



**Utrecht University**

MASTER'S THESIS

DEGREE IN HUMAN-COMPUTER INTERACTION

# **DIGITAL GREEN NUDGES TO FIGHT FOOD WASTE**

AUTHOR: ELIAS VICTOR BRUN HERRERA

Student Number: 8196567

Supervisor: Dr. Eelco Herder

Second Reader: Hanna Hauptmann

Utrecht, Netherlands

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# Personal statement of authorship

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Elias Victor Brun Herrera with student number 8196567, student of the Human-Computer Interaction Master's degree at Universiteit Utrecht, as the author of this Master's thesis titled **Digital Green Nudges to Fight Food Waste**.

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# Summary

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The present thesis focuses on examining young adults' food waste behaviour and the effectiveness of digital nudges in promoting sustainable behaviours through food waste reduction apps. The research begins with a comprehensive literature review on food waste, digital nudging, and relevant theoretical frameworks. A mixed-methods approach was employed, involving a questionnaire survey and focus groups to gather data from participants who used food waste reduction apps for a week.

By analysing survey and focus groups data collected before and after app usage, this research highlights a prevalent concern among participants regarding food waste, as well as a personal commitment to minimising it through various strategies. Participants' feedback provides valuable insights for improving app features and user experience, including enhanced intuitiveness, connectivity with household members, and flexible expiration dates. The study aligns with established theories on climate change perception and emphasises the need for tailored green nudges to foster sustainable behaviour change.

The thesis concludes by acknowledging limitations, including usability issues, potential response bias, and limited generalisability. Suggestions for future research include exploring different types of nudges, quantifying the impact of app usage on behaviour change, and conducting long-term studies. By addressing these areas, stakeholders can develop more effective interventions and strategies for reducing food waste among young adults and beyond.

Ultimately, the insights gained from this study can inform the design of more effective app-based nudges, enhance individuals' engagement with food waste reduction efforts, and contribute to the broader goal of achieving sustainable environmental practices.

**Key words:** Food waste, green nudge, nudge, social norms, sustainable development.

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**Part I**

**Preliminary Work**

# 1. Introduction

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Below are described the motivation for this project and its scope, as well as a glossary of terms.

## 1.1. Motivation

The global environment is facing multiple challenges, and transitioning to a more sustainable lifestyle has become an urgent priority. While individual behaviour plays a crucial role in shaping a sustainable future, encouraging environmentally friendly actions can be difficult, particularly in a digital context. Social networks and apps have become an integral part of our daily lives and offer an unprecedented opportunity to reach and influence large populations. However, understanding the factors that drive environmentally friendly behaviour on these platforms is a complex and multifaceted issue.

Nudging, a concept developed by behavioural economists, has been identified as a promising approach to promoting pro-environmental behaviour. By influencing the choice architecture, nudges aim to shift individuals towards making decisions that align with their underlying values and preferences, including environmental sustainability. Computer-generated nudges specifically can be effective because they can be personalised, delivered at the right time and place, reach a large audience, and be designed to be unobtrusive and easy to use. This thesis aims to contribute to the growing body of research on nudging and environmental behaviour by examining how cognitive, experiential, and socio-cultural factors influence the adoption of environmentally friendly behaviour, specifically reducing food waste.

By conducting an in-depth examination of these factors, this thesis will provide a deeper understanding of how nudging can be used to encourage environmentally friendly behaviour, such as reducing food waste, among digital users. This research will help advance the understanding of the complex interplay of factors that drive environmentally friendly behaviour on social networks and apps, and identify areas for future research. Through this, this research hopefully contributes to the development of more effective nudges that can help create a more sustainable future.

## 1.2. Scope & Objectives

The primary objective of this Master's thesis is to investigate how various factors affect individuals' engagement towards the issue of food waste, and how digital technology can be a remarkable tool, by being tailored to individuals' personal circumstances, in influencing people to face the food waste problem.

The research aims to understand why individuals may not be sufficiently engaged in addressing food waste, despite the availability of existing apps dedicated to this cause. Additionally, the study will explore how digital technology, through customised



approaches, can effectively encourage sustainable environmental behaviour, specifically in the context of reducing food waste.

### 1.3. Glossary of terms

- Cognitive bias: A systematic pattern of deviation in thinking that can affect judgment, decision-making, and the interpretation of information.
- Green nudge: Nudge that promotes environmentally sustainable behaviour.
- Nudge: Small, subtle change in the environment that can influence people's behaviour towards a particular outcome.
- Social norms: Shared beliefs, attitudes and behaviours that are considered acceptable and desirable within a particular society or group.
- Status quo bias: A type of cognitive bias, the tendency to prefer things to stay the same and to resist change.
- Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

## 2. Background

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This chapter details the context in which this study is carried out, and examines the existing body of research on nudging and its potential for promoting pro-environmental behaviour, specifically reducing food waste, among social media users. It shows a critical analysis of the different nudging strategies that have been used to encourage environmentally friendly behaviour and evaluates their effectiveness in reducing food waste. Its aim is to provide a comprehensive overview of the current state of research on this topic and identify areas for future research. This will serve as a foundation for the subsequent study and help direct its examination of the factors that influence the adoption of environmentally friendly behaviour, such as reducing food waste, on social networks, as it helps gaining a deeper understanding of the role of social networks and apps in promoting environmentally friendly behaviour and contributing to the development of more effective nudges for reducing food waste.

In the context section will be discussed the topic of climate change and specifically food waste, its causes and consequences, both in the supply chain and more specifically at the household level, as well as solutions already taking place and potential individual-level solutions, and why the solutions in place are not enough. Will also be discussed the topic of climate change perception from an environmental psychology perspective, getting into five theories that intend to explain environmental behaviour and the factors that can influence this from individual to individual.

Thereafter, in the existing techniques section will be discussed the topic of behaviour change interventions according to Abrahamse's book "*Encouraging pro environmental behaviour: what works, what doesn't, and why*" and its relation to environmental behaviour, as well as how one's individual situation can influence this, and how Bloom's taxonomy can be an interesting approach to solve this disparity. Will also be discussed the topic of nudges, with their effects and the challenges they present. Classic and recent literature will be reviewed to broaden one's and the readers' knowledge on the subject. This section will further dive into *green* nudges, examining their features, advantages, potentials, and limitations. Finally, an overview of some apps that engage against food waste will be carried out

### 2.1. Context

Climate change has become one of the most pressing issues of our time, with experts warning that we are rapidly approaching a tipping point that could result in irreversible and catastrophic environmental damage. The Intergovernmental Panel on Climate Change (IPCC) has repeatedly sounded the alarm about the urgent need for global action to curb greenhouse gas emissions and limit the rise in global temperatures to avoid the worst consequences of climate change. <sup>1</sup>

Despite the consensus among climate scientists and experts on the severity of the

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<sup>1</sup>IPCC, "Climate Change" (2022) Intergovernmental Panel on Climate Change

issue, climate change perception remains a complex and challenging problem. People often struggle to understand the scientific, economic, and political dimensions of the issue, and the intangible nature of its impacts can make it difficult for individuals to connect with the issue on a personal level.

While there are many different actions that individuals can take to reduce their environmental impact, one area that is often overlooked is food waste. According to the United Nations Food and Agriculture Organisation (FAO), approximately one-third of all food produced for human consumption is lost or wasted each year.<sup>2</sup> This not only represents a major economic and social cost but also contributes significantly to greenhouse gas emissions, as food waste in landfills produces methane, a potent greenhouse gas. By addressing the issue of food waste, individuals can make a significant contribution to reducing their environmental footprint and mitigating the effects of climate change. (Melikoglu, Lin, and Webb 2013)

### 2.1.1 Food Waste

The food waste problem refers to the excessive amount of food that goes uneaten and ends up in landfills. (Melikoglu, Lin, and Webb 2013) This is a significant issue because the production of food requires the use of resources such as water, land, and energy, and when food goes uneaten and is discarded, all of these resources are wasted.<sup>3</sup> This leads to overuse of natural resources and contributes to environmental degradation. As mentioned before, the food waste in landfills generates methane, which, when released into the atmosphere, contributes to climate change. (Melikoglu, Lin, and Webb 2013; Bagherzadeh, Inamura, and Jeong 2014; Scherhauser et al. 2018) Conventionally, food waste is typically disposed of through incineration or open dumping, which can lead to serious health and environmental problems. Incineration of food waste with high moisture content, for instance, can release dioxins that can exacerbate environmental issues. (Paritosh et al. 2017) This means that food waste has a major impact on the environment, and addressing this issue is crucial for creating a more sustainable and equitable world.

The causes of food waste are numerous and complex. Some of the main causes include overproduction by food producers, consumer behaviour, supply chain issues, poor infrastructure, excessive food packaging, misunderstandings about expiration dates, and economic incentives. Overproduction can occur when food producers aim to avoid shortages and meet consumer demand, leading to an excess of food that is either wasted or sold at a discounted price. (Scherhauser et al. 2018) Consumer behaviour can also lead to food waste if they purchase more food than they need or do not store it properly. (Stancu, Haugaard, and Lähteenmäki 2016) Supply chain issues, such as strict cosmetic standards for produce or lack of refrigeration and transportation in some developing countries, can also contribute to food waste. (Bagherzadeh, Inamura, and Jeong 2014) Many consumers misunderstand expiration dates and throw away food that is still safe to eat. (Aschemann-Witzel et al. 2015) Finally, the current economic system may not incentivise businesses to reduce food waste. (Migliore, Talamo, and Paganin 2020)

Addressing the problem of food waste would require a comprehensive approach

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<sup>2</sup>FAO, "Food Waste" (2022) United Nations Food and Agriculture Organization

<sup>3</sup>FAO, "Food Waste" (2023) United Nations Food and Agriculture Organization

that considers all of these factors. In both past and present a range of initiatives has been implemented, such as food recovery programs that aim to recover surplus food from restaurants, grocery stores, and other food providers, which would otherwise be discarded, and redirect it to people in need. <sup>4</sup> The Food Recovery Network in the United States of America is an example of such a program, having recovered close to five thousand tons of food and donated it to hunger-fighting organisations. <sup>5</sup>

Legislation and policies have also been implemented by governments worldwide, including tax incentives for food donations, landfill bans on food waste, and regulations requiring grocery stores to donate surplus food to food banks. In 2016, France became the first country to ban supermarkets from discarding unsold food, instead requiring them to donate it to charities or use it for animal feed. <sup>6</sup>

Food sharing apps are another initiative that allows individuals and businesses to share surplus food with others in their local communities, reducing waste and providing access to affordable food. <sup>7</sup> And other new technologies such as smart packaging and sensors that track food freshness are also being developed to reduce food waste. (Pirsa, Sani, and Mirtalebi 2022) Companies are also using food waste to create new products such as fertiliser, animal feed, and energy. (Paritosh et al. 2017; Siddiqui et al. 2021)

## Food Waste at Home

There is one particular place where food waste occurs in high income countries: households, which includes the distribution and consumption stages. It is one of the largest contributors to the problem, accounting for approximately half of the total food waste generated in these countries. (Stancu, Haugaard, and Lähteenmäki 2016) Globally, 17% of food production is lost at consumer level (houses, grocery stores, restaurants). <sup>8</sup> In world households alone, it amounts to 11% of food being expired and spoiled, nearly 570 million tons every year. <sup>9</sup>

There are many reasons why individuals waste food. In addition to misunderstanding expiration dates, which causes people to assume that food is no longer safe to eat once it has passed its expiration date when in reality many foods are still good beyond this date, (Aschemann-Witzel et al. 2015) people often simply buy more than they need or cook larger portions than they can consume, leading to excess food that eventually gets thrown away. (Stancu, Haugaard, and Lähteenmäki 2016) Other reasons for food waste can include forgetfulness, lack of meal planning, and purchasing too many perishable items at once. In some cases, people may also be overly selective about the appearance or freshness of their food, which can lead to discarding perfectly good items.

To solve this, awareness campaigns can be an effective way to educate consumers about food waste and its negative impact. By providing information on the issue and

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<sup>4</sup>UNEP, "Think, Eat, Save" (2013) United Nations Environment Programme

<sup>5</sup>Food Recovery Network (2021)

<sup>6</sup>Ministere de la Transition Ecologique et de la Cohésion des Territoires, "La loi anti-gaspillage pour une économie circulaire" (2023)

<sup>7</sup>Too Good to Go, "Movement" (2023) Too Good To Go International

<sup>8</sup>UN, "The Sustainable Development Goals Report 2022" (2022) United Nations, p. 50

<sup>9</sup>Hensel Kelly, "Facing the Food Waste Crisis" (2022) Institute of Food Technologists

offering practical tips and resources, these campaigns can help to change individual behaviour and reduce the amount of food that is wasted in households. (Jagau and Vyrastekova 2017) In particular, campaigns can address specific causes of food waste, such as consumer behaviour and misunderstandings about expiration dates. (Grilli and Curtis 2021) To avoid misunderstandings about expiration dates, food packaging can be re-evaluated to make it easier for consumers to understand and also reduce excessive packaging. (Bagherzadeh, Inamura, and Jeong 2014) Encouraging meal planning and proper food storage can also help consumers reduce the amount of food they waste. (Stancu, Haugaard, and Lähteenmäki 2016; Pickering 2023) Offering incentives, such as discounts or special promotions, for reducing food waste can encourage consumers to change their behaviour. (Bagherzadeh, Inamura, and Jeong 2014) Finally, donating excess food to those in need can reduce food waste while also benefiting others. (Bagherzadeh, Inamura, and Jeong 2014)

But despite these solutions being implemented, food waste is far from being tackled effectively. In some cases even, there is no significant reduction in food waste, like after the “Milieu Centraal” and “No Waste Network” awareness campaigns launched in 2009 in the Netherlands. (Jagau and Vyrastekova 2017) There are several reasons why people may still waste food, even when they are aware of the negative impacts and have access to information and resources to help reduce waste. One reason is simply habit - people may be used to throwing away certain types of food or may not be aware of the full extent of their waste. Additionally, factors such as busy lifestyles and limited storage space can make it difficult to properly use up all the food that is purchased. Finally, some people may still waste food because they do not fully understand the environmental and social impact of food waste, or because they prioritise other values, such as convenience or taste, over reducing waste. Addressing these barriers to reducing food waste will require a multi-faceted approach that includes education, incentives, and systemic changes to the food system as a whole.

