Enoughness in Food Consumption: Design Strategies for Achieving Sufficiency.

Master Thesis
Heleen Sinnige

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Preface

Dear reader,

It's a wrap!

With this thesis, I conclude my seven years as a student at the Faculty of Industrial Design Engineering at Delft University of Technology. Submitting this report brings a mix of happiness and relief, but also sadness as I'm saying goodbye to the wonderful years I've spent at this university

I can look back on a time where I gained knowledge, improved my abilities, and grew as a person. Through various ups and downs, challenges, and celebrations, I have come to know myself better. I had the privilege of working on numerous interesting and exciting projects with amazing fellow students and client companies who challenged me to look beyond the obvious and take risks. These experiences have helped me in broadening my perspective on design.

Writing this thesis boosted my confidence and highlighted areas where I still have room to grow. I am proud that I pushed myself to learn new things throughout this project, and I can confidently say that I put my best foot forward from start to finish.

Before I introduce you to the contents of this report, I would first like to say thanks to several people.

First, I would like to thank my thesis supervisors, Lise and Shahrokh, for their intensive coaching throughout the project. I can confidently say that I learned a great deal from you, and your feedback truly elevated this thesis to a higher level. I am very grateful for the large amount of time and support you dedicated to me and my project. Your attention and kindness made the process much easier than I could have hoped.

Secondly, I would like to thank all my former roommates from my previous student housing in Delft, where I happily lived for five years. The joy, humor, love, and support I experienced there greatly enriched my time as a student in Delft. Whenever I needed someone to talk to, I only had to walk to the next door in the hallway. Living with these wonderful people taught me not to take myself and life too seriously. I will keep the dear friendships I have made there for the rest of my life.

Thirdly, I would like to thank my study friends for all the fun we had in and outside of the faculty. With special thanks to Meike, Karien and Hella, for all the lunches, dinners and late night sushi in the exam weeks.

Fourthly, I would like to thank my yearclub for all the amazing activities, borrels, vacations and dinners we had together. I can't be thankful enough for this group of 17 friends who still stick together after six years. In particular I would like to thank Elja for the support and all the study days we had together at the faculty. It really made this thesis project a lot more bearable.

I would also like to thank my family for their unlimited support, not only during this project but throughout my entire study. Your late-night participation in my brainstorming sessions, feedback on my long reports, and supportive calls made the completion of my studies much smoother. Thank you for always being a safe place where I could go to whenever I was tangled up with myself. I couldn't have done it without you.

And lastly, I would like to thank the person who has been a very special addition to my life over the past 1.5 years. Fre, thank you for being my rock and enduring all my sighs and complaints over the past six months. You have helped me grow my confidence and remain positive. I couldn't have asked for a better partner.

My time as a student at the TUDelft has come to an end. I therefore proudly present to you my graduation report.

All the best,

Heleen

Executive Summary

Due to the economic prosperity and population growth, consumption has increased, particularly in the affluent parts of the world (WHO, 2023; WWF, 2020). This has lead to the surpassing of multiple planetary boundaries, resulting in catastrophic ecologcial and environmental damage (Rockström et al., 2009). Solely employing efficiency measures, meaning using technological advancements to make production 'greener', has not provided improvements in lowering the environmental impact caused by humans (Kallis, 2017; Wiedmann et al., 2020). Researchers therefore advocate to complement the efficiency approach with a 'sufficiency' approach, which focuses on bringing consumption closer to a level that fulfills basic needs (Lorek & Fuchs, 2013; Gossen et al., 2019).

One of the major fields of consumption where individuals can significantly reduce their impact is the food domain, with food waste being one the most urgent problems to address. Studies have identified that behaviour around leftovers is a promising, yet under-researched area to tackle food waste (Andrews et al., 2018; Stancu et al., 2016). Food waste reduction behaviours, in particular eating leftovers, is a very exemplary measure to take to reach a sufficient lifestyle. By eating leftovers, less new food needs to be bought, bringing down the level of consumption. It emphasizes the mindful use of resources to meet needs without excess.

This thesis therefore seeks to identify the drivers and barriers for the re-use of food leftovers and defines strategies to design interventions for behaviour change. A literature review is done on existing psychological theories and potential antecedents of leftover re-use behaviour. An initial conceptual model is built based on the Theory of Planned Behaviour (Ajzen, 1991), Norm Activation Model (Schwartz, 1977), the Motivation-Opportunity-Ability model (Ölander & ThØgersen, 1995) and other constructs to explain the intention to re-use food leftovers.

To further explore the topic, gain rich insights and evaluate whether the initial model should be adjusted or complemented, interviews have been conducted with a set of consumers. The interviews are analysed through Thematic Analysis (Braun & Clarke, 2006), which yielded three themes: (1) Difficulties of organizing, (2) Doing the right thing, (3) Ascribed value to leftover food. The results show that people are motivated to perform food waste reduction behaviour based on their personal principles and a desire to do the right thing. This in turn is influenced by their upbringing and knowledge about the consequences of their behaviour. Parents who are strongly motivated to produce as little food waste as possible, even make extra effort to convince their household members to do the same. The results also show that people are often less inclined to eat their leftovers, because they deem it as less valuable and usable. This has to do with the perceived attractiveness of leftovers, anxiety about food-borne illness and the skills needed to process and cook leftovers. On the other hand, there are also people who find leftovers tasty and convenient especially for lunch. Lastly, the re-use of food leftovers is hampered or facilitated by how well the household is organized. Especially a lack of overview and forgetfullness leads to people not being aware of what they still have at home.

The results show good overlap with the initial model. One factor of the initial model, sensory appeal, is replaced by another factor: perceived health risks. Both factors are found in the interview results, only perceived health risks has been identified as more important since this forms a stronger cut-off reason for why people do not want to eat their leftover.

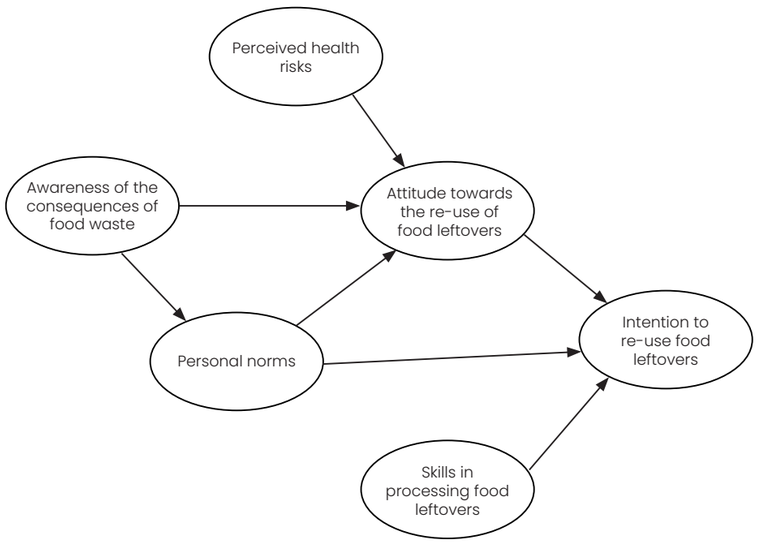

Figure A: Conceptual model for the intention to re-use food leftovers.

