. (2022). Gamification for behavior change: A scientometric review. *Acta Psychologica*, 228, 103657.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238–246

Bernstad, A. (2014). Household food waste separation behavior and the importance of convenience. *Waste Management*, *34*(7), 1317-1323.

Bhatti, S. H., Saleem, F., Zakariya, R., & Ahmad, A. (2019). The determinants of food waste behavior in young consumers in a developing country. *British Food Journal, 125(6), 1953 - 1967*

Birukou, A., Blanzieri, E., Giorgini, P., & Giunchiglia, F. (2013). A formal definition of culture. In Sycara, K., Gelfand, M., & Abbe, A. (Eds.), *Models for intercultural collaboration and negotiation*: *Vol.* 6. (pp. 1–26). Springer.

Blevis, E., & Morse, S. C. (2009). Sustainably ours food, dude. *Interactions*, *16*(2), 58-62.

Block, L. G., Keller, P. A., Vallen, B., Williamson, S., Birau, M. M., Grinstein, A., ... & Moscato, E. M. (2016). The squander sequence: understanding food waste at each stage of the consumer decision-making process. *Journal of Public Policy & Marketing*, *35*(2), 292-304.

Bluethmann, S. M., Bartholomew, L. K., Murphy, C. C., & Vernon, S. W. (2017). Use of theory in behavior change interventions: an analysis of programs to increase physical activity in posttreatment breast cancer survivors. *Health Education & Behavior*, *44*(2), 245-253.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Braun, V., Clarke, V., Hayfield, N. & Terry, G. (2019). Thematic analysis. In P. Liamputtong (Ed.), *Handbook of Research Methods in Health Social Sciences*. Singapore: Springer Nature.

Bravi, L., Francioni, B., Murmura, F., & Savelli, E. (2020). Factors affecting household food waste among young consumers and actions to prevent it. A comparison among UK, Spain and Italy. *Resources, Conservation and Recycling*, 153, 104586.

Bravi, L., Murmura, F., Savelli, E., & Viganò, E. (2019). Motivations and actions to prevent food waste among young Italian consumers. *Sustainability*, 11(4), 1110.

Brown, T. A. (2006). Confirmatory factor analysis for applied research. Guilford Press.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen and J. S. Long (Eds.), *Testing structural equation models* (pp. 136-162). Sage.

Buzby, J. C., & Guthrie, J. F. (2002). Plate waste in school nutrition programs. *The Journal of Consumer Affairs*, *36*(2), 220-238.

Choi, J. H. J., & Blevis, E. (2010). HCI & sustainable food culture: a design framework for engagement. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*. (pp. 112-117). ACM Press.

Clark, J., & Manning, L. (2018). What are the factors that an opportunity sample of UK students insinuate as being associated with their wastage of food in the home setting? *Resources, Conservation and Recycling*, 130, 20-30.

Clear, A. K., O'Neill, K., Friday, A., & Hazas, M. (2016). Bearing an open "Pandora's Box" HCI for reconciling everyday food and sustainability. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 23(5), 1-25.

Comber, R., Thieme, A., Rafiev, A., Taylor, N., Krämer, N., & Olivier, P. (2013). BinCam: Designing for engagement with Facebook for behavior change. In *Proceedings of INTERACT 2013:14th IFIP TC 13 International Conference, Part II (pp. 99 – 115)* Cape Town, South Africa, September 2-6, Springer.

Crabtree, B.F., & Miller, W.L. (1999). Using codes and code manuals. In B.F. Crabtree & W.L. Miller (Eds.), *Doing qualitative research* (2nd ed., pp. 163 - 178). Sage.

Crowley, M., Heitz, A., Matta, A., Mori, K., & Banerjee, B. (2011). Behavioral science-informed technology interventions for change in residential energy consumption. *CHI'11 Extended Abstracts on Human Factors in Computing Systems*, (pp. 2209-2214). ACM Press.

DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field Methods*, 23(2), 136-155.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining "gamification". *In Proceedings of the 15th International Academic MindTrek Conference: Envisioning future media environments*, (pp. 9-15).

DeVellis, R. F. (2003). Scale Development Theory and Applications (2nd ed.). Sage.

Douglas, B. D., Ewell, P. J., & Brauer, M. (2023). Data quality in online human-subjects research: Comparisons between MTurk, Prolific, CloudResearch, Qualtrics, and SONA. *Plos one*, 18(3), e0279720.

Dunteman, G. H. (1989). *Principal components analysis*. Sage.

Elshaer, I., Sobaih, A. E. E., Alyahya, M., & Abu Elnasr, A. (2021). The impact of religiosity and food consumption culture on food waste intention in Saudi Arabia. *Sustainability*, 13(11), 6473.

Evans, D. (2011). Blaming the consumer–once again: the social and material contexts of everyday food waste practices in some English households. *Critical public health*, 21(4), 429-440.

Farr-Wharton, G., Choi, J. H. J., & Foth, M. (2014a). Food talks back: exploring the role of mobile applications in reducing domestic food wastage. In *Proceedings of the 26th Australian computer-human interaction conference on designing futures: The future of design* (pp. 352-361). ACM Press.

Farr-Wharton, G., Choi, J. H. J., & Foth, M. (2014b). Technicolouring the fridge: reducing food waste through uses of colour-coding and cameras. In *Proceedings of the 13th International Conference on Mobile and Ubiquitous Multimedia* (pp. 48-57). ACM Press.

Farr-Wharton, G., Foth, M., & Choi, J. H. J. (2012). Colour coding the fridge to reduce food waste. In *Proceedings of the 24th Australian Computer-Human Interaction Conference* (pp. 119-122). ACM Press.

Farr-Wharton, G., Foth, M., & Choi, J. H. J. (2013). EatChaFood: challenging technology design to slice food waste production. In *Proceedings of the 2013 ACM conference on Pervasive and ubiquitous computing (adjunct publication)* (pp. 559-562). ACM Press.

Flick, U. (2018). *An introduction to qualitative research (6th Ed.)*. Sage.

Fogg, B. J. (2009). Creating persuasive technologies: an eight-step design process. In *Proceedings of the 4th International Conference on Persuasive Technology* (p. 44). New York: ACM Press.

Fogg, B. J. (2003). Persuasive technology: using computers to change what we think and do. Morgan Kaufmann Publishers.

Food and Agriculture Organisation of the United Nations (FAO). (2013). Food Wastage Footprint: Impacts on Natural Resources; Summary Report. Natural Resources Management and Environment Department: FAO. https://www.fao.org/3/i3347e/i3347e.pdf. Accessed 19 March 2023.

Food and Agriculture Organization of the United Nations (FAO). (2014). Reducing Food Losses and Waste in the Near East & North Africa Region http://www.fao.org/docrep/meeting/030/mj427E.pdf. Accessed 19 July 2023.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18, 39-50.

Ganglbauer, E., Fitzpatrick, G., & Comber, R. (2013). Negotiating food waste: Using a practice lens to inform design. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *20*(2), 11.

Ganglbauer, E., Fitzpatrick, G., & Güldenpfennig, F. (2015). Why and what did we throw out?: Probing on Reflection through the Food Waste Diary. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 1105-1114). ACM Press.

Giordano, C., Piras, S., Boschini, M., & Falasconi, L. (2018). Are questionnaires a reliable method to measure food waste? A pilot study on Italian households. *British Food Journal*, 120, 2885–2897.

Grant, M.J. & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, 26, 91-108.

Grasso, A. C., Olthof, M. R., Boevé, A. J., van Dooren, C., Lähteenmäki, L., & Brouwer, I. A. (2019). Socio-demographic predictors of food waste behavior in Denmark and Spain. *Sustainability*, *11*(12), 3244.