### **2.1.2 Climate Change Perception**

Climate change perception refers to individuals’ attitudes, beliefs, and understanding about the reality and consequences of global warming and its impact on the environment. It encompasses a range of views, from those who see climate change as an imminent threat requiring immediate action to those who dispute its existence or downplay its significance. (Wang et al. 2018) Such perception has become a crucial factor in shaping individual behaviour and policy preferences, and continues to play a critical role in efforts to mitigate and adapt to the impacts of climate change. (Hansen, Sato, and Ruedy 2012; Wang et al. 2018) Research has shown that individuals who perceive global warming as a significant threat are more likely to engage in pro-environmental behaviours, such as reducing their carbon footprint, and support policy measures aimed at mitigating its impacts. (Wang et al. 2018; Bouman et al. 2020)

The perception of climate change presents a complex challenge, given its scientific, economic, and political dimensions. This complexity makes it challenging for individuals to fully understand the causes and impacts of climate change. (Van der Linden 2015) Additionally, the abstract nature of many of the impacts of climate change presents a challenge in accurately perceiving the issue. The effects of climate change

are not always immediately noticeable, making it difficult for individuals to relate the issue to their daily lives. (Hansen, Sato, and Ruedy 2012; Van der Linden 2015; Wang et al. 2018)

Perceptions about climate change can be influenced by various factors, such as personal experiences, political ideologies, media coverage, and the availability and credibility of information sources. Some studies argue that climate change awareness is in many countries influenced by educational attainment. (Lee et al. 2015) Others argue that it particularly depends on political orientation, level of education and self-transcendence vs. self-enhancement values. (Poortinga et al. 2019) Numerous studies and meta-analyses have also consistently found that affect and emotions associated with climate change are the most important factors in predicting individuals' opinions and actions related to this issue. (Van der Linden 2015; Brosch 2021) Especially when it came to taking action and supporting climate policies. (Smith and Leiserowitz 2014; Wang et al. 2018; Goldberg et al. 2021)

In the book "*Environmental Psychology. An Introduction.*" by Steg & De Groot, Steg and Nordlund retrace five theories that explain environmental behaviour. (Steg and Nordlund 2018) These theories typically assume that people make reasoned choices, using Kahneman's system 2, and that these choices are influenced by various determinants. (Kahneman 2003)

- Theory of Planned Behaviour

The Theory of Planned behaviour (TPB) first introduced by Ajzen in 1985, proposes that individuals' behaviour is determined by their intentions, which in turn are shaped by three key factors: attitudes, subjective norms, and perceived behavioural control. If an individual has a positive attitude towards a particular behaviour, perceives social pressure to perform the behaviour, and feels in control of the behaviour, they are more likely to intend to perform the behaviour, and thus more likely to actually perform the behaviour. (Ajzen 1985; Steg and Nordlund 2018)

- Protection Motivation Theory

Protection Motivation Theory (PMT) suggests that individuals are motivated to engage in protective behaviour when they perceive that their environment is under threat and they are vulnerable to its negative effects. When it comes to environmental behaviour, this can include threats such as climate change, pollution, and habitat destruction. (Steg and Nordlund 2018) The theory proposes that there are four key factors that influence an individual's response to environmental threats: perceived severity, perceived vulnerability, response efficacy, and self-efficacy. When individuals perceive that the threat to the environment is severe and that they are vulnerable to its negative effects, they are more likely to engage in protective behaviour. This is especially true if they believe that their behaviour will be effective in reducing the threat and they have confidence in their ability to engage in environmentally-friendly behaviour. (Steg and Nordlund 2018)

- Norm Activation Model

The Norm Activation Model (NAM) advances that personal norms are a sense of obligation or responsibility that people feel towards the environment, based on their

beliefs and values. These personal norms are activated when an individual is faced with a decision that has an impact on the environment. NAM suggests that an individual's decision to engage in environmentally-friendly behaviour is influenced by the activation of their personal norms, as well as their awareness of the environmental impact of their behaviour. (Steg and Nordlund 2018) The model proposes that an individual's personal norms are activated in four steps: awareness of need, outcome efficacy, self-efficacy, and ascription of responsibility. Then the individual will go through four additional steps involving moral obligation, assessment and reassessments of possible responses, before eventually taking action. (Schwartz 1977)

- Value-Belief-Norm Theory of Environmentalism

According to the Value-Belief-Norm (VBN) theory, an individual's values, such as altruism or self-transcendence, influence their environmental beliefs, such as the belief that the environment is important for future generations or that humans have a responsibility to protect the natural world. These environmental beliefs, in turn, influence the personal norms that an individual holds, such as the belief that they have a responsibility to protect the environment. (Steg and Nordlund 2018) It suggests that there are four key values that are associated with pro-environmental attitudes and behaviour: biospheric values, altruistic values, egoistic values, and hedonic values. (Steg and Nordlund 2018)

- Goal-Framing Theory

The goal-framing theory explains how the way that goals are framed can influence an individual's decision to engage in environmentally-friendly behaviour. Promotion goals are focused on achieving positive outcomes, such as gaining rewards or experiencing pleasure. Prevention goals, on the other hand, are focused on avoiding negative outcomes, such as avoiding losses or preventing harm. The theory suggests that individuals are more likely to engage in environmentally-friendly behaviour when goals are framed as prevention goals, emphasising the potential negative consequences of not engaging in pro-environmental behaviour. (Steg and Nordlund 2018) When goals are framed as prevention goals, individuals are more likely to feel a sense of urgency and personal responsibility to engage in environmentally-friendly behaviour in order to avoid negative outcomes. This can lead to an increase in motivation to engage in pro-environmental behaviour. (Steg and Nordlund 2018)

From these five theories, Van Valkengoed et al. (2022) extract the following determinants of environmental behaviour that can be targeted through behaviour change interventions: attitudes towards the behaviour, self-efficacy, injunctive norms towards the behaviour, descriptive norms towards the behaviour, problem awareness, ascription of responsibility, outcome efficacy, personal norms, and risk perception, on top of knowledge, as lacking knowledge about the causes and impacts of environmental problems is commonly assumed to be a reason why people do not act pro-environmentally. (Valkengoed, Abrahamse, and Steg 2022) Van Valkengoed et al. (2022) additionally introduce three determinants: negative affect, which is the emotional response to a risk, a variation of risk perception from the PMT, self-focused emotion, and environmental self-identity. (Valkengoed, Abrahamse, and Steg 2022)

The study then defines interventions and classifies them into categories: infor-



mation provision, commitment, feedback, incentives, goal setting, and choice architecture. These interventions aim to influence people's behaviour by targeting specific factors and assuming that individuals consciously consider these factors when making decisions. However, when people lack the time, mental capacity, or motivation to thoroughly evaluate all possible options, they often rely on more automatic and heuristic decision-making processes. Nudges are designed to target these processes, helping to guide individuals towards more sustainable behaviours without requiring extensive cognitive effort. (Valkengoed, Abrahamse, and Steg 2022)

Nudges are subtle interventions designed to steer individuals towards making a certain choice. (Thaler and Sunstein 2008) When it comes to promoting pro-environmental behaviours, nudges can help to increase the salience of environmental issues and encourage individuals to adopt sustainable practices. Therefore, incorporating nudges as part of a broader strategy to raise awareness towards climate change can be a powerful tool in promoting environmentally-friendly behaviours. (Lehner, Mont, and Heiskanen 2016; Carlsson, C. A. Gravert, et al. 2019; Grilli and Curtis 2021)

There are other ways to raise awareness and emotional affect related to climate change, such as showcasing successful examples of environmentally-friendly practices. This can help to create a sense of optimism and inspire others to take action. (Grilli and Curtis 2021) Another way is through education, messaging that emphasises the social and personal consequences of climate change, and highlighting the individual's role in mitigating the issue. (Abrahamse 2019; Grilli and Curtis 2021) Of course, another method to promote environmental behaviour is by means of financial or non-financial incentives. (Abrahamse 2019; Grilli and Curtis 2021)

Van der Linden (2015) argues in his article on climate change risk perception that 70% of its variance from individual to individual can be explained by combining and integrating cognitive, experiential, and socio-cultural factors (Van der Linden 2015). Understanding these factors and being able to identify the perception someone has based on them can help future research in designing nudges towards promoting environmentally friendly behaviour. Nudges should be tailored to the specific needs, values, and behaviours of target audiences and continuously monitored and evaluated for their effectiveness, with the design being refined as needed to achieve more impactful results over time. (Lehner, Mont, and Heiskanen 2016) By following these steps, nudges can effectively promote environmentally friendly behaviour and mitigate the impacts of climate change.

### 2.1.3 Context Synopsis

In conclusion, addressing the issue of food waste is crucial for creating a more sustainable and equitable world. Approximately one-third of all food produced for human consumption is lost or wasted each year, which not only represents a major economic and social cost but also contributes significantly to greenhouse gas emissions. Addressing food waste at the household level is also crucial, as households are responsible for approximately half of the total food waste generated in high-income countries. By taking action to reduce food waste, individuals can make a significant contribution to reducing their environmental footprint and mitigating the effects of climate change.



The attitudes, beliefs, and understanding of individuals about global warming and its impact on the environment, influence climate change perception and can ultimately affect individual behaviour and policy preferences. However, the complexity of the issue and the abstract nature of many of the impacts of climate change can make it challenging for individuals to fully understand its causes and impacts. Five theories have been proposed to explain environmental behaviour: Theory of Planned Behaviour, Protection Motivation Theory, Norm Activation Model, Value-Belief-Norm Theory of Environmentalism, and Goal-Framing Theory. Understanding these theories can help in shaping policies and techniques aimed at mitigating and adapting to the impacts of food waste.

## 2.2. Existing Techniques

This section will explore various strategies and tools for promoting behaviour change and reducing food waste, including behaviour change interventions as a whole, and then nudges and green nudges specifically, as well as some apps targeting food waste reduction. These approaches have been developed to address the complex and multifaceted problem of food waste. By examining the latest research and practical applications, this section aims to provide a comprehensive understanding of these topics and their potential for diminishing food waste.

### 2.2.1 Behaviour Change Interventions

As seen by Abrahamse in his book *"Encouraging pro-environmental behaviour: what works, what doesn't, and why"*, there can be a distinction between structural and informational interventions. Structural interventions change the environment in which individuals make decisions, assuming that those changes at the structural level like technological innovations, policies and regulation that make environmentally harmful behaviour more expensive and vice versa, will encourage people to change their behaviour. (Abrahamse 2019)

Informational interventions, rather than change the context of decision-making, intend to change the determinants of environmentally significant behaviour, assuming that behaviour change will come from changing people's knowledge, attitudes and beliefs, for example by providing information that may raise the individual's concern about the consequences of climate change. Informational interventions can also take the form of feedback provision, goal setting, commitment making and use of social norms. (Abrahamse 2019)

When it comes to climate change, informational interventions have had contrasted results. Information provision, as shown in several studies, has a minimal effect on climate change concern and on encouraging behaviour change. Media coverage of climate change-related topics and political opinions proved to be better predictors of climate change concern. (Abrahamse 2019) But there are ways of increasing its effectiveness, such as message framing. According to various studies, information about climate change mitigation engaged people with higher levels of climate change concern, whereas for people who had low levels of climate change concern, information about adapting to it showed larger engagement. (Abrahamse 2019) This suggests that depending on

how the message is framed it is possible to target people with contrasting attitudes towards climate change.

Feedback provision, on the other hand, encourages environmental behaviour by providing insight into the links between certain outcomes and the behaviour changes necessary to obtain such outcome, thus motivating people to perform well. Especially when provided frequently and over long periods of time, feedback proved to be a promising intervention to encourage a more environmental behaviour. (Abrahamse 2019)

Another way to encourage pro-environmental behaviour is by setting specific and achievable goals. This can be done by providing individuals with information on what constitutes sustainable behaviour and encouraging them to set clear targets to reduce food waste for example. behaviour change is more likely to occur when difficult goals are set, but it's important that these goals are attainable within a given time frame. (Abrahamse 2019)

Commitment is yet another approach to spur pro-environmental behaviour. This type of intervention asks from individuals pledge to to a certain behaviour change. This works because according to the consistency principle, people would rather be consistent between their attitudes, beliefs and actions. Conflicting thoughts create internal discomfort which in turn motivates people to engage in a behaviour that will restore this asymmetry. Researchers also found that when people agree to commit to something, their self-perception is altered, which then makes it harder for individuals to not embrace a behaviour that is in line of that self-perception. (Abrahamse 2019)

Finally, social influence, which occurs when one's thoughts are influenced by others'. This behaviour change intervention uses people's tendency to form beliefs and opinions on how they ought to behave based on interactions they have with other people. Because information coming from somebody within one's social network is assumed to be more effective, social networks are a great way to disseminate information. One way to encourage information dissemination through social networks is via block leaders, who are volunteers that act as opinion leaders and spread a message through their social network. This approach is not only successful in encouraging behaviour change, but also in shifting social norms. (Abrahamse 2019)

### **Individual situations**

To deal with food waste can be a challenging issue, as it often requires, as seen before, changes to individual behaviour that can be difficult to maintain. In order to address this issue, it's important to consider the unique circumstances of each individual, there are a variety of individual factors that can impact one's ability to make changes. For example, one's family size, one's economic situation, and one's access to grocery stores and fresh food can all influence how people approach food waste reduction. Those living alone may have different challenges than those with larger families, and those living in food deserts may struggle with access to fresh food. For example, a family with young children may find it more difficult to reduce food waste, as children may be picky eaters or refuse to eat leftovers.

To effectively address food waste, it's important to consider individual circum-

stances and tailor interventions accordingly. This is where Bloom's Taxonomy can be helpful, as it provides a framework for creating behaviour change interventions that are personalised and effective. By understanding the unique needs and circumstances of each individual, it is possible to create interventions that are tailored to their specific situation, making it easier to adopt and maintain behaviour changes over the long term.

In the context of environmental behaviour change, Bloom's taxonomy has been used to design educational programs and interventions that target specific levels of learning. For example, remembering and understanding can be targeted through the provision of basic environmental knowledge and information about the impacts of human behaviour on the environment. Applying and analysing can be targeted through interactive activities that allow individuals to practice environmentally friendly behaviours and reflect on the consequences of their actions. Evaluating and creating can be targeted through opportunities for individuals to assess their own environmental impact and develop innovative solutions to environmental challenges. (Pappas, Pierrakos, and Nagel 2013)

### 2.2.2 Nudges

Nudges are yet another behaviour change intervention stated by Abrahamse in his previously mentioned book. (Abrahamse 2019) The classic literature on nudging reveals that individuals frequently make suboptimal decisions due to cognitive biases, limited attention, and insufficient information. (Thaler and Sunstein 2008) Nudges, were popularised by Thaler and Sunstein in their book *"Nudge: Improving Decisions About Health, Wealth and Happiness"* (2008). They can be defined as small changes to the environment that influence behaviour without imposing limitations on choice or significantly changing the incentives, and can be employed to encourage individuals to make better decisions. (Thaler and Sunstein 2008) They are intended to *"counteract poor choices made by individuals"* in other words a behavioural solution to a behavioural problem. (Carlsson, C. A. Gravert, et al. 2019; Carlsson, C. Gravert, et al. 2021) Examples of classic nudges include default options, social norms, and simplification of complex information. (Thaler and Sunstein 2008)

Default options involve presenting individuals with a pre-selected option that they can either accept or modify. This type of nudge takes advantage of the tendency to avoid making changes and can significantly impact behaviour. (Thaler and Sunstein 2008; Schubert 2017) Social norms are another form of nudge that draws on the desire to conform to social expectations. For instance, encouraging individuals to reduce food waste by informing them that most people in their neighborhood do so is an example of a social norm nudge. (McKenzie-Mohr and Schultz 2014; DesRoches et al. 2023) Simplification of complex information fundamentally involves making information more accessible and easier to understand. This nudge aims to mitigate cognitive biases that may arise due to insufficient information. (Lehner, Mont, and Heiskanen 2016)

More recent research has explored the use of digital nudges, which leverage technology to influence behaviour. Digital nudges include personalised recommendations, feedback, and reminders. (Weinmann, Schneider, and Brocke 2016) Digital nudges can be particularly effective in changing behaviour because they can be delivered in real-

time and tailored to individual preferences. (Schneider, Weinmann, and Vom Brocke 2018)

Carlsson et al. (2021) classify nudges into two categories. Pure nudges, usually work by rearranging the order in which options are presented, because of this there is always a natural nudge towards a certain choice, and this is often impossible to avoid. (Carlsson, C. Gravert, et al. 2021) For example if one puts vegetarian dishes at the top of a menu, clients will more likely choose to eat these than if they weren't. This phenomenon can be attributed to a cognitive bias known as "status quo bias", where individuals tend to perceive the default or top options as being recommended by experts or policy makers and therefore, the most viable choice. This results from the general assumption that those in positions of authority have access to additional information that justifies the placement of certain options as the default. (Carlsson, C. Gravert, et al. 2021)

Moral nudges are less subtle, they work by triggering a conscious psychological response from the individual being nudged. Because of this they are more prone to a negative response from individuals, as they could feel that the nudge is not in line with their preferences or simply they object to being nudged. (Carlsson, C. Gravert, et al. 2021) Although the effect of this is highly contextual.

Of course, there are challenges when it comes to nudging. Its effects will highly depend on whether the behaviour in question is actually "nudgeable". If the difference between two behaviours, actual and target, is too large, nudging won't work. (Van der Linden 2015) Which is why it is essential to know which nudges are applicable to which users, which in this case will be largely dependent on the individual's environmental concern. (Oakley and Salam 2014)

Furthermore, the effects of moral nudges decrease faster over time. Van der Linden (2015) argues that it may be optimal to couple a green moral nudge with another generating a sense of pride from applying the targeted green behaviour. (Van der Linden 2015) It is also important to note that the use of nudges raises ethical and societal questions about the manipulation of individual behaviour, and the potential for unintended consequences, as nudges can be manipulative and infringe on individual autonomy. (DesRoches et al. 2023) Another concern is that nudges may not work equally well for all individuals or in all contexts. For example, a nudge that is effective in one cultural context may not be effective in another. (Van der Linden 2015; Valkengoed, Abrahamse, and Steg 2022)

Overall, the literature on nudging and decision-making suggests that nudges can be a powerful tool for improving behaviour, but their effectiveness depends on a variety of factors, including the context, the individual, and the nature of the behaviour being targeted. It is important to carefully consider the ethical implications of using nudges and to ensure that they are designed to respect individual autonomy and promote well-being.

### 2.2.3 Green Nudges

In recent years, there has been a growing interest in the use of "green nudges" to encourage pro-environmental behaviour, including reducing individual food waste. A

”green nudge” can be defined, based on Carlsson et al. (2019) definition, as a subtle manipulation of the decision-making process that aims to encourage individuals to adopt more environmentally friendly behaviours. This can be achieved through small modifications in the presentation of choices and information, without limiting options or altering economic incentives. The goal is to influence behaviour in a predictable manner and reduce negative environmental impacts. (Carlsson, C. A. Gravert, et al. 2019) Such nudges offer a low-cost and scalable means of promoting environmentally sustainable behaviour.