The model (Figure A) is tested using an online questionnaire and analysed through PLS-SEM in SmartPLS. PLS-SEM (Partial Least Squares Structural Equation Modeling) is a statistical technique used to analyze complex relationships between observed and latent variables. The results from the analysis show that six of the seven hypotheses are confirmed. One hypothesis - the relationship between awareness of consequence and attitudes - is rejected, which shows that awareness of consequence only has a direct effect on people's personal norms. The results lead to the identification of five drivers and barriers that explain the intention to re-use food leftovers. Together with one barrier found in the interviews (household organization), six design opportunitities are defined: (1) attitudes, (2) personal norms, (3) skills, (4) awareness of the consequences, (5) perceived health risks, (6) household organization (Figure B). These design opportunities show areas to focus on when pursuing behaviour change.
For each of the design opportunities, two to four design strategies are defined that form a basis to design interventions.

The design strategies for attitudes focus on creating more positive perceptions, enjoyable experiences, rewards, and fostering positive expectations. To raise awareness about the consequences of food waste, these strategies help people realize the significant loss of resources and the magnitude of the food waste problem. Personal norms are targeted by instilling strong ethical beliefs against food waste and enhancing the perception of food as something very valuable. For perceived health risks, the strategies aim to increase confidence in food safety and provide support for safe food handling. Improving skills in processing food leftovers involves enhancing cooking skills and offering guidance for optimal storage. Lastly, the strategies for household organization help people maintain an overview of what they have and offer memory support to ensure leftovers are used.

To generate ideas for possible solutions, an ideation session is organized with a resource group existing of design students. Methods like flower association, brainwriting and creative confrontation are used to inspire the participants. Six design interventions concepts are selected from the session, one for each design opportunity, and further conceptualised by the researcher. These six concepts act as an inspiration and practical approach to encourage the re-use of food leftovers.

By addressing the six key areas, the proposed interventions aim to foster sustainable behaviors and significantly reduce food waste. The successful implementation of these strategies can lead to a more efficient use of resources and contribute to achieving broader environmental goals. Ultimately, this research highlights the importance of rethinking our approach to food consumption and waste, promoting a culture of sufficient consumption.

Attitudes towards the re-use of food leftovers Shifting evaluations and experiences of re-using leftovers towards the positive.	**Awareness of the consequences of food waste** Inducing a realization that one's personal behaviours around food waste have a significant negative effect.	**Personal norms** Touching upon and changing one's personal ethical beliefs and principles against food waste.
Perceived health risks Lowering anxiety of food-borne illness by reassuring safety.	**Skills in processing food leftovers** Improving one's capabilities in creative cooking, optimal storing and assessing edibility.	**Household organisation** Bringing overview and structure to stay up to date of stockage.

Figure B: Design opportunities.

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Chapter 1

INTRODUCTION.

This chapter provides the introduction and focus of this master thesis. It consists of two parts: in the first section the project context and goal is described, along with the starting point for the literature review.

In the second section, the project approach and structure is described and visualised. Additionally, the personal ambitions for this master thesis are listed and further elaborated on.

1.1 Project context and focus

This section introduces the main goal of this thesis. It elaborates on the context and provides arguments for further scoping. Additionally, it formulates initial research questions to guide the literature review and the activities further on in the project..

1.1.1 Project context

Living beyond the planetary boundaries
In the past 50 years, the global economic growth has strongly improved our knowledge level, health and standards of living (WHO, 2023; WWF, 2020). However, this has not come without consequences. In 2020, the human ecological footprint was more than 1.5 the amount that the planet can regenerate. In an attempt to provide a framework for understanding and quantifying the environmental limits within which they expect humanity can safely operate, Rockström et al. (2009) introduced the Planetary Boundaries (Figure 1).

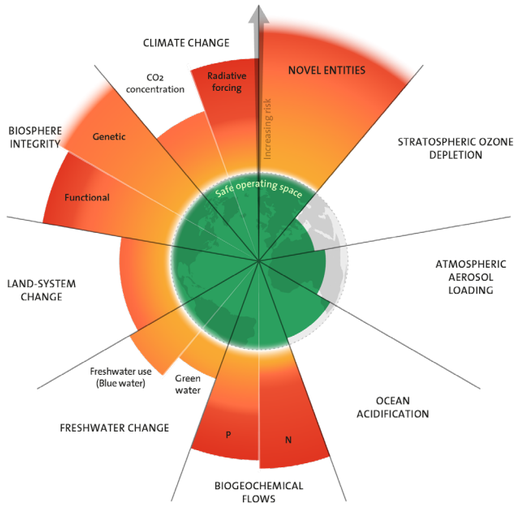

Figure 1: The Planetary Boundaries in 2023.

It sets limits for nine different boundaries for which seven are quantified. In case humanity transgresses one or more boundaries, it may have catastrophic consequences due to the triggering of non-linear environmental change that have an effect on systems that operate on a planetary scale (Rockström et al., 2009). Due to a major increase in population growth, consumption and trade, we have already exceeded the limits for a safe operating space in multiple planetary boundaries, resulting in significant changes in the environment and threats to the stability of the Earth's operating systems (World Bank Open Data, 2022; WTO, 2022; WWF, 2020).

According to the estimates of Rockström et al. (2009), in 2009 we had already surpassed the planetary boundaries of climate change, changes to the global nitrogen cycle and the boundary that describes the loss of biodiversity. After the first publication, this has only gotten worse. In an update in 2023, humanity has passed as much as six planetary boundaries (Richardson et al., 2023). Accelerated biodiversity loss is identified as 'particulary serious' (Rockström et al., 2009: p. 45), since more and more evidence shows that biodiversity is very important for the functioning of ecosystems and because it influences the underlying resilience of other planetary boundaries (Rockström et al., 2009; WWF, 2020). The Living Planet Index (LPI), which is a measure to showcase the world's biological diversity, continues to decline. Between 1970 and 2016, it has shown an average decrease of 68% amongst the population sizes of mammals, fish, birds, reptiles and amphibians (WWF & ZSL, 2022).

This is alarming, because the population trends of the species that live on the planet are one of the indicators for the health of our overall ecosystem. Biodiversity plays an important role in our self-preservation. Amongst others food provision, water and energy production are all influenced by biodiversity. This in turn has an effect on our climate, water quality and pollution levels (WWF, 2020).