Griethuijsen, R. A. L. F., Eijck, M. W., Haste, H., Brok, P. J., Skinner, N. C., Mansour, N., et al. (2014). Global patterns in students' views of science and interest in science. *Research in Science Education*, 45(4), 581–603.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate data analysis (7th Edition). New Jersey: Prentice Hall.

Hamari, J., Koivisto, J., & Pakkanen, T. (2014). Do persuasive technologies persuade?-a review of empirical studies. In *International conference on persuasive technology* (pp. 118-136). Springer.

Harjumaa, M., & Oinas-Kukkonen, H. (2007). Persuasion theories and IT design. In In Proceeding of the *International Conference on Persuasive Technology* (pp. 311-314). Berlin, Heidelberg: Springer.

Hebrok, M., & Boks, C. (2017). Household food waste: Drivers and potential intervention points for design–An extensive review. *Journal of Cleaner Production*, *151*, 380-392.

Hedin, B., Katzeff, C., Eriksson, E., & Pargman, D. (2019). A systematic review of digital behaviour change interventions for more sustainable food consumption. *Sustainability*, *11*(9), 2638.

Hekler, E. B., Klasnja, P., Froehlich, J. E., & Buman, M. P. (2013). Mind the theoretical gap: interpreting, using, and developing behavioural theory in HCI research. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*, 3307-3316. ACM Press.

Heng, Y., & House, L. (2022). Consumers' perceptions and behavior toward food waste across countries. *International Food and Agribusiness Management Review*, 25 (1030-2022-421), 197-209.

Herzberg, R., Schmidt, T. G., & Schneider, F. (2020). Characteristics and determinants of domestic food waste: A representative diary study across Germany. *Sustainability*, 12(11), 4702.

Hirsch, T., Sengers, P., Blevis, E., Beckwith, R., & Parikh, T. (2010). Making food, producing sustainability. In *CHI'10 Extended Abstracts on Human Factors in Computing Systems*, 3147-3150. ACM Press.

Hu, L.-t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55.

Institution of Mechanical Engineers. (2013). Global Food, Waste Not, Want Not. Available at: http://www.imeche.org/docs/default-source/default-document-library/global-food---waste-not-want-not.pdf?sfvrsn=b3adce12_0. Accessed March 21 2023.

Jarrah, M. (2020). It's official – almost half of Saudi women marry at this age. Article *Alarabiya News*. https://english.alarabiya.net/variety/2018/01/18/It-s-official-almost-half-of-Saudi-women-marry-at-this-age. Accessed 30 April 2023.

Kahneman, D. & and Tversky, A. (1977), Intuitive Prediction: Biases and Corrective Procedures. *Management Science*, 12, 313–27.

Kansal, M., Ananda, J., Mitsis, A., Karunasena, G. G., & Pearson, D. (2022). Food waste in households: Children as quiet powerhouses. *Food Quality and Preference*, 98, 104524.

Khan, M. S. M., & Kaneesamkandi, Z. (2013). Biodegradable waste to biogas: renewable energy option for the Kingdom of Saudi Arabia. *International Journal of Innovation and Applied Studies*, *4*(1), 101-113.

Kijboonchoo, K., Thasanasuwan, W., & Srichan, W. (2013). Gender differences in knowledge, attitude, food choice and body image perception among children aged 9-12 years in Bangkok, Thailand. *Journal of Public Health and Development*, *11*(3), 49-60.

Koivupuro, H. K., Hartikainen, H., Silvennoinen, K., Katajajuuri, J. M., Heikintalo, N., Reinikainen, A., & Jalkanen, L. (2012). Influence of socio-demographical, behavioural and attitudinal factors on the amount of avoidable food waste generated in Finnish households. *International Journal of Consumer Studies*, 36(2), 183-191.

Kormos, C., & Gifford, R. (2014). The validity of self-report measures of proenvironmental behavior: A meta-analytic review. *Journal of Environmental Psychology*, *40*, 359-371.