One of the key features of green nudges is that they are often tailored to the specific context and behaviour that they are designed to influence. One such nudge involves encouraging consumers to purchase only what they need, by providing smaller portion sizes or recommending appropriate portion sizes for different types of food. (Kallbekken and Sælen 2013; Lehner, Mont, and Heiskanen 2016) Another approach involves promoting meal planning and preparation, which can help reduce food waste by enabling consumers to make more informed purchasing decisions, and use up perishable foods before they expire. (Von Kameke and Fischer 2018) Another important feature of green nudges is that they can be designed to provide immediate feedback on the environmental impact of an individual’s behaviour.

Green nudges can also focus on encouraging responsible disposal of food waste. One example of this is digital nudges, which use technology to provide consumers with personalised feedback and reminders about reducing food waste. Such nudges can leverage data on food purchases, consumption patterns, and waste disposal to offer tailored feedback and encouragement to households. <sup>10</sup>

Green nudges have shown several advantages because they align with how people naturally make decisions. Rather than limiting choice, they alter the choice environment to promote the desired behaviour. This means that individuals feel in control of their decisions, and are more likely to comply with the nudge. (Thaler and Sunstein 2008) However, there are also limitations to the effectiveness of green nudges. One of the main challenges is that they may not be equally effective for all individuals. Different people respond differently to nudges, and some may be resistant to change. Additionally, the effectiveness of green nudges may decrease over time, as people become accustomed to the nudges and their impact decreases, and even more so when the nudge is no longer in place. (Schubert 2017; Grilli and Curtis 2021)

Another potential limitation of green nudges is that when opposed to marketing, results remain moderate. The best results can be found where the consumer is in a controlled environment in which few counteracting forces are present. This is because nudging is most effective when the decision-making context can be carefully designed to promote certain behaviours, without the conflicting influence of other factors. This means that the choice architecture can be optimised to nudge people towards making the desired choice, while minimising the influence of competing factors. (Lehner, Mont, and Heiskanen 2016)

Overall, green nudges have the potential to be a powerful tool for encouraging pro-environmental behaviour. By providing tailored interventions that address specific

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<sup>10</sup>CozZo (2023)

barriers to sustainable behaviour and providing immediate feedback on the environmental impact of behaviour, green nudges can help individuals overcome the cognitive and behavioural barriers that prevent them from acting in an environmentally-friendly manner.

## 2.2.4 Existing Food Waste Reduction Apps

The European and global markets offer a range of innovative apps designed to combat food waste, each employing unique approaches to address this pressing issue. These apps encompass various functionalities, including providing access to surplus food from food businesses or individuals, facilitating efficient kitchen inventory management, and assisting users in effective meal planning.

### Too Good To Go

Too Good to Go is a mobile application that aims to reduce food waste by connecting consumers with surplus food from restaurants, cafes, bakeries, and other food businesses. The app's core service is based on the idea of "rescuing" food that would otherwise go to waste and making it available to consumers at a discounted price. This feature provides a market for surplus food and helps to reduce food waste.

In addition to its primary function, the Too Good to Go app also includes several behaviour change interventions to encourage users to reduce food waste. One of the app's main features is the "magic bag" option, where users purchase a bag of surplus food from local food businesses at a discounted price. This feature is designed to encourage users to try new foods while also reducing food waste.

The app also provides educational resources for users to reduce food waste at home. This includes recipe ideas for using up leftovers, tips for meal planning, guidance on proper food storage, and information on the environmental impact of food waste. By providing users with practical advice on reducing food waste, the app aims to encourage behaviour change and promote sustainable food consumption. <sup>11</sup>

### CozZo

CozZo is a smart kitchen inventory management app that helps users to reduce food waste and save money. The app is designed to manage the groceries, expiration dates, and shopping lists, and offers features like barcode scanning, voice recognition, and real-time alerts to keep track of inventory.

The CozZo app offers a simple user interface that enables users to keep track of the contents of their fridge, freezer, and pantry. Users can easily scan barcodes or enter product details manually to create an inventory of items. The app then automatically monitors expiration dates and sends notifications when items are about to expire. It also allows users to create shopping lists and helps them plan meals with ingredients they already have. It also tracks food consumption, which helps users to understand their food habits and make better choices. The app provides helpful tips on how to store and cook different types of food to make them last longer.

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<sup>11</sup>Too Good To Go (2023)



The app provides users with information and tips on how to properly store food and reduce waste, as well as offering alerts when food is approaching its expiration date. This can encourage users to plan meals more carefully and make more conscious decisions about their food consumption. Additionally, the app provides insights into food consumption patterns, which can help users understand how much food they are wasting and where they can make changes to reduce waste. By providing feedback and encouraging mindful food consumption, the CozZo app can help users develop more sustainable food practices and reduce their environmental impact. <sup>12</sup>

## Olio

The Olio app is a mobile app designed to reduce food waste and help individuals and businesses share surplus food with their local communities. It enables people to connect with their neighbors and share excess food, which may otherwise go to waste.

The app works by allowing individuals and local businesses to upload photos of food that they no longer need or want, including fruits, vegetables, bread, dairy products, and non-perishable items. The food is then offered to other users in the area, who can arrange a time to pick it up. Users can also find local community fridges, where they can drop off food that they don't need and other people can take it for free. The app has a built-in messaging system that allows users to communicate with each other to arrange pickup times and discuss any dietary or allergy requirements.

To encourage this behaviour, the app presents several behaviour change interventions. It creates a community of users who share the same values of reducing food waste and helping their local community. By connecting with others in their area and sharing food, users are encouraged to adopt this behaviour themselves and feel a sense of belonging to a larger community. It also provides feedback to users on the amount of food they have shared and how many people have benefited from it. This positive reinforcement encourages users to continue sharing their surplus food and feel a sense of accomplishment and satisfaction. Moreover, the app encourages users to make a commitment to reducing food waste by signing up and setting up an account. Once they have made this commitment, they are more likely to remain consistent with the behaviour and continue to share food on a regular basis. Finally, the app promotes a sense of reciprocity among users. When users share food with others, they are more likely to receive food from others in return, encouraging individuals to continue sharing and creates a sense of trust and community within the app. <sup>13</sup>

## KitchenPal

KitchenPal is a mobile application that aims to simplify the groceries management process and enhance the overall grocery shopping and cooking experience for its users. Much like CozZo, it focuses on combating food waste by providing tools and features that promote ingredient awareness and help users make the most of their groceries.

The app offers an extensive recipe catalog featuring various cuisines and dietary preferences. Users can explore recipes and plan their meals for the week, ensuring a

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<sup>12</sup>CozZo (2023)

<sup>13</sup>Olio (2023)

well-balanced diet. By having a clear meal plan, users can be more mindful of their ingredient needs and avoid overbuying, which helps prevent food waste.

KitchenPal includes a shopping list function that enables users to create organised lists based on selected recipes and desired quantities. This feature promotes efficient grocery shopping by ensuring users only buy what they need, reducing the likelihood of excess food ending up in the trash.

Moreover, the app encourages ingredient awareness through features such as inventory management. Users can keep track of their existing ingredients, allowing them to see what they have on hand before going shopping or planning their meals. This feature helps users use ingredients they already possess and minimise unnecessary purchases.

Additionally, KitchenPal offers notifications and reminders to help users stay aware of their food items' freshness. Users can set notifications for items that are approaching their expiration dates or are at risk of going bad. This feature helps users consume perishable items before they spoil, thus reducing food waste.

By combining these features—meal planning, organised shopping lists, ingredient inventory management, and expiration date notifications, KitchenPal equips users with the tools they need to be more mindful of their ingredients, reduce food waste, and make the most of their groceries. <sup>14</sup>

## 2.3. Summary

In the literature review, various topics related to behaviour and climate change were explored, including food waste, climate change perception, environmental behaviour, nudges, and green nudges. Reducing food waste can contribute to mitigating the impacts of climate change, and understanding climate change perception and environmental behaviour theories can inform the design of effective behaviour change interventions and nudges towards said reduction. As seen in this review, by understanding what factors affect environmental behaviour, it is theoretically feasible to link behaviour change interventions to these, and therefore having a greater impact in influencing individuals into environmentally-responsible behaviours. (Valkengoed, Abrahamse, and Steg 2022)

Green nudges specifically, offer a promising approach to encourage pro-environmental behaviours, including food waste reduction, through subtle manipulations in decision-making processes that promote more sustainable choices. Additionally, by tailoring interventions and nudges to individuals' unique circumstances and considering their ethical implications, it is possible to create effective behaviour change interventions that promote sustainability and respect individual autonomy.

Through this review, it was discovered that there still is a gap in the research regarding how to effectively use green nudges through digital technology to promote sustainable environmental behaviour, specifically in the context of reducing food waste. Furthermore, while there has been some research on the effectiveness of green nudges in promoting sustainable behaviour, there is a lack of understanding of how these nudges

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<sup>14</sup>KitchenPal (2023)



can be tailored to individuals' unique personal circumstances, such as economic level, family size, and cultural background.

## 3. Methodology

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This section describes all aspects related to the project management: research questions, methodology, research design, data collection and analysis methods, planning, and ethical considerations. From this section on, participants in the reflective study will be referred to as respondents, while participants to the follow-up experiment and focus groups will be referred to as participants.

### 3.1. Research Questions

Based on the findings in the literature review, the research questions for this thesis project are the following:

RQ1: *What factors contribute to the insufficient engagement of individuals in solving the issue of food waste, despite the availability of existing apps dedicated to this cause?*

RQ2: *How can green nudges through digital technology be tailored to individuals' unique personal circumstances to promote sustainable environmental behaviour, specifically in the context of reducing food waste?*

#### 3.1.1 Hypotheses

For these research questions, the following hypotheses were made:

H1: *Most participants will declare caring about food waste but do not do anything due to time constraints and/or mismanagement of their groceries.*

H2: *Very few participants will have already used an app with the goal of reducing their food waste, due to a lack of motivation.*

H3: *The green nudges present in the apps will not be sufficient to make participants consistently use the app.*

H4: *Most participants will feel very few changes in their food waste behaviour or none at all, during or after the experiment, despite being subject to nudges.*

### 3.2. Research Methodology

The purpose of this study is to answer the previously mentioned research questions. To achieve this, a qualitative research was performed. This chapter will provide a detailed explanation of the methodology used, including the research design, participants, data collection and analysis methods, and ethical considerations. By outlining these aspects, readers will gain a comprehensive understanding of the research process and the validity of the results obtained.

### 3.2.1 Design

To answer the research question, this study involved two main stages: the initial reflective study and the follow-up focus groups, distributed into four weeks. The first week was used to recruit participants for the initial survey and for them to respond to it. The second week was to explain the second stage of the experiment to the participants that first agreed to participate in it as they were also given time to reflect if they further agreed to participate knowing all the terms and implications. The third week was for the participants to use the app before the follow-up focus groups. Finally, the fourth week was used to perform said focus groups with the participants. Thereafter a more detailed explanation of the methodology.

#### Reflective Study

The reflective study was conducted using a mixed-methods approach, involving both closed-end and open-ended questions, to collect data on participants' behaviour regarding food waste before the study. A questionnaire was developed based on existing literature related to food waste reduction and digital apps promoting sustainable behaviour (Visschers, Wickli, and Siegrist 2016). The questionnaire was developed on Qualtrics and answered online by the respondents after having been presented with a consent form. This questionnaire was to be available for two weeks, during which it was expected to get at least 100 respondents. This was to increase the chances of getting enough participants for the second stage (around 20) from those initial participants. Because of a more than sufficient amount of responses after only 48 hours, it was decided to leave it only one week.

The questionnaire included demographic questions, such as age, gender, country of residence, and education level, to understand how different demographic groups interact with food waste apps. Additionally, respondents were asked to answer closed-end and open-ended questions regarding their food waste behaviour, such as how they purchase and use the food they use in their daily lives, and the reasons behind them wasting it or not. These questions helped to learn about the kind of food waste that is happening and the factors contributing to it. Respondents were asked to describe how they feel about food waste, how capable they feel to do something about it, and to explain the reasons behind their behaviour. This qualitative data helped to provide a more in-depth understanding of the factors contributing to food waste. A 5-point Likert scale was used to quantify the answers to the closed-end questions, while the answers to the open-ended questions were analysed and classified in useful categories that might stand out.

To gather more detailed information, the questionnaire also included open-ended questions that allow respondents to provide insights about their existing knowledge and experience with apps that aim to prevent food waste such as the ones mentioned in the literature review. For example, what the reason behind them downloading the app was, if there were any internal or external factors contributing or withholding them from achieving to waste less food, what those factors were, and if they would try one again or for the first time for those who didn't have any experience. This qualitative data helped to provide a more in-depth understanding of what the existing apps already do and what is missing from them to burst into people's daily lives.

After completing the reflective study, respondents were asked if they want to further participate in the experiment using an app like the ones referred to in the survey, for one week. CozZo was chosen for its availability in various countries where participants were recruited, as well as its focus. Contrary to Too Good to Go for example, CozZo does not involve any financial expense, it is merely an intermediary through which the user is enabled to manage their kitchen inventory and make more informed decisions on their meal plan and grocery shopping list. Also, the concept of Too Good to Go is more well known by the public, whereas the one present in CozZo not so much. CozZo also presents some nudges in its interface that are relevant to this study such as notifications on expiration dates of bought products, as well as a downloadable widget that shows the user an inventory status overview. For this further part of the experiment, the respondents were asked for an email address through which they could be contacted.

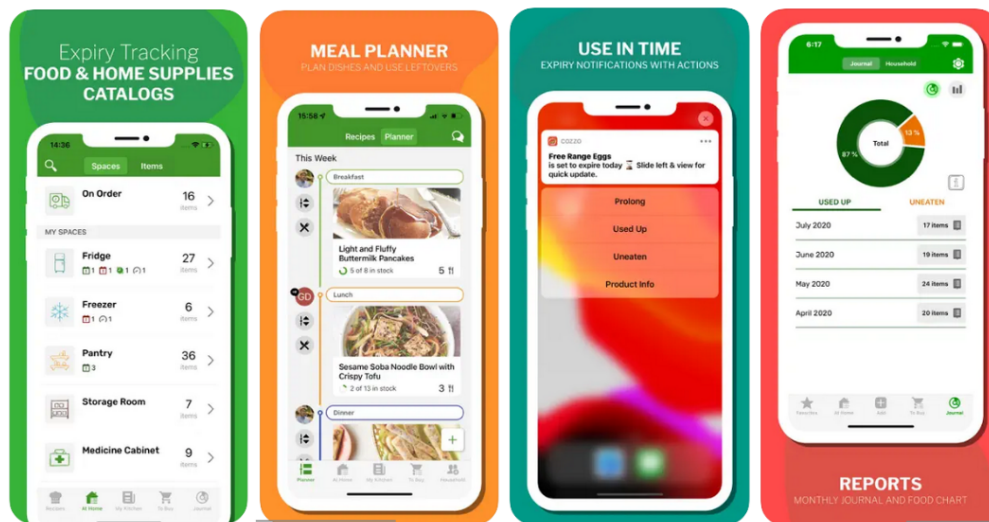


Figure 3.1: CozZo interface

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## App Use and Focus Groups

For this second stage, it was decided to do focus groups due to their ability to provide in-depth insights and capture diverse perspectives. By bringing participants together in a group setting, focus groups allow for interactive discussions where participants can share their experiences and perceptions regarding food waste reduction and the use of the selected app. This approach enables probing deeper into participant responses, uncovering social dynamics and norms and generating new insights and ideas.

It was necessary to get participants from the initial participants involved in the questionnaire to know what their initial behaviour was before going through this second stage. The respondents agreeing to engage in said second stage were sent a second consent form by email, where this second stage was explained in detail. In this email

<sup>1</sup>CozZo (2023)

participants were also provided with a link to CozZo so they could learn more about the apps they were to use during a week, as well as the features that it presents, before agreeing to participate, they were also given the green light to download CozZo once they did. Participants were given one week to answer by email where they stated that they agreed to the terms and conditions exposed in the email sent by the researcher.

Right after sending the email it was pointed out by a few participants that the app CozZo was not available in some app stores, therefore a second email was sent to all the participants offering them to download KitchenPal, a very similar app to CozZo, with the same basic features, similar interface, similar nudges, except for the widget which is not available on KitchenPal, but the barcode scanner is free to use contrary to CozZo. CozZo was still kept as an option in order not to create confusion and also since some participants had already downloaded it.

After four days, not many participants from the ones initially agreeing to participate in this further stage had replied to the email, therefore a second email was sent to the ones that had not responded reminding them to respond to the email if they wished to participate in the experiment.