Direct and indirect drivers
Climate change, direct exploitation, pollution and land use change, are a few direct drivers that have a negative impact on our environment and biodiversity. These direct drivers result from a combination of underlying indirect causes, such as societal or institutional causes, that have to do with our own values and behaviours (Díaz et al., 2015, 2019). For example, with the strong global economic growth in the past few decades, the consumption levels of the population have increased. This causes a high demand for material goods, predominately in the more affluent parts of the world (Díaz et al., 2019). The result is that especially in these affluent countries, the carbon footprints are far above the carbon emission targets that have been set globally. It is estimated that the carbon footprints of affluent regions should be reduced by 80-93% (IGES et al., 2019). Additionally, the consumption patterns in our diets have a detrimental direct effect on our terrestrial and freshwater ecosystems, due to land use change for livestock raising and plantations (Díaz et al., 2019). This is also why reducing the level of consumption and waste has been named as a leverage point for intervention (Díaz et al., 2019).

Efficiency & sufficiency
Amongst the scientific community there is a consensus that urgent changes need to be made in human activities in order to halt the environmental damage that is being done (Ripple et al., 2020). As Lorek and Fuchs (2013) describe, much of the research that has been done about reducing ecological footprints are dominated by, what they call, the 'weak sustainable consumption' approach. Meaning that studies have mostly focused on improvements in the efficiency of production, new technological innovations and making consumption 'greener'. This approach is rooted in market approaches and believes that technological innovations will allow our consumption patterns to remain largely the same.

However, certain academics argue that the efficiency approach alone, is improbable to curb environmental degradation (Kallis, 2017; Wiedmann et al., 2020). In-depth and extensive analyses on the results of efficiency measures, as well as historical data on environmental footprints, have shown that the efficiency efforts have not been successful in lowering the impact of human activities on our environment (Alexander & Rutherford, 2020; Lorek & Spangenberg, 2014; Wiedmann et al., 2015). Moreover, there are increasing concerns about rebound effects that come with efficiency, meaning that making production more efficient and cheap, results in even more production and consumption (IRGC, 2013; Kallis, 2017). This clearly shows that effective changes in unsustainable consumption patterns can only be accomplished if technological innovations are accompanied with lifestyle changes to lower consumption levels in affluent countries (Lorek & Fuchs, 2013; Spangenberg & Lorek, 2019; T. Wiedmann et al., 2020).

Therefore, although efficiency measures are indispensable to be taken in the future, the scientific community proposes to complement efficiency measures with a 'sufficiency' approach, also known as the 'strong sustainable consumption' approach (Jackson, 2016; Lorek & Fuchs, 2013; Lorek & Spangenberg, 2014; Wiedmann et al., 2020). Although there is not one definition for sufficiency yet, it has been defined as an approach that avoids over- and underconsumption, implying a reduction of absolute material consumption in affluent countries, while ensuring human well-being (Gossen et al., 2019). Putting the emphasis on directing production more towards satisfying needs, instead of materially intensive (Nesterova, 2020).

Meaning of sufficiency

In this research we see sufficiency as a way to achieve a lifestyle where people are more conscious about their basic needs and consume accordingly. Meaning that we bring our consumption levels back to a more purely functional level both in what we acquire or use, but also how we acquire and use. Important is to enable people to reject the perceived need of 'better, new and more' and highlight the fulfilment that can already be achieved by lower consumption levels.

1.1.2 Project focus

In order to scope and focus this thesis, a specific domain of consumption was chosen to further research. The domain was chosen based on the urgent need for change and on personal interest of the researcher. The urgency is based on the amount of impact that is caused within a certain domain and if there is room to improve.

The economic growth of the past few decades has inevitably increased the level of consumption, resulting in a bigger impact per capita on the environment. When we analyse the total environmental impact of households, there are three domains that have the biggest share: mobility, food and nutrition, and housing make up for almost 70% of material extraction and energy use and over 90% of the land use (Spangenberg & Lorek, 2002). Moreover, they are responsible for approximately 75% of the total lifestyle carbon footprints (Lettenmeier et al., 2019). These three domains, therefore constitute the most relevant consumption clusters and own the biggest potential for change (Jungell-Michelsson & Heikkurinen, 2022).

More specifically, food production has been recognized as having the greatest impact on environmental change globally, due to land-use change, water usage and biodiversity loss (Willett et al., 2019). In 2021, in the European Union, the domain of Food and Nutrition accounted for more than 48% percent of the total Consumption Footprint (based on life cycle assessments of a group of representative products in that domain). This was more than double the share of the housing domain (19,5%) followed by the mobility domain (14,9%) (European Commission, 2023)(Figure 2).

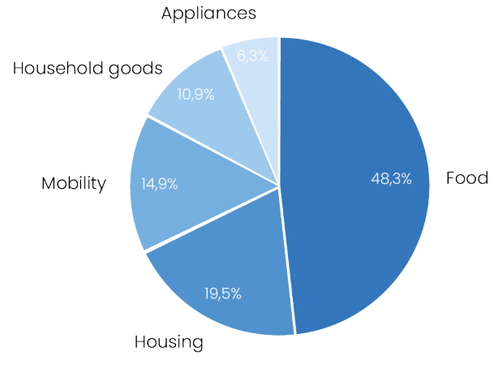

Figure 2: Contribution of areas of consumption in the European Union in 2021.

The food consumption patterns of affluent parts of the world causes detrimental effects on the environment. The way we produce food and where we produce the food that we consume daily, is one of the most severe human-caused dangers of our ecosystems. The decrease of biodiversity that comes along with this has a negative effect on our food security. More urgent than ever, the global food system should be transformed (FAO, 2019; WWF, 2020).

A great part of this can be influenced by the daily decisions that consumers make. Research has shown that by reducing the demand-side in the food system, changes towards a more sustainable food system can be made throughout the whole supply chain (Springmann et al., 2016; Tilman & Clark, 2014; WWF, 2020). By applying small changes in their food patterns and diets, people can have significant impact in reducing their environmental impact and making the way to a cleaner, safer and healthier planet (Speck & Hasselkuss, 2015).

Because of the urgent need to change the over-consumption in the food system and the fact that people have a great potential influence, this research will focus on sufficient food consumption practices on the individual and behavioural level.

The project goal is therefore formulated as:

*"Uncovering **design strategies** to enable individuals to initiate transformative shifts towards **sufficient consumption** within the **food domain**."*

1.1.3 Initial questions

By conducting research about sufficiency practices within the food domain, I aim to focus on one sufficiency practice and create a conceptual model that explains the drivers and barriers of that specific behaviour. The conceptual model forms a basis for which design opportunities and strategies can be developed to design interventions for behaviour change.