Kosseva, M. R. (2013). Introduction: causes and challenges of food wastage. Kingdom of Saudi Arabia- Vision2030. https://vision2030.gov.sa/en#. Accessed 21 March 2023.

Krippendorff, K. (2013). *Content analysis: an introduction to its methodology* (3rd edition). Sage.

Lenio, J. A. (2006). Analysis of the Transtheoretical Model of behavior change. *Journal of Student Research.* 5:73–87. 30.

Lim, Y. K., Stolterman, E., & Tenenberg, J. (2008). The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 15(2), 1-27.

Lovallo, Dan and Daniel Kahneman (2003). Delusions of Success: How Optimism Undermines Executive Decisions. *Harvard Business Review*, 81 (7), 56–63.

MacQueen, K. M., McLellan, E., Kay, K., & Milstein, B. (1998). Codebook development for team-based qualitative analysis. *Cultural Anthropology Methods*, 10(2), 31-36.

Mallinson, L. J., Russell, J. M., & Barker, M. E. (2016). Attitudes and behaviour towards convenience food and food waste in the United Kingdom. *Appetite*, 103, 17-28.

Mankoff, J. C., Blevis, E., Borning, A., Borning, A., Friedman, B., Fussell, S. R., Hasbrouck, J., Sengers, P., & Woodruff, A. (2007). Environmental sustainability and interaction. In *CHI'07 Extended Abstracts on Human factors in Computing Systems* (pp. 2121-2124). ACM Press.

Mattar, L., Abiad, M. G., Chalak, A., Diab, M., & Hassan, H. (2018). Attitudes and behaviors shaping household food waste generation: Lessons from Lebanon. *Journal of Cleaner Production*, 198, 1219-1223.

McAdams, B., von Massow, M., & Gallant, M. (2019). Food waste and quality of life in elderly populations living in retirement living communities. *Journal of Housing for the Elderly*, 33(1), 72-84.

Melikoglu, M., Lin, C. S. K., & Webb, C. (2013). Analysing global food waste problem: pinpointing the facts and estimating the energy content. *Central European Journal of Engineering*, *3*, 157-164.

Michie, S., Atkins, Lou, author, & West, Robert. (Eds.). (2014). *The behaviour change wheel: a guide to designing interventions.* Silverback Publishing.

Michie, S., Stralen, M.M. Van & West, R., (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(1), p.42.

Miles, M.B. & Huberman, A.M. (1984). *Qualitative data analysis: a sourcebook of new methods*. Sage.

Miles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis: an expanded sourcebook (2nd edition).* Sage.

Mohammed, Irfan (2014). Massive wastage 'unacceptable''. Article *Arab News* https://www.arabnews.com/node/596446/%7B%7B. Accessed 30 June 2019.

Mondéjar-Jiménez, J. A., Ferrari, G., Secondi, L., & Principato, L. (2016). From the table to waste: An exploratory study on behaviour towards food waste of Spanish and Italian youths. *Journal of Cleaner Production*, 138, 8-18.

Nederhof, A. J. (1985). Methods of coping with social desirability bias: A review. *European Journal of Social Psychology*, 15(3), 263-280.

Nikolaus, C. J., Nickols-Richardson, S. M., & Ellison, B. (2018). Wasted food: a qualitative study of US young adults' perceptions, beliefs and behaviors. *Appetite*, 130, 70-78.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education*, 15, 625 - 632.

Norton, J., Raturi, A., Nardi, B., Prost, S., McDonald, S., Pargman, D., Bates, O., Normark, M., Tomlinson, B., Herbig, N., & Dombrowski, L. (2017). A grand challenge for HCI: Food+ sustainability. *interactions*, 24(6), 50-55.

O'Connor, C., & Joffe, H. (2020). Intercoder reliability in qualitative research: debates and practical guidelines. *International Journal of Qualitative Methods*, *19*, 1609406919899220.