Following this, the participants that had agreed to further participate during this week were contacted by email in the middle of the week for them to give their availability for the week after to participate in the focus groups, they were also encouraged to make full use of the apps' features and to explore different ways in which they can reduce food waste via an additional message in the same email. The participants were also asked whether they preferred to have an online or in-person focus group. They were additionally reminded that the platform to be used for online sessions was Microsoft Teams, as mentioned in the first email they were sent, and hence asked to create a Teams account if they chose this method and did not already have one. Participants were also given three languages to choose from to perform these focus groups, English, Spanish, and French, having the possibility to choose several, for an easier organisation of the sessions.

Based on the choices of the participants, the focus groups were organised in such a way that every participant gets a session within their available times and language(s) of choice. At the end of the week, participants were contacted to inform them of the date, time, and language if necessary, their focus group session would happen. Participants were randomly grouped together for both online and in-person environments, depending on their preference, in groups of 3-4. If some participants did not have availabilities that matched the others', doing an interview was considered. There were 6 focus group sessions throughout the week, all of them online. One of them was in French while the rest was in English.

The focus groups were conducted in a structured format, with a facilitator guiding the discussion using a pre-defined set of questions, as well as extra questions that might be useful in the discussion context. The facilitator encouraged all participants to share their experiences, and ensured that the discussion stays on track. The focus groups was recorded with the participants' consent.

The focus groups included open-ended questions. These questions asked participants to rate the effectiveness of the apps in reducing food waste, and to provide

specific feedback on the different features of the apps, as well as encourage participants to share their personal experiences, and to provide suggestions for improving the apps.

Following a two-week interval since the focus group sessions, participants were contacted to determine whether they still retained the app and, if so, whether they used it. This inquiry aimed to discern whether participants' engagement with the app was exclusively limited to the duration of the research or extended beyond the experimental period.

The chosen research methodology aimed to provide a comprehensive understanding of the multifaceted aspects of food waste and individuals' engagement with apps designed to mitigate this issue. By employing this methodology, this research aimed to gain a comprehensive understanding of the underlying factors that influence food waste, explore the users' interaction with these apps, and uncover how these subtle environmental cues and reminders influence users' behaviours and decision-making processes regarding food waste.

### **3.2.2 Participants**

Participants were recruited from various sources, such as social media platforms, and university and personal networks. In order to be eligible for the study, participants must be between 18 and 30 years of age. Recruitment was conducted using a snowball sampling approach, whereby participants were asked to refer others who may be interested in the study.

To ensure a diverse sample, efforts were made to recruit participants from different socio-economic backgrounds, ethnicity, and gender. The aim was to have a sample size of at least 100 participants for the first stage and at least 20 for the second stage, which is deemed sufficient for a qualitative study. Participation in the study was voluntary, anonymous, and all participants were provided with a consent form outlining the aims of the study, their rights as participants, and the use of their data, at every stage of the experiment.

The recruitment happened between May 8th and May 15th, 2023. In the following week the recruitment for the second stage was further developed sending emails to the consenting participants during the first stage.

### **3.2.3 Data Collection**

The data collected from the participants through surveys and focus groups include age, gender, country of residence, economic situation, diets, and habits regarding food waste. During the second stage of the experiment, participants were also asked to give data regarding their habits regarding food waste.

Data from the survey were documented in an Excel sheet, and data from the focus groups were audio recorded as well as written down in a Word document for further analysis.

### 3.2.4 Data Analysis

Once the data were collected, they were analysed to gain insights and draw conclusions related to the research questions. The data analysis process involved examining both quantitative and qualitative data.

The data from the survey were analysed using statistical techniques. This includes descriptive analysis, where key variables such as participants' demographic characteristics and app usage data are summarised and described. For example, calculating averages, frequencies, and percentages to understand participants' characteristics and how they feel about food waste.

In addition, inferential statistics were used to test hypotheses and explore relationships between variables. Chi-square tests were performed, which helped determine if there are significant differences or associations among variables of interest.

Qualitative data, on the other hand, were analysed using qualitative analysis techniques. This involved carefully reading and interpreting focus group transcripts to identify common themes, patterns, and categories related to participants' experiences and attitudes towards food waste reduction and experience with the selected app. The qualitative data from the survey was also carefully analysed, looking for common themes and categories, and compared where useful to the qualitative data obtained through the focus groups. This qualitative analysis provided valuable insights into participants' perspectives and helped to understand the subjective aspects of their engagement with the selected app.

To ensure a comprehensive understanding of the research questions, both qualitative and quantitative findings were integrated. By comparing and combining the qualitative and quantitative results, we can identify areas of agreement or divergence, allowing for a more holistic interpretation of the data. This integration strengthened the validity of the findings and provide a richer understanding of participants' engagement with the apps and their impact on reducing food waste.

Finally, the results of the data analysis were interpreted and discussed in relation to the research questions and objectives. The implications of the findings were explored, considering their alignment or divergence with existing literature. Any limitations or biases in the data collection and analysis were acknowledged. Based on the analysed data, conclusions were drawn, and recommendations for future research or practical applications are provided.

By employing rigorous data analysis techniques and considering both quantitative and qualitative perspectives, it was possible to derive meaningful insights from the data collected and contribute to the understanding of factors influencing individuals' engagement with food waste reduction apps.

### 3.2.5 Ethical Considerations

In the scope of this research, the following ethical considerations were taken into account:

First and foremost, informed consent was obtained from all participants. They

were fully informed about the purpose of the research, the procedures involved, and how their data were to be handled. It was emphasised that participation is entirely voluntary, and participants have the right to withdraw from the study at any time without facing any negative consequences.

Confidentiality and anonymity were strictly maintained to protect the privacy of participants. All personal information was kept confidential and participants' identities were anonymised during data analysis and reporting. The only time when this is not to be ensured is during the focus groups, where only other participants and the researcher were aware of the participants' identity, with their previous consent.

Participants' well-being and safety were given utmost importance. Potential risks to participants, such as psychological discomfort, were assessed, and steps were taken to minimise these risks. Care was taken to ensure that participants were not coerced or unduly influenced to participate in the research. Respect for participants was maintained throughout the whole research process. Their autonomy, dignity, and rights were upheld, and they were treated with fairness and respect.

Transparent reporting was emphasised, ensuring that the research findings are presented accurately and honestly. Any limitations or potential biases of the study were acknowledged, and the data were interpreted and reported in a responsible manner.

Dissemination of the research findings will be done responsibly, with consideration for the potential impact on individuals, communities, or organisations involved in food waste reduction efforts. The results will be shared in a manner that respects the privacy and confidentiality of the participants.

Finally, the UU Ethics Quick Scan was filled out by the researcher and approved by the due authorities.

By adhering to these ethical considerations, the research aims to uphold the rights and well-being of the participants, ensure integrity in data collection and reporting, and contribute to the advancement of knowledge in the field of sustainable environmental behaviour.



**Part II**  
**Research**

## 4. Results

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This section describes the results of the performed experiment previously exposed. It will be divided in two parts, with first the results of the reflective study, followed by the results of the follow-up focus groups. The numbers on the graphs shown in this section represent the number of respondents/participants.

### 4.1. Reflective Study

#### 4.1.1 Participants & Demographics

The questionnaire was accessed by 346 respondents in total. From those 346 responses only 223 (64%) were deemed usable after removing responses from people not in the required age group and incomplete responses. From these 223 respondents, 48 (21%) were between the ages of 18 and 21, 119 (53%) between the ages of 22 and 25, and 56 (25%) between the ages of 26 and 30. 148 (66%) identified themselves as pertaining to the female gender, 73 (32%) to the male gender, one declared to be non binary/third gender and one preferred not to say. 135 (60%) respondents declared to be students while 88 (39%) declared not to be.

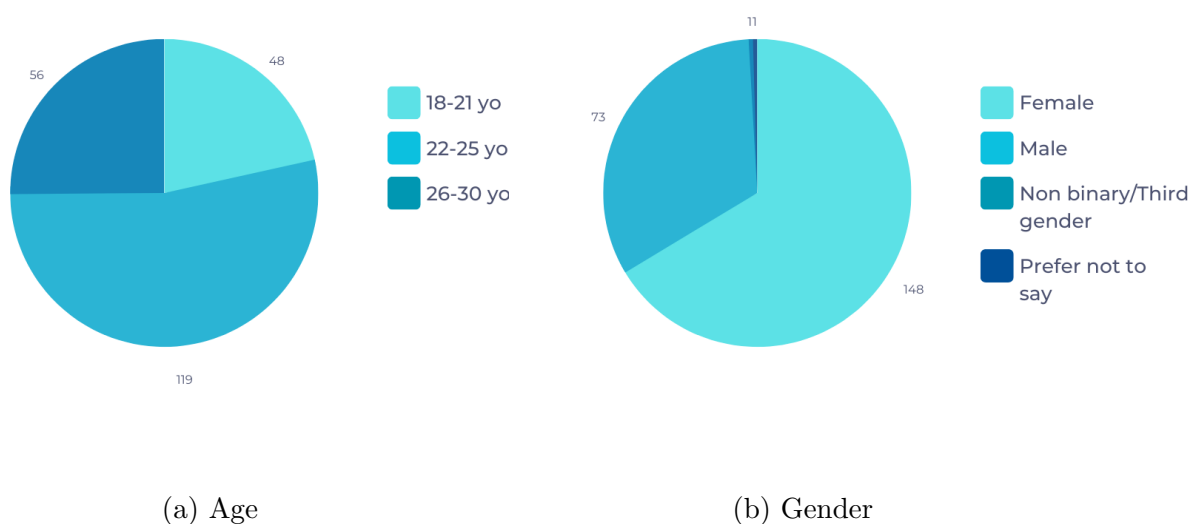


Figure 4.1: Demographics

There were 19 declared countries of residence among the 223 respondents, shown in the table below, the major ones being, in order, France (28%), the Netherlands (23%), and Mexico (18%).

Argentina	8	Germany	6	Slovenia	1
Austria	2	Italy	4	Spain	19
Belgium	4	Kenya	1	Sweden	1
Canada	3	Mexico	42	Switzerland	4
Ecuador	1	Netherlands	52	United Kingdom	2
Finland	1	Paraguay	2	United States of America	3
France	64				

Figure 4.2: Country of residence

### 4.1.2 Cooking habits

Regarding the number of people they live with, 53 respondents (23%) reported living alone. Among the respondents, 49 (21%) indicated living with one other person, while 44 (19%) stated they reside with two other people. Additionally, 43 (19%) respondents reported living with three other people, and 32 (14%) mentioned living with four or more other people. These findings highlight the diverse range of living arrangements represented among the respondents, showcasing a mix of households of varying sizes. More specifically, the analysis revealed a positive association between respondents' age categories and the size of their households, indicating that younger individuals tended to have a greater number of people residing in their homes. ( $X^2(8, N = 221) = 28.70, p = .0003$ ).

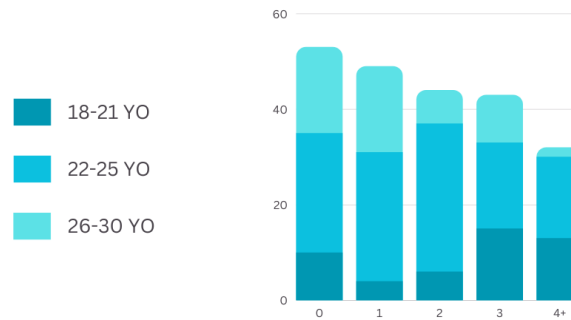


Figure 4.3: Number of people in respondents' households, by age.

The respondents were then asked about their cooking habits and the frequency with which they prepare meals. The responses varied across the respondents. 42 respondents (18%) reported cooking every meal they have, while 73 (32%) of them cooked almost every time. There were also 48 respondents (21%) who cooked about half the time and 53 (23%) that only cooked some of their meals. A small number of respondents (4, 1%) stated that they never cooked a meal for themselves.

A further question inquired the respondents about the frequency with which

they cooked for other people than themselves. The majority of the respondents (136, 60,98%) declared that they did only on a few occasions, while 34 (15%) never did. In contrast, only 3 respondents (1%) always cooked for others, 13 (5%) did for almost every meal, and a further 35 (15,69%) did about half the time. In terms of the people for whom respondents cooked, the data shows that 120 respondents (53%) cooked for their family, while an equal number of respondents (120, 53%) cooked for their friends. Furthermore, 84 respondents (37%) cooked for their partners, and 51 (22%) cooked for their housemates. It is worth noting that 114 respondents (51%) selected more than one choice, indicating that they cooked for multiple groups of people.

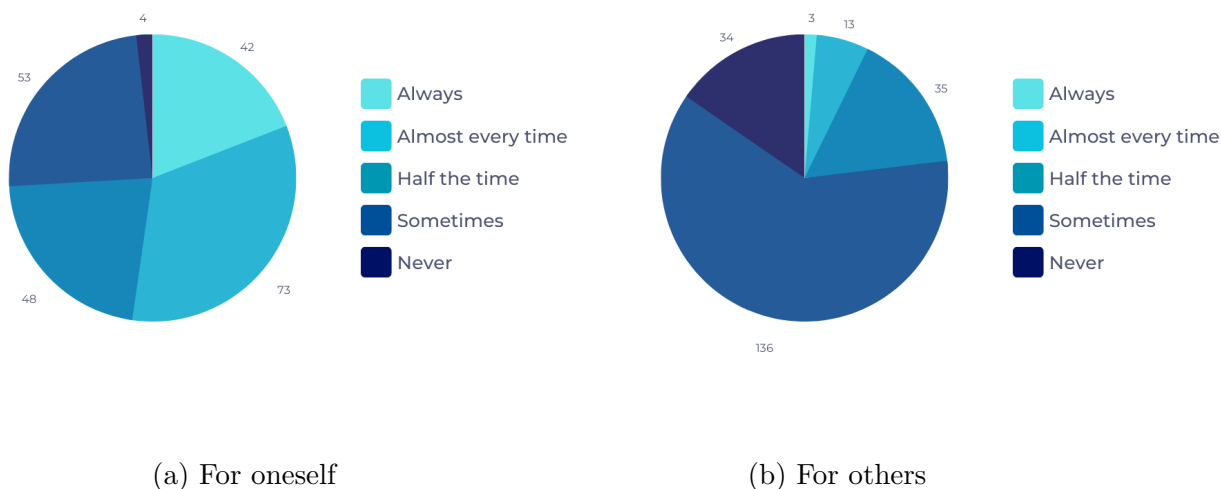


Figure 4.4: Cooking frequency

The next question regarded the frequency with which the respondents went grocery shopping. The most recurring response was once a week, chosen by 118 respondents (52%). 51 respondents (22%) mentioned going grocery shopping twice or more per week, while a small percentage of 4 respondents (1%) reported shopping for groceries every day. On the other hand, 45 respondents (20%) stated that they went grocery shopping twice a month or less, and 3 respondents (1%) mentioned never going grocery shopping.

Upon closer examination of the data, several noteworthy observations can be made. Firstly, a moderate correlation was observed between the frequency of cooking for others and the frequency of grocery shopping ( $X^2(6, N = 211) = 14.55, p = .0240$ ), when looking at the relevant rows and columns (more than 5 instances). Specifically, individuals who reported cooking for others more frequently tended to engage in more frequent grocery shopping. This finding may suggest that these respondents may not have adequately accounted for the additional guests when initially planning their grocery shopping trips, necessitating subsequent visits to replenish their supplies.

There is, naturally, a stronger correlation between the frequency with which respondents cook for themselves and the frequency with which they go grocery shopping ( $X^2(6, N = 211) = 22.29, p = .0010$ ), again, when looking at the relevant rows and columns (more than 5 instances). This finding aligns with the intuitive notion that

individuals who cook for themselves are likely to have a higher level of involvement in meal planning and preparation, which in turn necessitates more frequent trips to the grocery store.

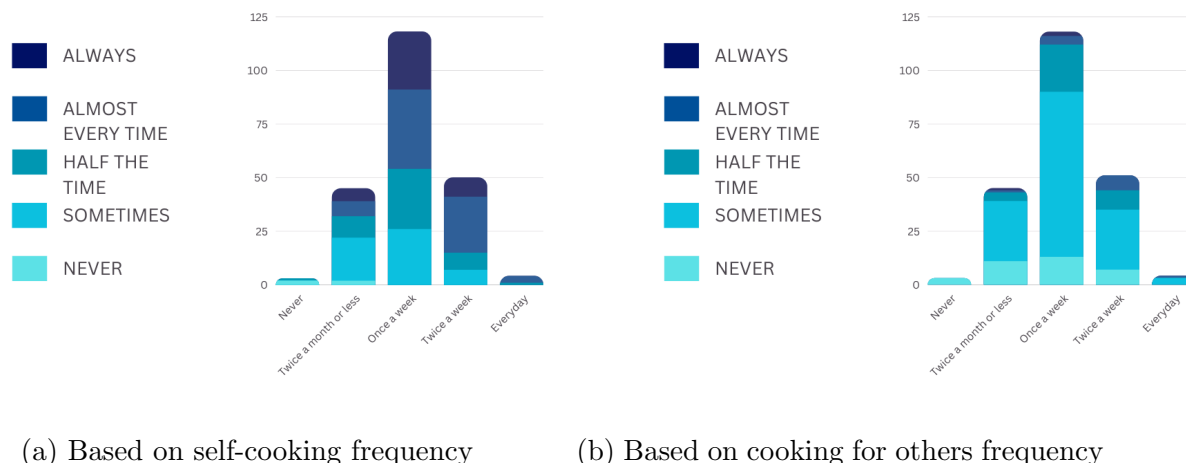


Figure 4.5: Grocery shopping frequency

In terms of monthly grocery expenses, 59 respondents (26%) stated they spent less than the equivalent of 100€/US\$110. A big portion of them (105, 47%) declared they spent between 100 and 200€ (US\$110-220), while 45 (20%) were in a 200-300€ (US\$220-330) span. Only 7 (3%) stated that they spent more than the equivalent of 300€/US\$330.