To further determine the focus of this thesis towards one sufficiency practice, a set of initial questions are defined to guide the literature review:

1. What strategies to move people towards a more sufficient lifestyle have been employed and shown to be effective?

2. What changes in people's daily behaviours and routines can be undertaken to move towards a more sufficient lifestyle within the food domain?

3. What are the design opportunities that can act as a starting point for designing interventions for behaviour change?

4. How can design interventions motivate and support people in their adoption of a sufficiency lifestyle?

1.2 Project approach

This section lists the personal ambitions for this master thesis with a detailed description. Additionally, the project structure, including the research and design steps that are taken in the project are further explained.

1.2.1 Personal ambitions

In addition to accomplishing all the general attainment levels for the master Strategic Product Design, several personal ambitions for the project are defined. These personal ambitions are used to keep track of the personal learning goals of the researcher and to determine the activities that are taken in the project.

Personal ambitions:

1. Improving the ability to manage projects in terms of complex challenges and time management. For this thesis, I want to practice and improve my ability to keep an overview of the tasks that need to be done and own a sense of control over the project. This includes estimating how long certain tasks will take and what is possible within the stated duration of the project. Also, I aim to calmly and effectively overcome complex challenges and to always stay one step ahead.

2. Gaining experience in stakeholder management and executing effective meetings. During this thesis I would like to improve my skills in keeping people well informed and involved in the progress of the project. Additionally, I would like to become better at effectively preparing and leading progress meetings.

3. Gaining knowledge and skills in performing quantitative research. During my studies I have only performed a limited amount of quantitative research projects. For my thesis I therefore want to step out of my comfort zone and do a quantitative research, where I learn about survey testing and statistical analysis.

4. Learning about consumer behaviour and psychological theories. The user is the most important stakeholder in Industrial Design Engineering. I therefore want to improve my ability to understand and map out what drives people's behaviour and how we can leverage those factors.

5. Improving interview skills and qualitative analysis. Interviewing is a very important part of qualitative research. I aim to become more comfortable and skilled in conducting interviews. Additionally, I have only done qualitative analysis in a group where we could discuss and help each other. This thesis allows me to experience doing a thematic analysis on my own, which is a challenge I am happy to take.

1.2.2 Project structure

Several research and design methods are employed in this thesis. The project is for the most part a research project, where only the ending phase consists of designing. The findings and conclusions that are derived from the empirical research, form the basis for formulating design opportunities to help design interventions for behaviour change. The full structure of the project is depicted in Figure 3.

Research steps
This study uses a mixed method approach (Johnson et al., 2007) using both qualitative (interviews) and quantitative (questionnaire) research methodologies. First a literature review is performed to explore some key elements of the project brief, using a narrative approach (Gregory & Denniss, 2018). Then based on the literature review results a research gap and target behaviour change is defined. To identify drivers and barriers of the targeted behaviour, an initial conceptual model is proposed that explains the aimed intentional behaviour. Subsequently, interviews are conducted to gain a deeper understanding of the intentional behaviour and the factors that might influence individual's intention. Subsequently, the conceptual model was revised and refined based on the additional rich insights.

Once the conceptual model is complete, it is statistically tested using PLS-SEM (Hair et al., 2011) in Smart-PLS.

Design steps
Based on the results, design opportunities and strategies are defined that give a direction for designing interventions. A creative ideation session is organized to generate as much solutions for each design opportunity as possible. The session design was based on the Integrated Creative Problem Solving framework (Buijs & Van der Meer, 2013). The end result of the thesis are the design opportunities and strategies, and one example of a design intervention per opportunity. Diverging, reverging and clustering techniques have been used all through the design phase and partly in the research phase.

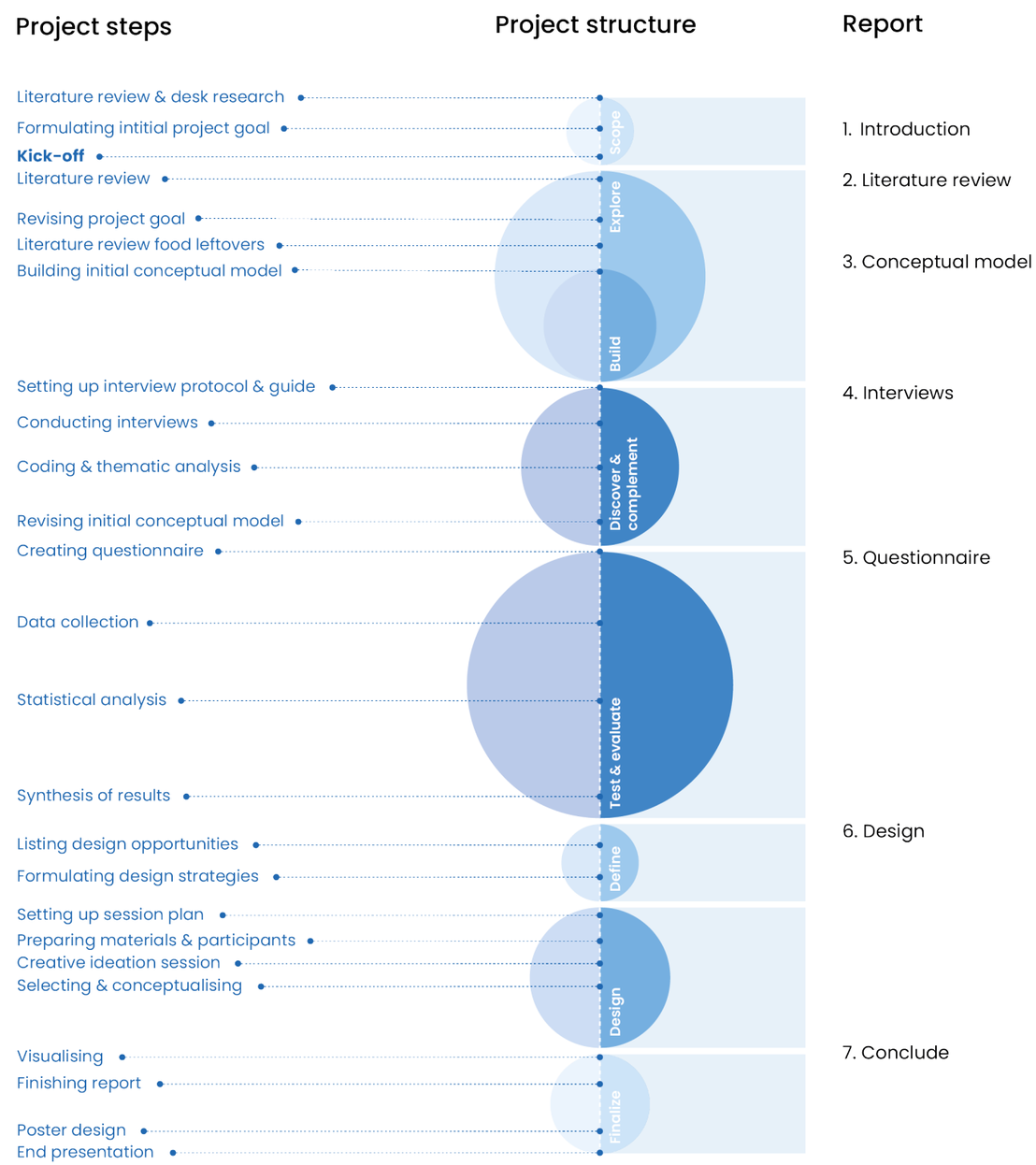

Figure 3: Project approach and report structure.