O'Sullivan, O. P. (2015). The neural basis of always looking on the bright side. *Dialogues in Philosophy, Mental and Neuro Sciences,* 8(1),11–15.

Oinas-Kukkonen, H., & Harjumaa, M. (2008). A systematic framework for designing and evaluating persuasive systems. In the Proceedings of *International conference on persuasive technology* (pp. 164-176). Springer.

Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems*, *24*(1), 28.

Ojo, S. O., Bailey, D. P., Brierley, M. L., Hewson, D. J., & Chater, A. M. (2019). Breaking barriers: using the behavior change wheel to develop a tailored intervention to overcome workplace inhibitors to breaking up sitting time. *BMC Public Health*, *19*(1), 1-17.

Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical transactions of the royal society B: biological sciences*, 365(1554), 3065-3081.

Patra, D., Feng, S., & Howard, J. W. (2022). Confusion of food date label with food safety-implications for food waste. *Current Opinion in Food Science*, 100917.

Petrie, H., & Buykx, L. (2010). Collaborative Heuristic Evaluation: improving the effectiveness of heuristic evaluation. In *Proceedings of UPA 2010 International Conference*. Omnipress.

Petrie, H., & Power, C. (2012). What do users really care about?: a comparison of usability problems found by users and experts on highly interactive websites. *In Proceedings of the 30th SIGCHI Conference on Human Factors in Computing Systems (CHI '12)* (pp. 2107-2116). ACM Press.

Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, 360(6392), 987-992.

Preece, J., Sharp, H., & Rogers, Y. (2015). *Interaction Design: Beyond Human-Computer Interaction* (4th Edition). Wiley.

Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behavior change. *American journal of health promotion*, *12*(1), 38-48.

Przezbórska-Skobiej, L., & Wiza, P. L. (2021). Food waste in households in Poland—Attitudes of young and older consumers towards the phenomenon of food waste as demonstrated by students and lecturers of PULS. *Sustainability*, 13(7), 3601.

Quested, T. E., Marsh, E., Stunell, D., & Parry, A. D. (2013). Spaghetti soup: The complex world of food waste behaviours. *Resources, Conservation and Recycling*, 79, 43-51.

Ratcliffe, E., Baxter, W. L., & Martin, N. (2019). Consumption rituals relating to food and drink: A review and research agenda. *Appetite,* 134, 86-93.

Raturi, A., Norton, J., Tomlinson, B., Blevis, E., & Dombrowski, L. (2017). Designing sustainable food systems. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 609-616. ACM Press.

Rogers, Y. (2012). HCI theory: classical, modern, and contemporary. *Synthesis Lectures on Human-Centered Informatics*, 5(2), 1-129.

Russell, S. V., Young, C. W., Unsworth, K. L., & Robinson, C. (2017). Bringing habits and emotions into food waste behaviour. *Resources, Conservation and Recycling*, *125*, 107-114.

Schneider F. (2008). Wasting food: an insistent behaviour. Paper presented at the *Conference on Waste: The Social Context '08 (Urban Issues and Solutions)*. Edmonton, Canada: Edmonton Waste Management Centre of Excellence.

Schwartz, T., Denef, S., Stevens, G., Ramirez, L., & Wulf, V. (2013). Cultivating energy literacy: results from a longitudinal living lab study of a home energy management system. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1193-1202). ACM Press.

Shneiderman, B., & Plaisant, C. (2005). *Designing the User Interface (4th Edition)*. Pearson, Addison Wesley.

Stancu, V., & Lähteenmäki, L. (2022). Consumer-related antecedents of food provisioning behaviors that promote food waste. *Food Policy*, *108*, 102236.

Stancu, V., Haugaard, P., & Lähteenmäki, L. (2016). Determinants of consumer food waste behaviour: Two routes to food waste. *Appetite*, *96*, 7-17.

Stuart, J. (2016). Chinese Red. National Museum of Asian Art. https://asia.si.edu/red/. Accessed 29 March 2023.