Respondents were also asked about their monthly income, including parental, governmental, or any financial assistance they received. 93 (41%) of them declared earning less than the equivalent of 1000€ or US\$1100. Among the respondents, 41 (18%) had a monthly income ranging between 1000€/US\$1100 and 1500€/US\$1650, 39 (17%) had a monthly income between 1500€/US\$1650 and 2000€/US\$2200, 19 (8%) fell within the 2000€/US\$2200 and 3000€/US\$3300 income bracket, and only 12 (5%) respondents declared having a monthly income exceeding 3000€ or US\$3300.

Furthermore, while the proportion of people spending between 100€ and 200€ does not vary much in relation to the respondents' income, the proportion of people spending less than 100€ shows an important decline from people earning less than 1000€ monthly (40%) to people earning more than 3000€ monthly (8%). Inversely, the proportion of people spending more than 200€ shows a substantial increase from people earning less than 1000€ monthly (18%) to people earning more than 3000€ monthly (41%). However, after chi-square tests were performed, it was found that this correlation is only significant at  $p < .1$  ( $X^2(12, N = 203) = 20.53, p = .0576$ ).

Finally, the analysis of the data using chi-square tests revealed a significant correlation between respondents' grocery shopping frequency and their weekly expenses ( $X^2(12, N = 219) = 65.47, p < .0001$ ). This finding indicates a strong relationship between these two variables, suggesting that individuals who engage in more frequent grocery shopping also tend to incur higher expenses on their groceries.

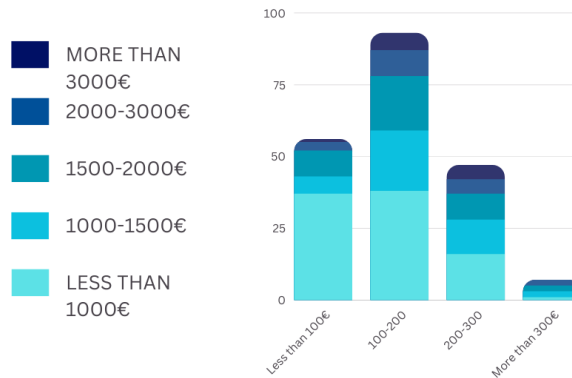
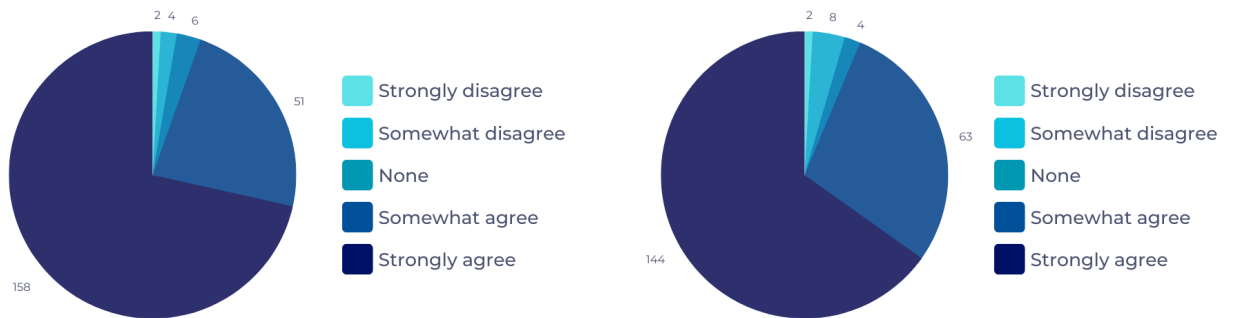


Figure 4.6: Respondents' grocery expenses by respondents' income.

### 4.1.3 Food Waste Behaviour

This survey, as stated in the methodology, sought to gain insights on the respondents' behaviour regarding food waste.

As expected, most of the respondents were deeply invested in the cause as seen in the answers to the statement saying *"I feel bad when I throw food away"*, where 158 (70%) respondents strongly agreed, while 51 (22%) declared they somewhat agreed. Both answers amounting to 93% of the total number of respondents. This was also



(a) "I feel bad when I throw food away"

(b) "I try not to waste food at all"

Figure 4.7: Respondents' implication in food waste reduction.

seen in the answers to the statement regarding their implication in trying not to waste food. 144 respondents (64%) declared that they strongly agree that they try not to waste food, and 63 (28%) declared to somewhat agree. Both answers to this latter

statement amount to 92% of all the respondents, confirming the first part of H1.

While it is not surprising to find a significant number of respondents expressing a commitment to reducing food waste, it is worth noting that the survey did not exclusively target individuals with prior awareness or involvement in this issue.

Looking deeper into this, the reason behind the respondents not wasting food varies a lot. 67 respondents (30%) declared that they did not or tried not to waste food due to the education they received, some of them based their reasons on culture, like shown in this respondent's answer: *"I grew up in a culture with collective trauma from war and hunger. Food wasting was not an option and I picked it from my mom and grandma"*, and others on the view of people who do not have access to food.

The same amount of respondents (67) declared that they did not endorse food waste since it represented a waste of money they had spent. And 47 (21%) declared that it was for environmental reasons, as they were aware of *"the ecological cost of production and transportation of that food"* and that *"overconsumption is bad"*.

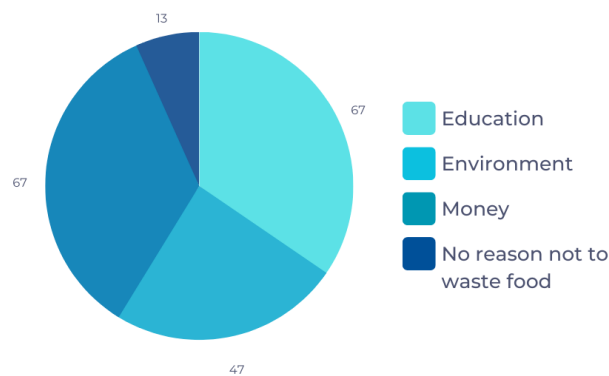


Figure 4.8: Reasons for respondents not to waste food.

In response to the specific question regarding financial considerations, 110 respondents (49%) agreed that money was a major factor influencing their decision not to waste food. Additionally, 57 respondents (25%) acknowledged that money played a role, but it was not a major determining factor. Only 20 respondents (8%) indicated that money was not a reason for them to avoid wasting food.

Interestingly, no significant correlation was observed between the former and the respondents' income or weekly grocery expenses. Despite initial expectations, the data did not reveal any meaningful relationship between these variables.

Regarding potential health issues associated with consuming leftovers that have been left for too long, the responses varied. Out of the respondents, 38 individuals (17%) agreed that health concerns were a factor, stating for example that *"[they] throw away food after the expiration date"*, while an additional 33 (14%) mildly agreed. On the other hand, a majority of 106 respondents (47%) declared that health concerns were

not a reason at all, stating for example that "[their] rule is that if the taste is weird it has to be thrown away, otherwise [they] try and eat the food item even if expired", and a further 16 respondents (7%) specified that health concerns were not a factor unless the food showed clear signs of spoilage, such as mold, bad taste, or smell.

#### 4.1.4 Actions

Respondents were asked about their actions and approaches to reduce food waste, and their responses demonstrated a range of strategies. Some individuals also mentioned adopting multiple solutions. A significant number of respondents (75, 33%) focused on consuming and finishing the food they already had in their fridge or pantry. They emphasised the importance of buying food in smaller quantities or reducing overall purchases to avoid excess waste, like this respondent: "I shop more frequently, and am careful with the quantities, even if it means paying a little more".

Another group of respondents (43, 19%) identified meal planning as their primary approach. By carefully planning their meals in advance, they could purchase only the necessary ingredients, thereby minimising food waste, like this respondent said: "I know my dietary needs, so I buy exactly what I need. My weekly menus are planned, so I never have too much or too little food".

Another notable portion of respondents (45, 20%) emphasised the importance of finishing leftovers. Some even mentioned consuming leftovers from their family or friends. Additionally, a few respondents discussed the practice of requesting doggy bags when dining out or composting their leftovers. 25 (11%) of the respondents also highlighted the significance of proper food preservation. They mentioned using techniques such as freezing leftovers or utilising airtight containers to store food for future consumption.

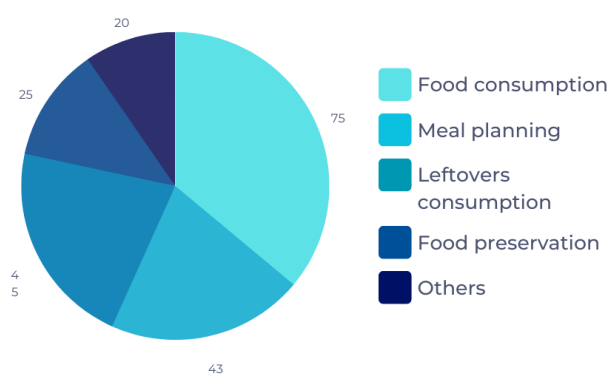


Figure 4.9: Respondents' approaches to reduce food waste.

Finally, a portion of respondents expressed concerns about the persistence of food waste despite the awareness of its societal, ecological, and financial implications.



Although they did not provide specific solutions, they shared their dissatisfaction with the continued occurrence of food waste, like this respondent who said *"I can't take it anymore, it depresses me too much, and it enrages me, even more when it comes from animals"*.

Considering the previous question, it can be inferred that a substantial number of respondents (138, 61%) who mentioned buying or cooking only what they eat, consuming everything they had, or finishing their leftovers would likely agree with the statement: *"I try to always eat everything I purchased"*. Among this group, 108 respondents strongly agreed with the statement, while 26 respondents somewhat agreed. Additionally, 31 more respondents strongly agreed, and 13 respondents somewhat agreed with the statement. In total, this results in a significant majority (79%) of respondents declaring their efforts to finish consuming their food.

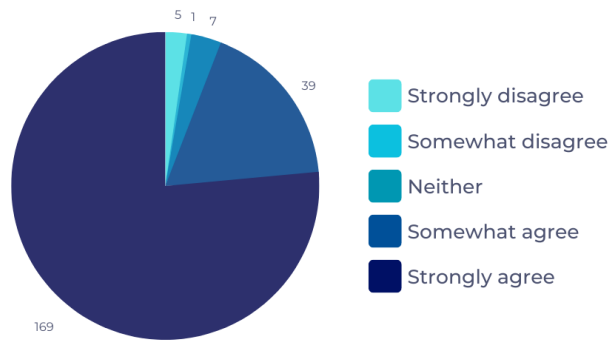


Figure 4.10: "I try to always eat everything I purchased."

### Specific Actions

Going deeper into the respondents' solutions to reduce their food waste, the questionnaire then asked them if they rather planned their meals before going shopping or cooked their meals based on what they had bought. A significant portion (90, 40%) reported planning their meals before going shopping, while 25 individuals (11%) engaged in meal planning but also allowed room for improvisation to use potential leftovers. Others (32, 14%) declared to cook all their meals based on what they had purchased. A smaller percentage (8, 3%) followed this approach for most meals. Additionally, 44 respondents (19%) combined both meal planning and cooking based on purchased ingredients in equal measures.

Regarding the shopping stage, respondents exhibited various approaches to adhering to their shopping lists. 40 (17%) individuals declared that they strictly followed their shopping lists without any deviations. A majority of 116 individuals (52%) adopted a more measured approach, allowing for last-minute additions to their shopping lists. A small number of respondents (5, 2%), strongly disagreed with the state-

ment of strictly adhering to their shopping lists, while 34 respondents (15%) somewhat disagreed. Meanwhile, 26 individuals (11%) indicated that their behaviour fell between following the list and deviating from it.

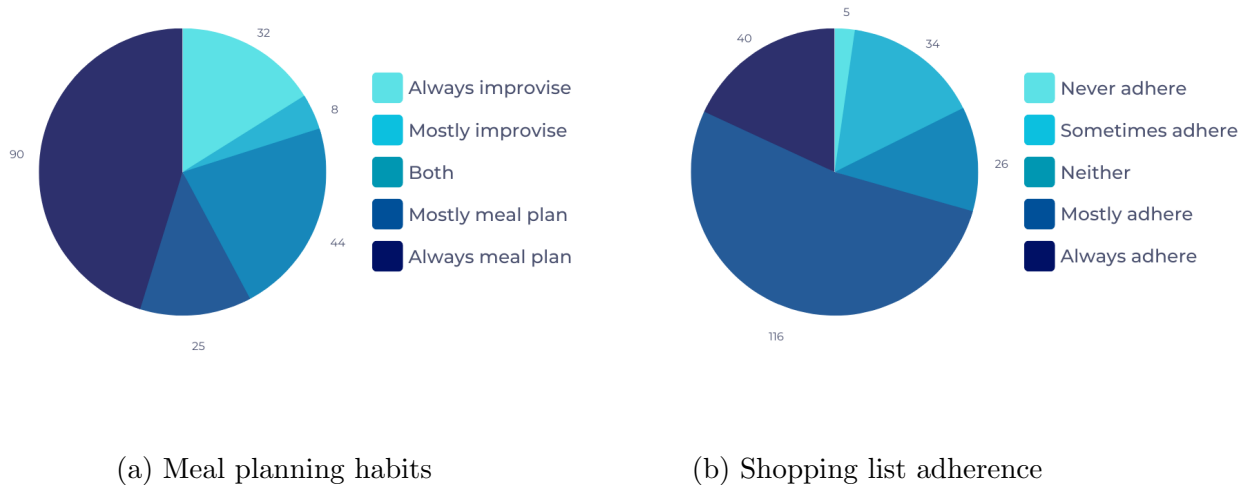


Figure 4.11: Grocery shopping habits.

A notable finding emerged when examining the relationship between the two aforementioned practices. A strong correlation ( $X^2(16, N = 204) = 56.04, p < 0.0001$ ) was observed, indicating that individuals who engage in meal planning are naturally more likely to adhere to their shopping lists.

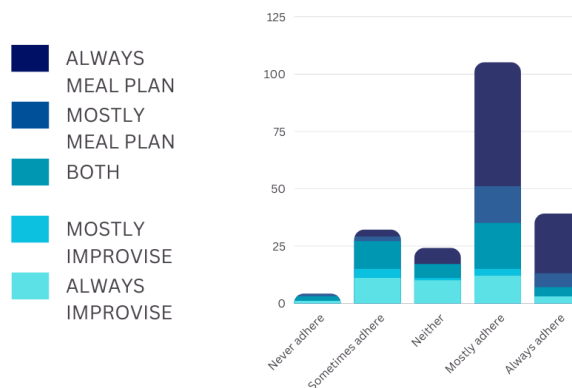


Figure 4.12: Relation between meal planning habits and shopping list adherence.

Concerning the purchase of fresh products, respondents had varying perspectives. Only 4 individuals (1%) admitted to buying more fresh products than they anticipated consuming, knowing that not all of them would be eaten. An additional 25 respondents (11%) acknowledged occasionally engaging in this practice. In contrast, a significant

portion of respondents, (83, 37%), strongly disagreed with this approach. Furthermore, 89 respondents (39%) expressed a moderate disagreement with buying more fresh products than necessary.

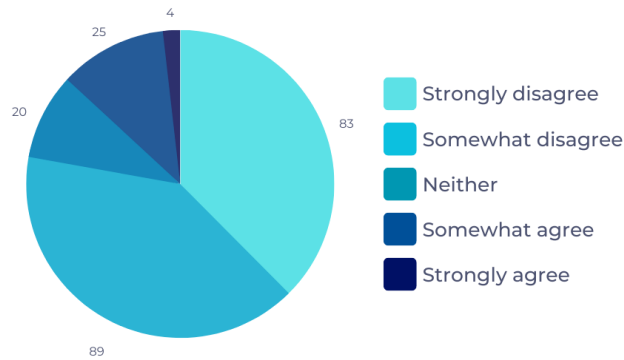


Figure 4.13: "I regularly buy many fresh products although I know that not all of them will be eaten."