Chapter 2

LITERATURE REVIEW.

This chapter contains a literature review on the meaning of sufficiency, why the term sufficient consumption was developed and which sufficiency strategies exist. Furthermore, it explores strategies that people can undertake to move towards a more sufficient lifestyle within the food domain.

The chapter ends with a revised and refined project goal and research questions for this thesis.

2.1 The sufficiency concept

This section introduces the concept of sufficiency and the meanings that it has been given in literature. It also describes what it would entail for individuals and which strategies have been or can be taken to initiate the shift towards a sufficiency lifestyle along the population.

Methodology for literature review
A literature review was done to gain a deeper understanding of the subject and to collect information to create a theoretical framework. The literature review was done through a narrative approach (Gregory & Denniss, 2018). Both qualitative and quantitative as well as mixed-method studies were included in the review. The review was done following a sequence of subjects. At first, the literature about sufficiency in general was reviewed, whereafter specifically in the food domain.

The articles were found through Web of Science, Science Direct and Google Scholar. Keywords used were 'sufficient consumption', 'strong sustainable consumption', 'food consumption sufficiency', and 'sustainable food practices'.

An overview of the literature was kept by making use of the reference manager Zotero.

2.1.1 Introduction to sufficiency

Sufficient consumption, also known as sustainable consumption or 'enoughness', has recently gained significant attention in many different disciplines within the academic literature. Research has been done on sufficiency in relation to sustainable consumption behaviour (Di Giulio & Fuchs, 2014; Kropfeld, 2023), philosophy (Kallis, 2017), energy economics (Samadi et al., 2017), ecological economics (Steinberger & Roberts, 2010) and more. Although this is a positive development, this has not yet lead to a generally accepted definition (Daoud, 2018).

The lack of shared understanding makes that sufficiency plays an abstract role in sustainability thinking and research, making it difficult to attribute a meaning to it (Jungell-Michelsson & Heikkurinen, 2022). However, it does have a clear connection with the environment and the natural limits of our planet, addressing the fact that we are living outside the planetary boundaries and overconsumption should be diminished (Alexander & Rutherford, 2020; Lehtonen & Heikkurinen, 2021).

One of the areas where the trade-off between consumption and the planetary boundaries is most evident, is the food domain. As Berners-Lee et al. (2018) explain, the way to sufficiently feed the growing population in the future will not be solved by increasing the production, because a limit exists in efficiency gains. Rather, changes to our consumption patterns and the reduction of food waste are the necessary measures to take towards a sustainable and equal food system (Berners-Lee et al., 2018).

2.1.2 Individual needs and responsibilities

Sufficiency is often presented in literature in a sociological or behaviouralist context, where it is treated as a voluntarily simplicity strategy where one rejects the currently dominating consumerist values (Jungell-Michelsson & Heikkurinen, 2022; Lehtonen & Heikkurinen, 2021). The understanding of sufficiency here is that it is a consumer-based concept, focused on individual responsibility (Allievi et al., 2015; Kropfeld, 2023; Schmidt & Matthies, 2018). This is why sufficiency has also been linked to various social movements including voluntary simplicity (Boulanger, 2010) and down-shifting (Geels et al., 2015). Here it seems that sufficiency entails questioning the widespread tendency of always wanting more and better, as Spangenberg & Lorek, (2019, p. 1071) call it "the antithesis to 'faster, further, more' orientation of the consumer society." They argue that sufficiency implies restructuring the household consumption, meaning that there is the same amount of satisfaction with less new material goods, while being satisfied with the material goods that were already acquired. Additionally, satisfaction is also acquired by immaterial social goods. Important is that being satisfied does not mean a loss of quality of life, but rather a reassessment of needs where these needs are fulfilled in a more sustainable way, while overconsumption is avoided (Jungell-Michelsson & Heikkurinen, 2022; Spangenberg & Lorek, 2019). Thus being satisfied does not necessarily imply 'less' in a negative sense, but rather an intuitive feeling of 'enough' (Gossen et al., 2019).

This perspective allows us to make a distinction between superfluous and necessary consumption, which entails consumption that does not lead to basic needs fulfilment and consumption that does satisfy human needs respectively (Spangenberg & Lorek, 2019; Wiedmann et al., 2020). However, the level of basic needs or the feeling of having 'enough' is not necessarily the same for every individual. In the search for understanding what sustainable development entails and the meaning of the concept of 'the good life', Di Giulio & Fuchs (2014) argue that people consume in pursuit of certain goals, and these goals are individually felt needs. This is potentially conflicting with sustainable development goals, since the heavy use of resources of affluent lifestyles jeopardizes the chances of others to have sufficient access to resources. The food system is a good example of this. Access to food and food security have been named as one of the central challenges of this century, since food is not equally divided across parts of the world (Diaz-Ruiz et al., 2018).

They therefore argue that sufficient lifestyles should not only have a minimum level of natural and social resources, but also a maximum level of resources that people are entitled to. This implies that sustainable and sufficiency lifestyles lie in a 'sustainable consumption corridor', meaning they are situated between upper limit of sustainable use and a lower limit of the necessary use (Di Giulio & Fuchs, 2014; Wiedmann et al., 2020). Another example of such a model is the 'Doughnut Model' (Raworth, 2017)(Figure 4), where the inner circle represents the 'social foundation' including all the basic human needs. These are things like water, food and energy. The outer circle represents the 'ecological ceiling', which includes boundaries like climate change and land conversion. This model illustrates that no one should fall below the lower limit, the social foundation, and no one should cross the upper limit, our ecological ceiling. As long as we stay within these two limitations, we are in a responsible and safe space for humanity, where everyone can live a wealthy life (Ross, 2019).