Teng, C. C., Chih, C., Yang, W. J., & Chien, C. H. (2021). Determinants and Prevention Strategies for Household Food Waste: An Exploratory Study in Taiwan. *Foods,* 10(10), 2331.

Thaler, R., & Sunstein, C. (2008). *Nudge: Improving Decisions about Health, Wealth, and Happiness*. Yale University Press.

Thieme, A., Comber, R., Miebach, J., Weeden, J., Kraemer, N., Lawson, S., & Olivier, P. (2012). "We've bin watching you" designing for reflection and social persuasion to promote sustainable lifestyles. In Proceedings of the *30th SIGCHI Conference on Human Factors in Computing Systems* (pp. 2337-2346). ACM Press.

Tsai, W. C., Chen, X., & Yang, C. (2020). Consumer food waste behavior among emerging adults: Evidence from China. *Foods*, 9(7), 961.

Tuckett, A.G. (2005). Applying thematic analysis theory to practice: a researcher's experience. *Contemporary Nurse,* 19, 75-87.

United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development.:https://sustainabledevelopment.un.org/content/documents/2125203

0%20Agenda%20for%20Sustainable%20Development%20web.pdf. Accessed 21 March 2023.

Van Boxstael, S., Devlieghere, F., Berkvens, D., Vermeulen, A., & Uyttendaele, M. (2014). Understanding and attitude regarding the shelf life labels and dates on pre-packed food products by Belgian consumers. *Food Control*, 37, 85-92.

Vandenberg, R. J. (2006). Introduction: statistical and methodological myths and urban legends: where, pray tell, did they get this idea? *Organizational Research Methods*, *9*(2), 194-201.

Visschers, V. H., Wickli, N., & Siegrist, M. (2016). Sorting out food waste behaviour: A survey on the motivators and barriers of self-reported amounts of food waste in households. *Journal of Environmental Psychology*, *45*, 66-78.

Wang, Y. S., Odle III, W. S., Eleazer, W. E., & Barlaz, M. A. (1997). Methane potential of food waste and anaerobic toxicity of leachate produced during food waste decomposition. *Waste Management & Research*, *15*(2), 149-167.

Waste and Resources Action Programme (WRAP). (2012). Household Food and Drink Waste in the United Kingdom. https://wrap.org.uk/sites/default/files/2020-12/Household-Food-and-Drink-Waste-in-the-United-Kingdom-2012.pdf. Accessed 25 April 2023.

Waste and Resources Action Programme (WRAP). (2021). Food surplus and waste in the UK – key facts. https://wrap.org.uk/resources/report/food-surplus-and-waste-uk-key-facts. Accessed 01 June 2021.

Wellesley, L., Happer, C. & Froggatt, A. (2015). Changing climate, changing diets: pathways to lower meat consumption. Chatham House, the Royal Institute of International Affairs.

Wong, E. (2021). Shneiderman's Eight Golden Rules Will Help You Design Better Interfaces. The Interaction Design Foundation. https://www.interaction-design.org/literature/article/shneiderman-s-eight-golden-rules-will-help-you-design-better-interfaces. Accessed 21 March 2023.

Yagoub, M. M., Al Hosani, N., AlSumaiti, T., Kortbi, O., Alshehhi, A. A., Aldhanhani, S. R., & Albedwawi, S. A. (2022). University students' perceptions of food waste in the UAE. *Sustainability*, 14(18), 11196.

Yoreh, T., & Scharper, S. B. (2020). Food waste, religion, and spirituality: Jewish, Christian, and Muslim approaches. In C. Reynolds, T. Soma, C. Spring & J. Lazell (Eds.), *Routledge Handbook of Food Waste* (pp. 55-64). Routledge.

Young, S. D., Adelstein, B. D., & Ellis, S. R. (2006). Demand characteristics of a questionnaire used to assess motion sickness in a virtual environment. In *IEEE virtual reality conference*, (pp. 97-102). IEEE.