A further analysis revealed no significant correlation between the regular purchase of fresh products and the frequency of grocery shopping among the respondents. This finding suggests that individuals who express a preference for buying fresh products do not necessarily engage in more frequent grocery shopping. It is worth noting that this lack of correlation raises the possibility that the purchase of fresh products may contribute to a higher likelihood of food waste, as these items may spoil before being fully used.

Furthermore, when hosting a meal, 44 (19%) respondents declared to like buying more food than necessary out of generosity, with an additional 94 (42%) somewhat agreeing to this proceeding. Conversely, 14 respondents (6%) completely disagreed with buying excess food for the sake of generosity, while 34 of them (15%) held a more moderate disagreement. Furthermore, 35 individuals (15%) neither agreed nor disagreed with this practice.

It is worth noting that no correlation was found between the former practice and the respondents' frequency of preparing meals for others. This suggests that the more people engage in meal preparation for others do not necessarily buy more food nor are they more careful about buying precisely the amount needed.

Regarding the ease of using leftovers, respondents' opinions can be summarised as follows. A majority of 187 individuals (83%) agreed that they find it easy to use leftovers. They acknowledged the convenience and practicality of repurposing leftover food. In contrast, a smaller group of 33 individuals (14%) expressed difficulty in using leftovers effectively.

On how they use their leftovers, respondents also came with various methods.

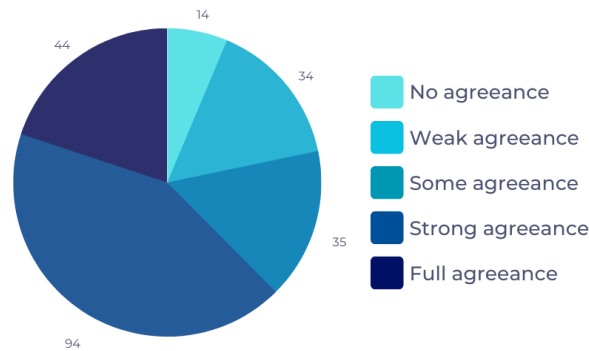


Figure 4.14: Excessive food purchases due to generous hosting.

The vast majority (137, 61%) simply reheat the leftovers or mix them with other food to make a complete meal. 22 (9%) of them declared to compost their leftovers, and a further 20 (8%) declared to practice both methods. Contrarily, 9 (4%) respondents declared not to use their leftovers at all, with 6 (2%) of them using them only in some occasions.

#### 4.1.5 Feeling of Capability

Taking all this into account, the respondents were presented with another statement regarding their feeling of capability to do something about their food waste. Only 4 (1%) respondents deemed they could not do anything about it, whilst 16 (7%) stated they could do only little about it. Meanwhile, 99 (44%) respondents declared that they strongly disagreed to not feeling capable of doing something about their food waste, with a further 76 (34%) somewhat disagreeing to the statement.

This does not show a profound change with the first results where it was seen that above 90% of the respondents were highly aware of the issue and deeply concerned about it. Here, the percentage of people feeling capable to stand up to the issue goes down only to 78%, and a further analysis shows a strong correlation between both ( $X^2(16, N = 221) = 46.89, p < 0.0001$ ). The difference is seen with how strongly the respondents felt about it. From 70% and 64% respectively for the statements presented at the beginning, less than half the respondents assured that they had the ability to work on their actions. A difference of around 50 people ( 22%).

#### 4.1.6 Previous Experience with Apps

Subsequently, respondents were asked about their previous experiences with apps designed to address food waste. Unsurprisingly, only 28 respondents (12%) indicated having used such apps in the past. Among them, 19 respondents (67%) specifically mentioned the app "Too Good to Go," which comes as no surprise given its widespread

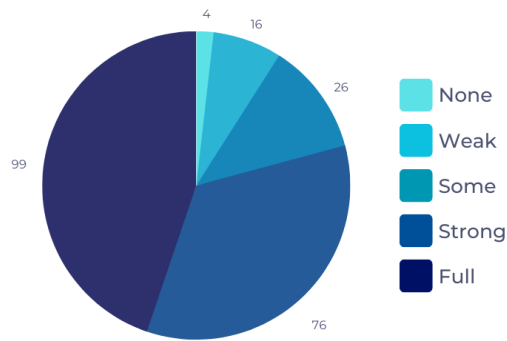
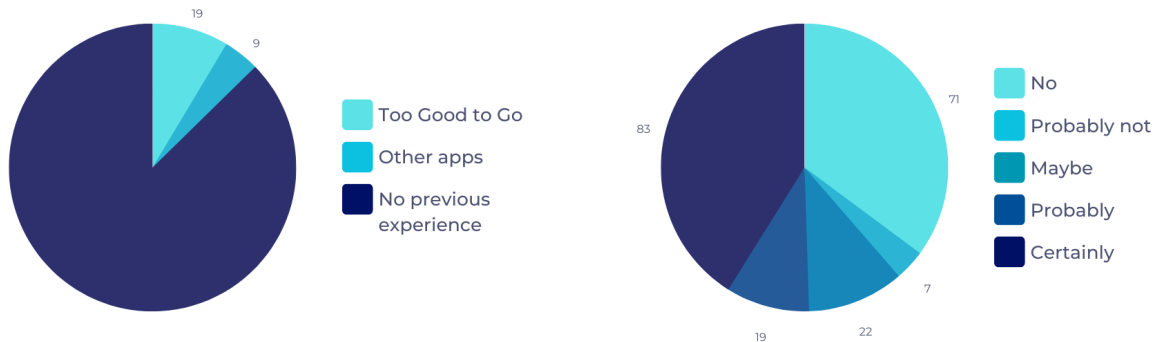


Figure 4.15: Feeling of capability to reduce their food waste.

popularity.

Furthermore, respondents were queried about their willingness to use an app to assist them in reducing food waste. Out of the respondents, 83 individuals (37%) expressed their readiness to use such an app. Additionally, 19 respondents (8%) stated that they might consider using an app if it proved helpful, while 22 (9%) remained uncertain. On the other hand, 7 respondents (3%) stated that they probably would not use such an app, and 71 (31%) outright declared their disinterest.



(a) Previous experience with food waste reduction apps (b) Potential use of food waste reduction apps

Figure 4.16: Previous and potential food waste reduction app use.

Interestingly, no significant correlation was observed between these findings and the respondents' willingness to minimise food waste or their belief in their ability to take action against it. These results suggest that respondents' attitudes towards food

waste and their perceived efficacy in addressing the issue are not directly associated with their inclination to use an app for food waste reduction purposes.

When asked about the reasons for their reluctance to use food waste reduction apps, respondents cited a variety of factors. These included constraints such as lack of time or motivation, limited knowledge of available apps, uncertainty regarding the app's potential benefits, concerns about app overload or excessive screen time, and some respondents even mentioned feeling adequately mindful of their food waste, believing that an app was unnecessary in their case.

#### **4.1.7 Summary**

The previously shown findings shed light on several key aspects that contribute to the understanding of individuals' perspectives and engagement with food waste and with apps designed to address its reduction.

Firstly, the majority of respondents expressed concern about food waste, indicating a widespread recognition of the issue's significance. A substantial proportion of respondents also reported feeling upset when food was discarded, demonstrating a personal emotional connection to the problem. Moreover, a significant number of respondents expressed their active efforts to minimise food waste in their daily lives, whether it was careful planning, proper leftover use, or appropriate conservation.

In the analysis of the questionnaire data, no statistically significant correlations were observed between respondents' age, gender, or country of residence. However, the quantitative analysis revealed interesting findings that merit attention. For instance, a strong correlation was observed between meal planning and adherence to shopping lists, suggesting that individuals who plan their meals are more likely to follow a structured shopping approach. On the other hand, no significant correlation was found between regularly purchasing fresh products and the frequency of grocery shopping, indicating that individuals who prioritise fresh items may not necessarily shop more frequently.

Furthermore, the absence of correlations between certain practices, such as buying excess food when hosting guests, and participants' attitudes towards food waste and their perceived efficacy in addressing it, suggests that these behaviours are driven by factors beyond individuals' beliefs and intentions related to waste reduction.

Regarding the usage of apps aimed at mitigating food waste, the results revealed mixed patterns. A considerable percentage of respondents had not previously used such apps, highlighting a potential lack of familiarity or motivation to engage with this specific technology. However, a notable portion of participants expressed willingness to use an app for food waste reduction purposes, indicating the potential for behavioural change through digital interventions.

It remains to be investigated whether the use of the app leads users to experience a change in their approach to food waste, how they perceive the effectiveness of the nudges embedded in the app, whether they have any discernible impact, and what modifications they would propose for the app to enhance its efficacy in their daily lives and facilitate a reduction in food waste.

## 4.2. App Use and Focus Groups

From the initial 121 respondents who had agreed to further participate to the second phase of the experiment and use an app for a week, only 25 actually responded to the further email sent to them to use either CozZo or KitchenPal, and only 20 ended up participating in the focus groups, which was still within the initial prospects. This amounts to 8,96% of the survey respondents. From these 20 participants, 1 (5%) was between the ages of 18 and 21, 11 (55%) between the ages of 22 and 25, and 8 (40%) between the ages of 26 and 30. 11 (55%) identified themselves as pertaining to the female gender, and 9 (45%) to the male gender. 14 (70%) participants declared to be students while 6 (30%) declared not to be. There were 10 declared countries of residence, in order of relevance (number of participants if more than one): The Netherlands (10), France (3), Belgium (2), Canada, Mexico, Slovenia, Spain, UK. None of the participants had previous experience with either CozZo or KitchenPal.

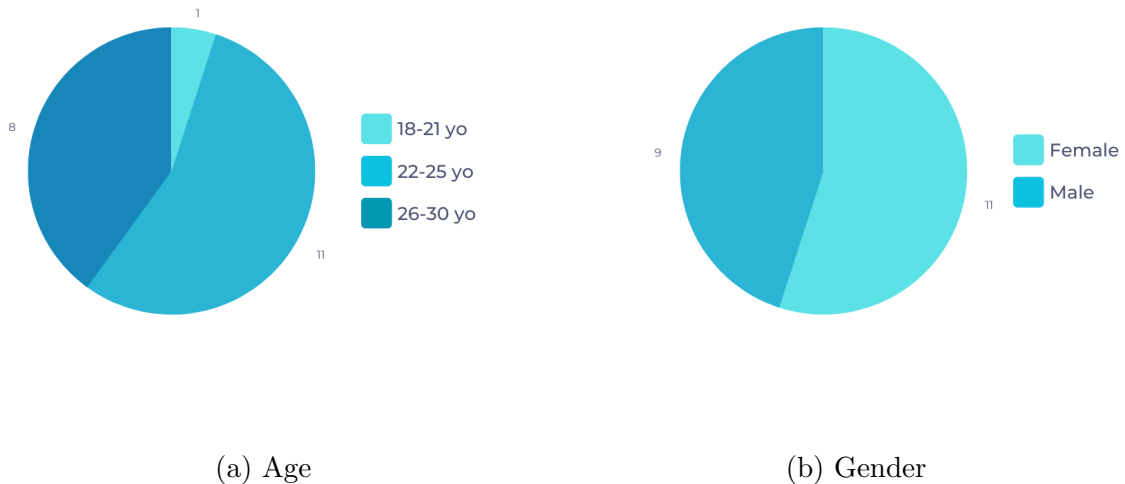


Figure 4.17: Demographics

The first question asked to the participants was whether they had made use of the app, to which 13 (65%) responded positively and 7 (35%) negatively. Nevertheless, the people having not used it all went through it or used for a few days. 3 of these latter participants' reason was because they were staying at their parents' and they did the groceries and/or the cooking, while 3 other participants' reason was that just that week they moved around a lot, and therefore were not home often or at all. The last one had a very busy week at work and therefore did not have the time to use the app. Still, these 7 participants had valuable insights for the study which will be included in the next paragraphs along with the other participants' comments.

The first topic discussed with the participants in the focus group was the app features, which ones they had used, were they useful, and was their use intuitive. Because not everyone used the app in the same way, nor the same features, the numbers vary for every topic discussed and do not necessarily amount either to 13 or 20.

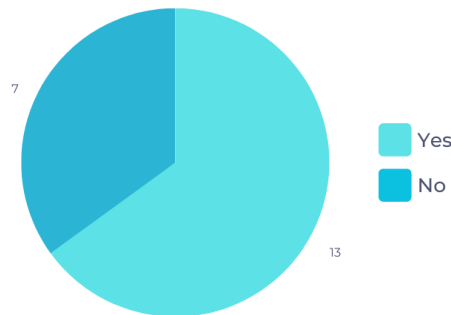


Figure 4.18: Participants' app use

### 4.2.1 Features

A notable portion of participants (5, 25%) expressed a strong preference for the convenience of accessing information about their available food items from anywhere, which facilitated meal planning and shopping list creation without the need to be in their kitchen. They appreciated the ability to avoid purchasing items they already had. Additionally, a smaller group (3, 15%) expressed a positive sentiment towards the app concept, not without suggesting that certain improvements or fixes were necessary.

First, many (10, 50%) considered that the design was not intuitive at all, some even struggling to find their way through straight away. Many participants (10, 50%) also felt that the need to enter every food item took too much time and/or effort, making not appealing to them to keep using the app. Interestingly enough, only 6 (30%) people tried the scanning feature, which was deemed faster and better by 5 (25%) of them. This was due to the fact that CozZo users did not have access to it unless they paid for a subscription. Moreover, when it came to take out food items from the app, a participant commented *"not feeling worse when telling the app whether the food item was consumed or thrown away"*.

### Notifications

The notifications were a big part of the app, since it was the easiest way for the user to learn about a food item potentially going bad and use it in their next meal before that happened, but only 7 participants (35%) declared having turned on their notifications. *"I do not have notifications on my phone in general, I do not see a reason why I should turn them on for this"* said one. Many participants stated that they did not like having too many notifications or not at all, while others would not turn on their notifications for this app since it was not a priority. Furthermore, 3 of these participants having turned on the notifications did not receive any, even though having had food items going bad.



Some participants (3, 15%) did have a significant experience with the app thanks to the notifications, as it let them know when a product was about to go bad. This led two of them to use the product before then, which according to them would not have happened if they did not become aware of their closing expiration date. One of these participants said that *"[they] did not use the app consistently, but [they were] surprised when seeing a notification saying [they] had a soon to be spoiled product, which made me decide to take action by preparing the chicken en question for [their] upcoming meal"*.

It is important to highlight that one participant, despite the app's intervention, chose not to use the perishable product. This decision was attributed to their extremely busy work schedule and very limited preparation of meals at home during the course of the experiment.

## Recipes

Another feature that received a mixed feedback was the recipes, 4 participants (20%) indicated having liked the recipes that were shown, for their variety, and also for the fact that it used the items that one had at home. But 7 (35%) of them did not like them, some stating they were too complex saying *"they need a lot of ingredients that [they] would only have back at [their] parents"*, and contrarily some found some recipes too basic, as *"[they] do not need a recipe to make scrambled eggs"*. Others stated they just did not look appetising or were not close to anything they would cook for themselves, one specifically pointing the vegetarian options out. One of the participants also mentioned that the recipes were all occidental-oriented, leaving no room for recipes from other parts of the world, which can limit the possibilities for users from the Global South.

Another aspect that was disliked was the fact that the recipes offered did not focus on ingredients that were close to going bad, one had to tell the app which ingredients to focus on to enable that. Things that, on the other hand, were appreciated from the recipes include that it was easy to see what ingredients were missing and therefore work with that information whether it was to skip those ingredients or to add them to the shopping list, that you can select specific diets like vegetarian or lactose intolerance, although a few users mentioned some options were lacking such as no sugar for chronic diseases, and finally the cost estimation and the nutritional values of a recipe.

## Additional Comments

A small number of participants (2, 10%) also expressed appreciation for the meal planner feature. The meal planner feature allowed them to plan their meals in advance, ensuring that they only purchased and prepared the necessary ingredients. By having a structured plan, participants felt it helped them make more conscious choices, avoid overbuying, and use their food items effectively.

The participants that used CozZo were asked if they knew about the widget that the app offered and if they had used it. All 9 of them responded that they were not aware of its existence, from whom 2 stated that if they had known, they would have used it, as it was easier to get the essential information directly rather than getting on

the app and look for it.

During the discussions, participants brought up two significant issues that were not adequately addressed by the apps. The first concern raised was related to unconsumed leftovers, which contribute to food waste. Participants noted that none of the recipes offered in the apps specifically addressed this issue. They felt that incorporating recipe suggestions that use leftover ingredients could be beneficial in reducing food waste and maximising resource use. Some participants also mentioned understanding that this may be hard as it could imply a risk in users consuming leftovers that are not edible anymore for health reasons.