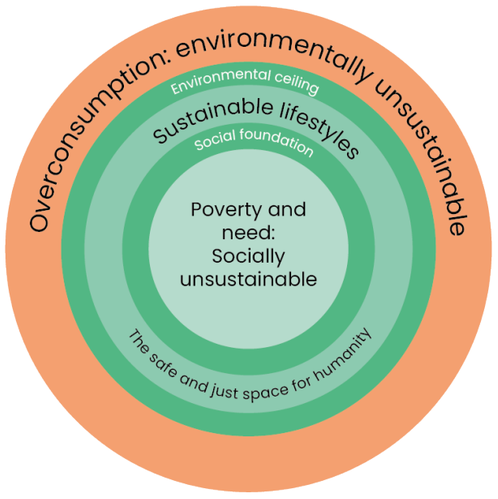

Figure 4: The safe and just space for humanity.

In light of these corridors, it is clear that the affluent population now consumes above the maximum level of the corridor and therefore exceeds the planetary boundaries, and a big portion of the world now lives below the minimum level (Ross, 2019; WWF, 2020). In relation to the food domain, this becomes evident in the wide availability and access to food in the affluent parts of the world and the insufficient access to food in quantity and nutritional value in the poorer parts of the world (Berners-Lee et al., 2018; Kowalewska & Kołłajtis-Dołowy, 2018). In the more affluent societies, this does mean that measures should be taken to for example avoid or reduce the material consumption until the consumption level falls within the planetary boundaries (Spangenberg, 2014).

2.1.3 Sufficiency strategies

It is clear that sufficiency is widely understood as an end, where it is seen as a worldview or a way of life. However, to get to this end of sufficient consumption, it is also important to consider the way to. Recently, sufficiency has therefore also been researched as 'a means to', where it is conceptualized as a strategy. Aiming to bringing consumption and production down within natural limits of the planet (Jungell-Michelsson & Heikkurinen, 2022).

The research fields where these strategies adhere to, widely differ. For example, sufficiency has been described as a "strategy for sustainable development" (Verfuerth et al., 2019: 374), and a strategy for sustainable consumption (Crivits et al., 2010), where they focus on changing individual behaviour. Other scholars argue that behavioural changes are hard to establish, without changing the social and institutional environment (Lorek & Spangenberg, 2014; Pettersen, 2016; Spangenberg & Lorek, 2019). Therefore, governance also plays a role in this, where policy measures like legal rules and economic incentives are part of their toolbox. However, to change the 'way that things are normally done', scholars argue that social norms and cultural meanings have to evolve (Spangenberg & Lorek, 2019). Social initiatives and innovations are argued to have large potential impact in this, and governance should play a facilitating role, to help spread sustainability activities amongst communities so individuals will pick this up more easily (Gossen et al., 2019; Lorek & Fuchs, 2013). Enforcing this will not be done by policy interventions, but it will potentially accelerate it. This for example can be done by creating space for experiments with new sustainable practices or renewing existing practices within households. Another way is to perform campaigns to stimulate change. Important is that these campaigns are focused on subjective motivations, values and norms, and raising awareness on the fact that people overestimate the cost of behavioural change (Spangenberg & Lorek, 2019).

Some scholars also argue that businesses have a responsibility in changing the social and economic environment that is now mostly focused on the consumption of products. Business studies mostly have done research on promoting sustainable consumption through marketing means (Gossen et al., 2019; Gossen & Kropfeld, 2022). Next to that, as Jungell-Michelsson & Heikkurinen (2022) explain, sufficiency can be found both in behavioural change as well as the production side. When it comes to businesses, this also includes changing their business models (Bocken & Short, 2016; Nesterova, 2020; Niessen & Bocken, 2021). One of the suggestions mentioned is that companies put more focus on immaterial oriented services, that do not have to do with buying material goods but to enhance social activities and personal ability improvement. Examples could be group activities or music lessons (Gossen et al., 2019).

This is also in line with the arguments that a large portion of human needs can be fulfilled by social processes and social interactions with other humans, instead of material goods (Kronenberg, 2007). This way creating satisfaction in a different way and keeping material consumption within the planetary boundaries (Spangenberg, 2014). It is also mentioned that the focus should be put on the benefits, like well-being and happiness - often feelings reported when participating in social initiatives and movements - than what people will 'lose' (Nesterova, 2020; Ziesemer et al., 2019).

Lastly, scholars have argued that education can play a role in creating awareness but also in building knowledge about sufficient lifestyles (Ross, 2019; T. Wiedmann et al., 2020; Ziesemer et al., 2019). The topic of consumption should be integrated in the curriculum to strengthen the consciousness of children. Mostly hands on experiences for students, where they are brought in contact with local resources, can create enthusiasm and understanding (Ziesemer et al., 2019). Moreover, people who are adequately informed about overconsumption, are better able to understand the individual and societal consequences. Resulting in the ability to make more responsible purchase decisions, reducing the quantity but increasing the quality (Ziesemer et al., 2019).

In conclusion, a lot of different strategies and angles have been discussed as starting points towards a more sufficient oriented society. Although policy measures have been mentioned as most effective in changing consumption patterns, governments are reluctant due to concerns about consumer response and the influence of strong lobby groups from businesses (Lorek & Spangenberg, 2014). Related to this, businesses are also reluctant towards promoting sufficient lifestyles, since they are still largely driven by the neo-liberal thinking and strong sustainable consumption is not in their short-term interest (Lorek & Spangenberg, 2014). Since a change in the demand-side can have a large impact with bottom-up initiatives (WWF, 2020) and individual changes in lifestyles can be relatively fast implemented, this research will only focus on the behaviour and personal decisions of individuals.

2.2 The way back to the safe consumption space

In this section, an exploration is made through literature on different sufficiency lifestyle changes people can take. This exploration is performed on four different types of consumption changes and an overview is visualised.

2.2.1 Behavioural measures for sufficiency transitions

Given the planetary boundaries and the urgence to return and remain in the safe operating space (Rockström et al., 2009), we have to face that drastic changes are to be made. The unlimited freedom of choice, which is the standard in affluent populations today, is no longer viable and should be fiercely restricted to ensure a good quality of life for the whole world population (Lorek & Spangenberg, 2019). The question is, how can households and individuals adapt their lifestyles to reduce their environmental impact and make their way back to the safe consumption space?

Recently, Sandberg (2021) made an effort to clarify the field by systematically reviewing the literature on sufficiency and summarizing it into a typology for consumption changes. This resulted in four types of consumption changes: (1) absolute reductions, (2) modal shifts, (3) product longevity, and (4) sharing practices. These four types of changes in individual-collective consumption can provide a starting point to determine what individual or collective actions can be taken, to reduce the consumption levels.

In her research, Sandberg (2021) provides an example overview of what these sufficiency practices might entail in the mobility domain (Table 1). This example is focused on private car ownership.