The second issue highlighted by participants was the common scenario where not all of a purchased food item is consumed. They expressed a desire for the apps to provide guidance on how to use the remaining portions effectively, reducing the likelihood of food waste. Participants emphasised the importance of strategies and recipe suggestions that can provide alternative options for these food items' consumption.

### 4.2.2 Development

The participants were then asked if they had felt a change in their food waste behaviour, their meal plans, or their expenses during or since this experiment took place. Like suspected, the vast majority (13, 65%), stated they did not feel any change in neither of these categories. Two good examples are this participant who declared *"... not [thinking] that it could have any effect on the long term, especially because I am already very careful with the food I buy and consume"*, and this other who stated that *"[they] knew [they] had the app and it could help them avoid food waste, but it just took too much effort the way it is designed, and [they] let many vegetables go bad in the end"*, adding *[they] wish [they] could do something about it"*.

Nevertheless, 4 (20%) participants did observe a slight change in their behaviour, declaring that their awareness or guilt went up. These 4 participants, after further questioning said that this was due to the study rather than because of the app itself, but one of them mentioned that the app was a good reminder, it *"forced [one] to stay active"*. Another participant mentioned that the use of the app changes the relationship one has with eating. It takes more time and requires more consciousness.

In relation to the app features, participants were requested to provide their suggestions for changes or additions that would align with the objective of assisting users in reducing food waste. Several ideas were generated during the various focus group discussions, with the following five recurring suggestions receiving the highest frequency of mention or garnering positive consensus:

- The possibility to connect with other people in the household.
- More flexible expiration dates
- Meal filtering by difficulty and/or duration
- No paying subscriptions
- Overall a more intuitive design

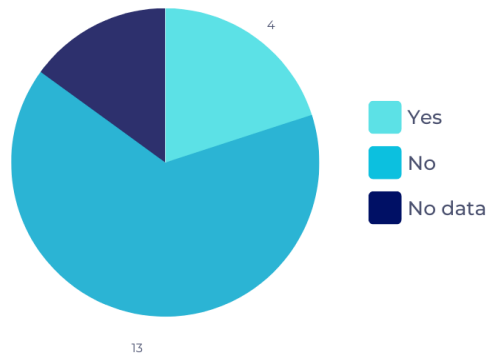


Figure 4.19: Change felt in participants' food waste behaviour.

The possibility of connecting with other household members in the app was devised to cater to households where food is shared among individuals. The rationale behind this feature was to ensure that if one person used a food item, others would be notified when accessing the app. This facilitated effective meal planning and shopping list management for all members of the household.

Some participants also mentioned that the expiration dates of the food items entered in the app were, for some, not available, and for some others, not accurate, meaning some food items had an earlier expiry date than the true expiration date. This was not welcomed by the participants as it left them with less time to consume their products, and this is in fact an issue as seen in the literature review and the questionnaire results, since it leads users to throw away food that can still be consumed. Some participants did specify that this might not be easy because of the risk and potential consequences of the app telling a user that a perished item is still consumable.

Another addition that was requested by the participants was the possibility to filter the meals offered in the recipe section. Some mentioned the need to filter the meals by difficulty, another by type (breakfast, dinner, dessert, etc.), and another by time needed to prepare said recipe.

As anticipated, a subset of participants (5, 25%) expressed annoyance and even frustration regarding certain features being accessible only through a paid subscription. Features such as scanning (CozZo) and full recipes (KitchenPal) were specifically mentioned as examples.

Lastly, the thing on which participants agreed the most is that both apps needed a more intuitive design. As mentioned earlier, many participants struggled to find their way through the app, which was obviously a barrier for participants to fully and consistently use the app throughout the experiment. One participant mentioned that a more colourful design would be welcome, but on the other hand one participant made the opposite comment. An additional suggestion put forth by participants was the

implementation of a feature that would allow users to customise the arrangement of their items within the app. Specifically, participants expressed the desire to have the ability to order their items according to their preference and to easily move food items from one location to another (e.g., from the fridge to the freezer).

### 4.2.3 Additional suggestions

Participants also expressed a few other noteworthy recommendations. A point of consensus among multiple participants was the expressed interest in having the ability to exclude specific ingredients from recipe suggestions. Several participants acknowledged the importance of accommodating individual preferences, and not necessarily only dietary restrictions, by allowing users to avoid certain ingredients they dislike or choose not to include in their meals. This feature would enable users to receive recipe ideas that align more closely with their culinary preferences and enhance their overall engagement with the app.

Another suggestion was the inclusion of information on proper food storage techniques. Participants highlighted the value of receiving guidance on how to store different types of food items to maximise their shelf life and reduce the likelihood of spoilage. This feature would empower users with knowledge and practical tips to ensure the longevity and quality of their food items, ultimately contributing to a reduction in food waste.

Furthermore, a participant proposed the enhancement of app notifications to provide more informative messages. Instead of generic alerts such as "Something is waiting for you on the app", the participant expressed a desire to receive notifications that deliver specific and relevant information. This could include reminders about impending food expiration dates, personalised tips on reducing waste based on users' behaviours, or suggestions for using specific ingredients before they spoil. By offering more targeted and informative notifications, the app can actively engage users, provide them with valuable insights, and encourage them to take proactive measures in managing their food inventory.

The last suggestion put forth by a participant was the potential inclusion of a reward system or gamification elements within the app. This suggestion aims to enhance motivation by introducing incentives and a sense of achievement. Implementing a reward system could encourage users to actively participate in reducing food waste by setting goals, tracking their progress, and receiving recognition for their efforts. This approach leverages the principles of gamification to tap into users' intrinsic motivation and foster a sense of accomplishment, ultimately fostering long-term engagement and behaviour change.

Interestingly, despite the numerous identified areas for improvement, it is noteworthy that a considerable portion of participants expressed a willingness to recommend the app to individuals aspiring to reduce their food waste. Out of the participants, 9 individuals (45%) stated that they would indeed recommend the app, citing the lack of viable alternatives as a contributing factor to their recommendation.

Conversely, 7 participants (35%) expressed a preference for focusing on educating individuals to raise their awareness about food waste rather than relying on the app,

also because the app required building a habit that is not easy to establish. It is worth highlighting that within this group, 4 participants indicated that they would be inclined to recommend the app if it incorporated the improvements that were discussed during the focus group sessions. This suggests that these individuals recognised the potential value of the app but emphasised the need for certain enhancements to fully endorse its recommendation.

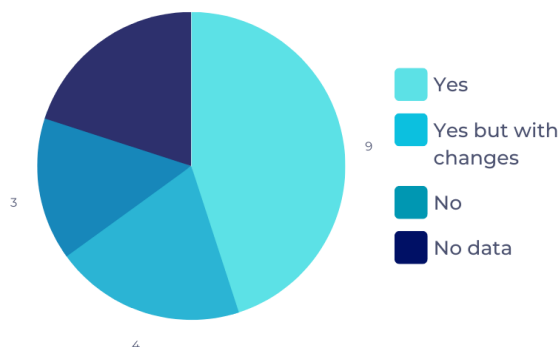


Figure 4.20: App potential recommendation.

After a two-week period, participants were revisited to inquire about their continued use of the app. Unsurprisingly, the findings revealed a notable decline in app retention and usage. Only 5 participants (25%) reported still having the app installed on their phones, with a mere 2 participants (10%) admitting to using it to a limited extent. These results indicate that participants' engagement with the app was heavily influenced by the experimental context rather than stemming from a sustained interest or active involvement. Interestingly, during the focus group sessions, some participants had already suggested that their involvement was primarily driven by the experimental context rather than genuine interest in the app itself.

### 4.3. Summary

With the presentation of all the results complete, it is now pertinent to examine the most significant and valuable observations before proceeding to their analysis.

The findings indicate a noteworthy level of concern among questionnaire respondents regarding food waste, with a majority expressing their worries. Moreover, a substantial number of participants reported emotional distress when food was discarded, and a significant proportion actively implemented measures to mitigate food waste in their daily routines. While no significant correlations were discovered among the demographic variables, notable insights were obtained through statistical tests. For instance, a strong correlation was observed between meal planning and adherence to

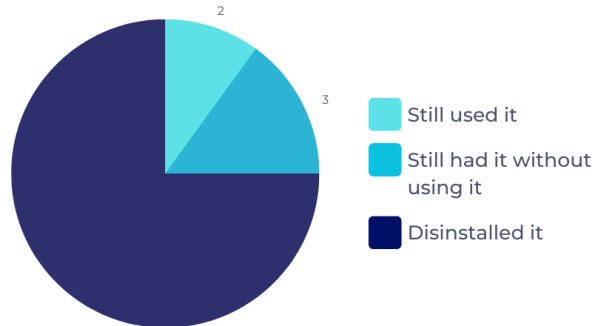


Figure 4.21: Participants' app usage two weeks after the experiment.

shopping lists, while the frequency of grocery shopping interestingly did not correlate with the regular purchase of fresh products.

Another curious finding is that, despite the absence of prior experience with food waste reduction apps, a considerable proportion of participants demonstrated a willingness to use such applications.

Regarding the evaluated apps, users found certain features to be advantageous, particularly the accessibility of information on available food items from any location, as well as the ability to avoid purchasing duplicate items. However, the non-intuitive and time-consuming design of the apps impeded their usage for many participants.

The use of notifications, intended to serve as reminders to use food items before they spoil, was not widespread among participants. Nevertheless, those who enabled notifications expressed appreciation as it facilitated timely action, whereas others regarded them as bothersome or unnecessary. The recipe feature received mixed feedback, with some participants appreciating the variety of recipes and the use of existing ingredients, while others found the recipes either too complex or too basic. Participants also expressed a desire for a more diverse selection of recipes, particularly those representing different cultural backgrounds.

Participants provided valuable suggestions for app improvements, including features such as household member connectivity, greater flexibility in setting expiration dates, meal filtering options, elimination of paid subscriptions, and an enhanced intuitive design. Additionally, recommendations were made to incorporate functionalities like excluding specific ingredients from recipe suggestions, offering information on proper food storage techniques, and enhancing informative notifications.

To augment motivation and engagement with the app, the inclusion of a reward system or gamification elements was proposed. However, some participants expressed a preference for prioritising education and raising awareness about food waste, rather than relying solely on the app for behaviour change.

Despite the identified areas for improvement, a considerable portion of participants expressed their willingness to recommend the app to others, citing the scarcity of viable alternatives as a contributing factor. Nevertheless, some participants emphasised the importance of prioritising awareness and education on food waste alongside app usage.

# 5. Analysis

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This section provides an analysis of the aforementioned results in relation to the research questions and hypotheses formulated. The relation between the results and the literature review will be explored later in the discussion section. By examining the data presented earlier, the section shows insights and starts drawing conclusions that address the core objectives of this study.

## 5.1. Food Waste and Action-Taking

Based on the comprehensive analysis of the obtained results, H1, which states that most participants express concern about food waste but face challenges in taking action, is strongly supported. The questionnaire responses revealed that over 90% of the respondents expressed a genuine interest in reducing food waste, and this goes up to 100% for the participants in the experiment. However, during the subsequent focus group sessions, when participants were specifically asked about their engagement with the app, 35% reported non-participation due to time constraints or being physically away from their kitchen. Still, 65% did use the app during the experiment.

But as expected, two weeks after the experiment concluded, the number of non-participants increased significantly, contrasting with the initial high level of concern expressed by the majority of the participants. This observation suggests that the temporary nature of their participation may have been influenced by the experimental timeframe rather than a lack of genuine concern. This was even acknowledged by some of the participants as seen in the results.

Considering these findings, it can be confidently concluded that H1 is confirmed. The results illustrate that while participants genuinely care about food waste, external factors such as time constraints and logistical difficulties hinder their ability to take action in a consistent manner.

## 5.2. Former App Usage

According to the questionnaire results, a mere 12% of the respondents had prior experience with apps designed to address food waste. However, delving deeper into the reasons behind participants' hesitation to use such apps, it becomes apparent that the lack of motivation is just one among several factors influencing their decision. Participants cited time constraints, a desire to limit phone usage and app overload, uncertainty about how an app could assist them, and a general lack of awareness regarding available apps for this specific purpose. Consequently, while H2 is partially confirmed, it is evident that the underlying reasons for individuals not using food waste reduction apps are more diverse than initially anticipated.

The findings highlight the complexity of factors contributing to low app adoption rates in the context of food waste reduction. Merely assuming a lack of motivation as



the primary deterrent oversimplifies the underlying challenges individuals face in integrating such apps into their daily lives. Time constraints emerge as a prominent barrier, suggesting that individuals may prioritise other demands over actively engaging with food waste reduction apps. Furthermore, concerns about app overload, excessive screen time and uncertainty about the app's efficacy indicate a need for clearer communication regarding the benefits and functionalities of these apps.

While H2 is partially confirmed with only a small percentage of participants having prior experience with food waste reduction apps, it is evident that the lack of motivation alone does not fully explain individuals' reluctance to use such apps. The study reveals a broader range of barriers, including time constraints, screen time concerns, uncertainty, and limited awareness. These findings underscore the importance of comprehensive strategies that address the diverse challenges individuals face in adopting and engaging with food waste reduction apps.

### **5.3. Green Nudges**

Although a few participants mentioned specific instances where the app helped them consume items nearing spoilage or provided recipe suggestions for ingredients they were unsure how to use, the overall findings indicate a lack of consistent and extensive app usage among the majority of participants. The primary factor contributing to this limited engagement was the poor intuitiveness of the app's design. Therefore, H3, which posited that the green nudges embedded in the apps would not be sufficient to consistently drive participant usage, is confirmed.

While some participants did benefit from the app's features on select occasions, the lack of sustained usage suggests that the impact of the green nudges was diminished by the app's counter-intuitive design. Participants' reluctance to fully embrace the app's functionalities highlights the importance of user-friendly interfaces that seamlessly integrate the green nudges into the user experience. The counter-intuitive nature of the app's design hindered participants' willingness to engage and use the app consistently, thus undermining the potential effectiveness of the embedded green nudges.

While some participants experienced isolated benefits from the app's green nudges, the majority did not consistently use the app due to the inherent challenges associated with its design. This finding underscores the need for user-centric app development and emphasises the significance of intuitive interfaces to maximise the impact of green nudges.

### **5.4. After-Effects**

The feedback provided by the focus group participants reveals that only a small fraction of them, specifically 4 individuals, reported experiencing a change in their food waste behaviour during the experiment. However, it is important to note that these changes were primarily attributed to their participation in the study rather than the influence of the app itself. This finding strongly supports the confirmation of H4, which posited that most participants would perceive minimal to no changes in their food waste behaviour,

both during and after the experiment, despite being exposed to nudges embedded in the app.

The lack of substantial impact on participants' food waste behaviour can be attributed to various factors. Firstly, the study's experimental nature may have motivated participants to be more mindful of their food waste and engage in behaviours aligned with the objectives of the research. Consequently, any observed changes in their behaviour can be largely attributed to the study's influence rather than the effectiveness of the app's nudges.

Furthermore, the limited impact of the app on participants' food waste behaviour suggests that the deployed nudges may have fallen short in terms of their persuasive power. This may be attributed to factors such as the lack of personalised recommendations, insufficient frequency or timing of nudges, or a failure to effectively communicate the benefits and importance of reducing food waste. These shortcomings may have hindered participants' receptiveness to the nudges and their ability to translate them into meaningful behavioural changes.

In conclusion, the findings support H4, indicating that the majority of participants perceived minimal or no changes in their food waste behaviour during or after the experiment, despite exposure to nudges within the app. The study's influence appeared to be the primary driver of any reported behavioural changes, rather than the app's nudges themselves. To enhance the app's effectiveness in influencing food waste behaviour, future iterations should consider refining the nudges to make them more compelling, personalised, and aligned with users' motivations and needs.

## **5.5. Contributing factors to individuals' insufficient engagement towards food waste**

Thanks to these findings, it is possible to identify several factors that contribute to the insufficient engagement of individuals in solving the issue of food waste, despite the availability of existing apps dedicated to this cause. Firstly, participants mentioned a lack of time or motivation as a barrier to engagement with food waste reduction apps. This suggests that individuals may not perceive the issue of food waste as personally relevant or as a priority in comparison to other activities.

Additionally, limited knowledge of available apps was mentioned, indicating a need for improved awareness and education regarding the existence and benefits of these apps. Concerns about app overload or excessive screen time also emerged as potential factors inhibiting engagement, highlighting the importance of designing user-friendly and time-efficient apps.

Interestingly, some participants expressed a sense of adequate mindfulness regarding their food waste practices, considering an app unnecessary in their case. This suggests that individuals may have differing perceptions of their own behaviours and may not see the need for additional support. These findings provide insights into the various factors that contribute to the insufficient engagement of individuals in addressing food waste despite the presence of dedicated apps

## 5.6. Green nudges to promote sustainable environmental behaviour specifically food waste

The findings also provide valuable insights for tailoring digital interventions effectively. One key aspect is the design of the apps, as highlighted by participants' complaints regarding the counter-intuitive design. Improving the user experience and interface should be a priority to enhance engagement and usability, regardless of users' personal circumstances.

Furthermore, considering the household context is crucial. Taking into account multiple persons sharing groceries within a household can help tailor the app's features and functionalities to accommodate collective decision-making and reduce food waste collaboratively. Cultural background also emerged as a factor to consider, suggesting the importance of incorporating diverse recipes and food-related practices from different cultural backgrounds to cater to a wider user base.

Additionally, it is essential to consider individuals' time and budgetary constraints when designing green nudges. Providing time-saving strategies and budget-friendly options within the app can motivate users to adopt sustainable behaviours without significant burdens.

Understanding the reasons behind individuals' reluctance to waste food is another critical aspect. By addressing and providing solutions to their concerns or misconceptions about food waste reduction, digital green nudges can effectively promote behaviour change. This can include educational content, personalised tips, or targeted messaging that resonate with individuals' specific motivations and values.

**Part III**

**Conclusion**

## 6. General Discussion

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In this section, the lessons learned after the development of this thesis are detailed and possible opportunities for improvement on the developed research are identified, as well as the limitations encountered and the future work that can be done.

### 6.1. Summary of Findings

In this research, young adults' food waste behaviour was examined, before testing the effects of digital nudges on said behaviour via an app (CozZo or KitchenPal) that participants would use for a week.

The questionnaire's results demonstrate a prevailing concern among respondents regarding food waste, indicating a widespread recognition of its significance. Furthermore, a considerable number of participants actively implemented strategies to minimise food waste in their daily lives, exemplifying a personal commitment to the issue. While no statistically significant correlations were found between demographic factors and food waste-related behaviours, notable associations emerged, such as the strong correlation between meal planning and adherence to shopping lists. The analysis also revealed mixed patterns in the usage of food waste reduction apps, with a notable portion of participants expressing willingness to embrace these digital solutions.

The focus groups' results showed that the counter-intuitive design of the apps hindered the effectiveness of the green nudges. Several participants expressed difficulty navigating the apps and understanding how to fully make use of the implemented features. The lack of user-friendliness observed in the apps could have significantly diminished the impact of the green nudges, particularly considering their intended seamless integration, as highlighted in the literature review. The confusing interface created a barrier that hindered users' engagement with these nudges, making them less likely to fully embrace and benefit from their intended effects.

Regarding the notifications about food going bad, the results indicated mixed effectiveness. Some participants reported that these notifications served as helpful reminders, prompting them to use or consume the items before they spoiled. Furthermore, the recipe suggestions provided by the apps did not consistently prioritise the utilisation of "soon to spoil" ingredients.

Participants' feedback also provided valuable insights for enhancing the app's features and user experience, such as connecting household members, offering flexibility in setting expiration dates, incorporating meal filtering options, eliminating paid subscriptions, and improving the app's intuitive design. Participants also recommended additional functionalities such as excluding specific ingredients from recipe suggestions, providing information on proper food storage techniques, and enhancing informative notifications. To boost motivation and engagement, the inclusion of a reward system or gamification elements was proposed. Despite the areas for improvement, a significant

portion of participants expressed their willingness to recommend the app, attributing the scarcity of alternatives as a contributing factor.

## 6.2. Implications

The findings of this research have significant implications for the broader context of food waste reduction among young adults and the effectiveness of digital nudges in promoting sustainable behaviours. Firstly, the widespread recognition and concern expressed by participants regarding food waste highlight the relevance and importance of addressing this issue. The personal commitment demonstrated by individuals in actively implementing strategies to minimise food waste emphasises the potential for behavioural change and the need for effective green nudges.

The associations observed between meal planning and adherence to shopping lists underscore the importance of promoting structured approaches to grocery shopping and meal preparation. These findings contribute to existing knowledge by highlighting the positive correlation between these behaviours and a reduction in food waste (Stancu, Haugaard, and Lähteenmäki 2016).

Furthermore, the mixed patterns in the usage of food waste reduction apps suggest the need for further exploration and improvement in the design and usability of these digital tools to maximise their effectiveness. The limitations identified regarding the counter-intuitive design of the apps used in this study reveal the potential barriers that can hinder the impact of digital green nudges.

The practical implications of this study extend to relevant stakeholders, including app developers, policymakers, and organisations involved in promoting sustainable consumption. The valuable feedback provided by participants regarding app improvements, such as connectivity with household members, flexible expiration dates, and intuitive design, can guide the development of more user-friendly and impactful food waste reduction apps. Additionally, the recommendations for incorporating features like ingredient exclusion in recipe suggestions and providing information on proper food storage techniques can enhance the practicality and relevance of these apps in users' daily lives.

Furthermore, the suggestion to incorporate reward systems or gamification elements highlights the potential for increasing motivation and engagement with food waste reduction apps. This finding opens avenues for further research exploring the effectiveness of different incentive structures in promoting sustained behaviour change.

## 6.3. Discussion

Firstly, it is important to emphasise the need to prioritise improvements in app design before focusing on the effectiveness of nudges. The counter-intuitive design of the tested apps hindered the implementation and impact of green nudges, as participants faced usability challenges and had difficulty fully using the features. This aligns with the findings from the literature review, which highlight the importance of tailoring nudges to the specific needs, values, and behaviours of the target audience (Lehner, Mont, and

Heiskanen 2016), as 70% of variance from individual to individual on climate change risk perception can be explained by cognitive, experiential, and socio-cultural factors (Van der Linden 2015).

The research findings align with several established theories on climate change perception. The Theory of Planned Behaviour supports the connection between attitudes, subjective norms, and perceived behavioural control, as evidenced by respondents expressing their intention to engage in food waste reduction behaviours despite existing challenges (Ajzen 1985; Steg and Nordlund 2018). The Protection Motivation Theory reinforces the relationship between participants' perception of severity, vulnerability, response efficacy, and self-efficacy, as demonstrated by respondents' engagement in sustainable practices and reluctance to adopt additional apps due to already practicing food waste reduction (Steg and Nordlund 2018). The Norm Activation Model illuminates how personal norms and environmental awareness drive individuals to adopt environmentally-friendly behaviours, exemplified by respondents who actively implemented strategies to minimise food waste (Steg and Nordlund 2018; Schwartz 1977). The Value-Belief-Norm Theory of Environmentalism underscores the influence of participants' values, environmental beliefs, and personal norms in shaping their commitment to protecting the environment, exemplified by participants who expressed a deep sense of responsibility and suggested incorporating educational elements into the app (Steg and Nordlund 2018). Finally, the Goal-Framing Theory highlights the impact of goal framing, with participants recommending the inclusion of gamification or reward systems to enhance motivation, aligning with the theory's emphasis on prevention goals. (Steg and Nordlund 2018) These theories provide valuable insights into the underlying mechanisms and can serve as a guide for future interventions aimed at promoting sustainable behaviour change.

The study conducted by Van Valkengoed et al. (2022) examined these theoretical frameworks and identified determinants of environmental behaviour, listed in the literature review. These determinants were also observed in the study results, with notable factors such as outcome efficacy, as the participants noticed that to see a positive change it required quite some effort, personal norms, as seen in the results of the survey, where 30% of respondents declared not to food waste because of how they were taught, and of course knowledge, as several instances highlighted how a lack of knowledge hindered respondents and participants from effectively reducing their food waste.

## 6.4. Limitations

This study encountered several limitations that warrant consideration. Firstly, the usability of the apps used presented a challenge due to their counter-intuitive design and time-consuming nature, impeding participants' engagement and potentially influencing their overall experience. Consequently, these usability issues may have impacted the research findings by affecting participants' usage patterns and feedback.

Secondly, it is important to acknowledge the potential presence of positive response bias, given the study's focus on food waste reduction and its underlying goal of promoting sustainable behaviours. Participants may have exhibited more favorable

responses or greater willingness to adopt the app due to the study's inherent nature, thereby influencing the outcomes. Another reason for the latter is that the participants' attitudes were self-reported and therefore probably biased towards political correctness.

Furthermore, the generalisability of the findings is limited by the sample composition, primarily consisting of participants from the occidental world. The cultural variations, diverse norms, values, and infrastructural disparities associated with food consumption and waste management across different regions and cultural contexts must be considered when interpreting and applying the results.

Lastly, a demographic limitation arises from the study's emphasis on young adults who primarily cook for themselves rather than for a family. Consequently, the applicability of the findings to other age groups and household compositions is restricted. The dynamics of food waste reduction, including behaviours, motivations, and challenges, may significantly differ for individuals responsible for feeding larger family units.

## 6.5. Future Work

In terms of future work, there are several avenues that could enhance the understanding and effectiveness of food waste reduction apps. Firstly, it is worthwhile to explore the potential of incorporating a wider range of nudges within the app design. The current study examined the impact of limited nudges present in apps such as Cozzo and KitchenPal, but there is room for experimentation with different types of nudges, including gamification elements, competition, and reward systems. These additional features may further motivate and engage users in reducing food waste, and could be implemented after having assessed at what stages of typical "food user" daily life it is pertinent to add these interventions, such as food planning and waste moments.

Additionally, it would be valuable to quantify the impact of app usage on individuals' feelings and behaviour changes. Incorporating measures to assess users' awareness levels, actual food waste reduction, and related behaviours could provide more rigorous and quantitative data for analysis. This would not only strengthen the validity of the findings but also offer insights into the specific ways in which the app influences users' attitudes and actions.

Furthermore, conducting a long-term study would provide valuable insights into the sustainability and long-lasting impact of using food waste reduction apps. Tracking participants' behaviours, habits, and attitudes over an extended period would allow for a deeper understanding of the long-term effectiveness of the app and its potential to instigate lasting behaviour change.

By addressing these areas in future research, a more comprehensive understanding of app features, user experiences, and long-term impacts can be achieved, ultimately contributing to the development of more effective interventions and strategies for reducing food waste.



# 7. Conclusion

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In this section, the final conclusion will be drawn the key takeaways from this research, emphasising the main findings, highlighting their relevance to the research questions, and discussing how they contribute to the existing knowledge in the field.

## 7.1. Conclusion

In conclusion, this research sheds light on young adults' food waste behaviour and the effectiveness of digital nudges in promoting sustainable behaviours through food waste reduction apps. The findings reveal a widespread concern among participants regarding food waste and a significant number of individuals actively implementing strategies to minimise it, highlighting the potential for behavioural change. Associations between meal planning, adherence to shopping lists, and a reduction in food waste further emphasise the importance of structured approaches to grocery shopping and meal preparation.

However, the study also identifies limitations in the design and usability of the tested apps, hindering the impact of green nudges. Participants faced challenges in navigating the apps and fully using the implemented features, leading to decreased engagement and effectiveness. Recommendations provided by participants for app improvements, such as improved intuitiveness, connectivity with household members, and flexible expiration dates, can guide the development of more user-friendly and impactful food waste reduction apps.

The research findings align with established theories on climate change perception, including the Theory of Planned Behaviour, Protection Motivation Theory, Norm Activation Model, Value-Belief-Norm Theory of Environmentalism, and Goal-Framing Theory. These theories offer valuable insights into the underlying mechanisms driving sustainable behaviour change and can inform future green nudges.

The study acknowledges several limitations, including the usability issues of the tested apps, potential positive response bias, limited generalisability to different cultural contexts, and the focus on young adults without considering other age groups and household compositions. Addressing these limitations and conducting future research with a wider range of nudges, quantitative measures of app impact, and long-term studies can enhance our understanding of app features, user experiences, and long-lasting behaviour change.

Ultimately, this research contributes to the broader context of food waste reduction and highlights the need for improved app design, user experience, and effective nudging techniques to promote sustainable behaviours among young adults and beyond. By integrating these findings into app development and promoting tailored interventions, stakeholders can work towards mitigating food waste and fostering sustainable consumption practices.

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**Part IV**

**Appendix**

## .1. Consent form

Terms and conditions Hello, thank you for taking the time to complete this survey.

My name is Elias Brun Herrera, and for the scope of my Master's thesis, I am researching on the effectiveness of nudging in influencing people to waste less food in their daily behaviour. For this, I need to know a little more about how people already behave regarding this which is why I need your help filling in this questionnaire as honestly as possible. For this purpose, there is a set of 29-37 short questions (the number varies according to your answers), for which all your answers are anonymous. The information that you will provide is purely for the purpose of statistical analysis and will in no way be used for other projects or shared to other parties other than myself. I will also not ask you for any information that might identify you. Please note that your participation is voluntary and that you can withdraw from this survey at any time. You can also contact me if you wish to change or delete your answers, at the email address below. If you have any questions now or later you can contact me at *Researcher's email*. Do you accept the above conditions and wish to continue to the survey?

## .2. Initial Questionnaire

- **Age requirement**
- What age group do you belong to? (!) Note that for the scope of this research we are focusing on people between 18 and 30 years old. If you are not in this range you will be taken directly to the end of this survey. Thank you for taking the time to click on the link. We trust you to keep up the good work and waste as least food as you can to take care of our planet.
- **Demographics**
- Gender
- Country of residence
- Are you a student?
- How often do you cook for yourself?
- How many people do you live with?
- How often do you cook for other people than yourself?
- When you cook for other people who is it for?
- How often do you go grocery shopping?
- Roughly how much do you spend monthly on groceries?
- Roughly how much is your monthly income? Please include any financial (parental, governmental) help.
- **Food waste behaviour**

- *Likert Scale* I try to not waste food at all.
- Why?
- *Likert Scale* I always try to eat all purchased food.
- Do you think leftover food can always be used in some way. How do or would you use it?
- Does it upset you when unused products end up in the waste bin. If so, why?
- Is money a reason for you not to waste food?
- Is possible health issues from eating leftovers a reason why you waste food?
- Do you plan your meals before going shopping or do you cook your meals based on what you've bought?
- *Likert Scale* When I have made a shopping list, I always keep strictly to it.
- How easy is it for you to use leftovers in future meals?
- *Likert Scale* I have the feeling that I cannot do anything about my food waste.
- *Likert Scale* I feel bad when I throw food away.
- *Likert Scale* I regularly buy many fresh products although I know that not all of them will be eaten.
- *Likert Scale* When I am expecting guests, I like to buy more food than is necessary because I am a generous host.
- **App use**
- Have you ever used an app to try and reduce your food waste?
- Which one(s)?
- Was your main purpose to reduce your food waste or something else?
- For how long did you use it?
- Did you notice any changes in your food waste behaviour during or after using the app?
- What in the app helped you reduce your food waste?
- What in the app did not help you reduce your food waste?
- Did anything external to the app influenced your food waste behaviour? If so, what?
- Would you use an app (again) to try and reduce your food waste?
- What is the main reason you would?
- What is the main reason you would not?
- Would you use an app to try and reduce your food waste?
- What would be the main reason you would?

- Why not?
- Would any change in the existing apps change your mind?
- Would you accept to use such an app for a week for the scope of this research?
- Thank you for agreeing to participate in the experiment, you will be contacted shortly by the researcher. We would only need your email address for this further part of the experiment. Email
- **End Message**  
Thank you for taking the time to fill this questionnaire, if you have any questions you can contact the researcher with this email: *Researcher's email*

### .3. Focus Group Questions

- Welcome everybody, thanks again for your participation, this is the last step of the experiment, no more after this. Before we begin, well first my name is Elias and I am conducting this research for my Master's thesis. As told in the email this session will be audio recorded, only in Teams I don't think you can only audio record so if you do not wish to appear in the screen you are welcome to cut off your camera, but know that the video won't be used for anything nor outside or for the research. On a further note, know that I did not make these apps, so feel free to make any comment, and more importantly, feel free to share anything you want, whether you used the app or not, your contributions are always valuable. Alright, anybody any questions? Then let's start.
- First of all, who used the app? The ones who did not, why?
- The ones who did, how did you use it, what features did you use?
- Who here activated the notifications, did they help you plan your meals or your shopping lists?
- What did you think of the recipes offered by the app?
- For the ones who used CozZo did you use the widget they offer? Would you have liked to?
- Did you notice any changes in your food waste behaviour during or after this week?
- Did you notice any changes in your meal plans?
- Did you notice any difference in expenses?
- What features did you enjoy the most?
- What features did you avoid the most?
- Were there any barriers or challenges that prevented you from using the app consistently or effectively?
- What would you change or add if anything, even something specific to you?



- Did you ever use an app to try and reduce your food waste before this experiment?
- Were there any differences between this app and the last one?
- Were there any differences between this time and the last related to your behaviour?
- If people around you told you that they want to reduce their food waste amount, what would you tell them? Would you recommend them CozZo or KitchenPal? Another app?
- Is there anything else you would like to share about your experience using the app?