As explained in the name, absolute reductions entails lowering the quantity of what an individual consumes (Sandberg, 2021). Modal shifts entail that an individual changes their mode of consumption to a more environmentally friendly one (Lettenmeier et al., 2019). As seen in Table 1, absolute reduction entails for example shorter distance travelled, while modal shifts can be a shift from using a private car to taking public transportation. It is useful to make a distinction between these two measures. This is because they both have the same result, namely the distance travelled in a private car is reduced, but the way to is different. While the modal shift to taking the public transport resulted in a less resource-intensive way of travelling, travelling shorter distances reduce private car use in absolute terms. This indicates that with a modal shift, people continue the practice of mobility in a different form, whereas implementing absolute reduction measures leads to the practice being reduced or completely eliminated (Sandberg, 2021).

The consumption change types product longevity and sharing practices have to do with making the usage of existing products more efficient, eventually resulting in less demand of new products. When a user increases the lifespan of a product, they extend the time that the product is used and delay the purchase of a new one (Cooper, 2005). With sharing practices, the product gets shared with other individuals, which allows for more efficient use of resources and fully utilizing the capacity of the product (Frenken & Schor, 2017; Plewnia & Guenther, 2018). In the car example, this would mean extending the lifetime of the existing private cars, resulting in a reduction of new cars being bought. Meanwhile, sharing practices would mean that a number of individuals share existing cars, reducing the amount of cars that are needed (Sandberg, 2021).

Table 1: A classification of the four types of consumption changes that sufficiency may involve.

Type of consumption change	Definition	Example
Absolute reduction	Reducing the amount of consumption	Travelling shorter distances
Modal shifts	Shifting from one consumption mode to one that is less resource intensive	Shifting from private car use to public transportation
Sharing practices	Extending product lifespans	Prolonging use of existing vehicles
Increasing longevity	Sharing products among individuals	Car sharing among individuals

Photo taken by Alfred Kenneally (2019), Retrieved from Unsplash.com.

2.3 Sufficient food consumption: Applying consumption changes

Possible actions that could be effective to reduce environmental damage to ecosystems in the food domain, is amongst others sustainably increasing yields, reducing waste and changing our dietary choices (Díaz et al., 2019). This implies that our food consumption patterns as well as the consumption levels should be changed.

As a starting point, the four consumption changes of Sandberg (2021) are used to explore and review sustainable food practices mentioned in literature, that can be undertaken by individuals. In Figure 5, an overview of the identified sufficiency strategies within the food domain is depicted.

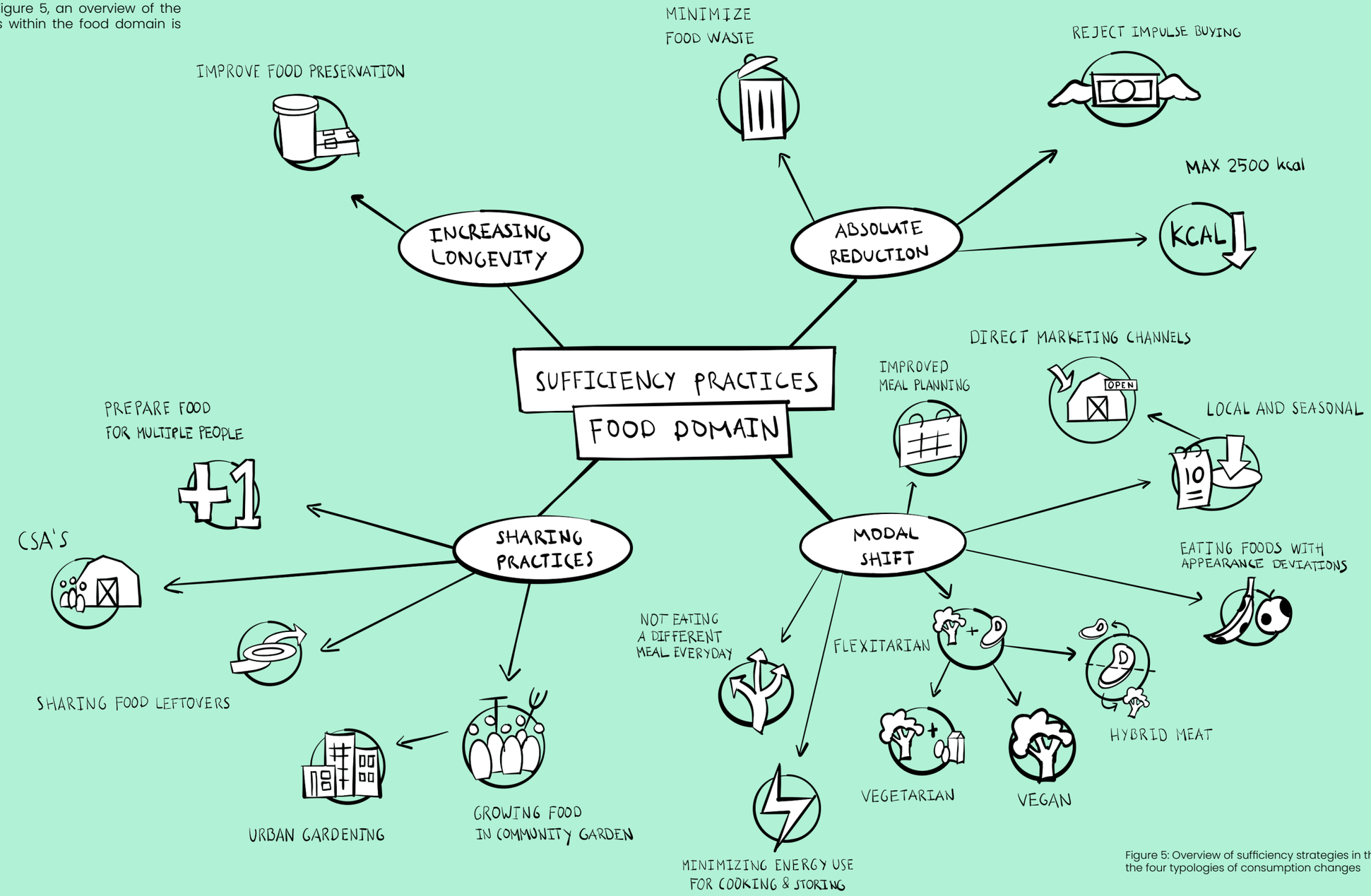

Figure 5: Overview of sufficiency strategies in the food domain based on the four typologies of consumption changes

2.3.1 Absolute reduction

The first typology, absolute reduction, is about reducing the absolute amount of consumption. In the food domain, the most obvious absolute reduction would mean lowering the amount of calories you eat to the point where you eat a sufficient amount for good health. Other ways to lower the absolute amount of consumption in the food domain is to buy less food through impulsive buying and to reduce the amount of food you waste. In these two cases it is more about lowering the absolute amounts of food that you buy instead of what you consume.

Eating less food

A significant part of the affluent population eats more calories than they need every day. Since 1975, the rate of people that are obese around the world has tripled (WHO, 2011). Simply eating less, meaning you do not eat more than you need to ensure good health, can directly reduce the environmental damage you have on the environment. Obesity is a large problem and it is the most basic and evident result of overconsumption (Garnett, 2008).

Bajželj et al. (2014) calculated a healthy diet that reduces the intake of energy rich food in regions where diets are projected to exceed recommended levels for good health. This diet still provides enough protein and a daily caloric intake of no more than 2500 calories.

Rejecting impulse purchases

Studies have shown that excessive buying is an important factor that drives food waste (Janssens et al., 2019; Lahath et al., 2021; Stancu et al., 2016; Stancu & Lähteenmäki, 2022; Stefan et al., 2013). This also has to do with the fact that people get driven to impulse purchases through marketing stimuli, especially people who score higher in impulsive buying tendency (Stancu & Lähteenmäki, 2022). By reducing the impulsive purchases of foods, the household waste can be reduced (Stancu & Lähteenmäki, 2022).

Reducing food waste

The population is wasting an unsustainable amount of food, which greatly contributes to carbon emissions levels. In 2021, society produced around 931 million tonnes of food waste and 8-10% of the global carbon emissions are linked to this produce that is unconsumed (United Nations Environment Programme, 2021). Although food waste occurs all throughout the production and supply chain, the biggest percentage of food waste occurs at the consumer stage (Janssen et al., 2017; Zeinstra et al., 2020). Causes for food waste have a lot to do with people's behaviours and food habits. According to literature things like falling for marketing tricks, unorganized provisioning behaviours, not re-using food leftovers and insufficient awareness and motivation are causes of food being wasted (Schanes et al., 2018; Stancu et al., 2016; Stefan et al., 2013). When the amount of food waste declines, the total amount of food that gets produced would in theory also decline (Stancu et al., 2016).

2.3.2 Modal shifts

The second typology, modal shifts, implies for the food domain that people eat the same amounts of food, only in a more sustainable way. The most important strategies include changing dietary choices, like consuming less meat and dairy. Other strategies have to do with the food we acquire and how we acquire it, like buying more local grown and in season products, buying directly from the farmer to cut out harmful transport pollutions and accepting foods that have appearance deviations. Lastly, shifts could be made in how we plan and prepare our meals. Using less energy to cool and heat our foods, better planning of meals to reduce food waste and being prepared to eat the same meal more than one day are examples of these strategies.

Reducing meat consumption

The first and foremost mentioned strategy towards a more sustainable diet, is eating less meat. A substantial body of research has found that shifting from a meat-heavy diet to a predominantly plant-based diet has arguably the highest potential to reduce the environmental impact of nutrition. (Lettenmeier et al., 2019; Willett et al., 2019).

In the Lettenmeier et al. (2019) report, they made a distinction between a vegan and a vegetarian diet. Although both will have a very strong impact reduction of the per capita carbon footprint, a vegan diet has a stronger effect than a vegetarian diet.

One way to achieve vegetarian or vegan diets is through the consumption of meat substitutes. It is proposed that the amount of land needed to grow the crops to produce meat substitutes is less than the land needed for keeping animals (Stehfest, 2014). Studies have shown that meat substitutes are not only better for the environment, but also favourable for health and ethical benefits (Apostolidis & McLeay, 2016).

Recently, a new concept called 'hybrid meat products' have been developed, where meat and plant based ingredients are mixed into one product. The idea is that this product has the advantage of having the nutritional benefits from plants, but with the meaty texture and taste (Grasso & Goksen, 2023). Research has shown that for some meat products, a 50% replacement of meat by plant based food can reduce the greenhouse gas emissions up to 32% (Baune et al., 2021).

Reducing dairy consumption

In the European Union, the consumption of dairy accounts for on average 27% of the greenhouse gas emissions (Sandström et al., 2018). Keeping cow's for producing dairy puts an enormous pressure on the environment. A US dairy cow is being fed a 100 pounds of food per day and a 545 liters of water is needed to produce less than 3,8 liters of milk (Milk's Impact on the Environment, 2019). Reducing the dairy intake is an important strategy of getting towards a sustainable diet (Westhoek et al., 2014).

Local Seasonality

One of the dietary changes that is proposed to be more sustainable, is eating more seasonal and more local food (Garnett, 2008). Consumers all over the world are now used to the year round supply of fresh foods and goods, due to increased international trade. This is made possible by intensifying agriculture, technological innovations and the extension of natural production. This has created a food culture where there is a supply of a very diverse set of food, that were previously not available in many developed countries. These products are virtually non-stop available at supermarkets. This has not come without consequences and put a high cost on the environment with an increased use of energy and more land use change. Moreover, due to an increased use of monocultures in farming, the biodiversity has decreased in loss of species as well as in crops (Fanzo et al., 2013; Macdiarmid, 2013).

There is some discussion what a seasonal diet actually means, since foods that are produced in season in another country but then imported somewhere else, could also be defined as seasonal grown (Vargas et al., 2021). The DEFRA suggested two definitions: Global Seasonality and Local Seasonality. The first definition is food that is produced in its natural growing period, but is not necessarily consumed where it was produced. The second definition is food that is produced outdoors without excessive use of energy by creating a modified climate, and is consumed in a region close to where it was produced (Brooks et al., 2012). According to results of a few case studies, Brooks et al. (2011) affirm that applying the local seasonality definition is more likely to be beneficial for the environment than the 'global' definition. The rise in global trade has increased the travelling distance of products from the place of production and consumption, increasing the risk of food loss in transportation and distribution (Facchini et al., 2018). This also points to the necessity of eating more locally.

Direct marketing systems

Eating more seasonally locally could also imply buying directly from the farmer or agricultural community farms (Boer et al., 2020). This shortens the transport distances between the place of production and consumption, reducing the risk of food loss (Priefer et al., 2016). Moreover, by making more visible to the consumer how food is produced and what the natural seasonal limits are of food types, consumer are encouraged to a more responsible handling of the food (Priefer et al., 2016).

Although direct marketing improves the efficient use of food, it can never fully replace the regular supermarket for most people, due to seasonal constraints (Priefer et al., 2016).

Not eating a different meal everyday

A lot of people nowadays have the habit of cooking a different meal every single day. Cooking in bulk for more days, is more energy efficient than cooking all those meals in one go. However, there should be taken in account that when the food does not get eaten, there will possibly be more food waste (Garnett, 2008).

Food appearance deviations

Often, retailers set high aesthetic standards for their products that they sell, which results in a large scale rejection of perfectly edible food in the production stage. This is accompanied by supply agreements with retailers, pushing farmers to overproduce (Priefer et al., 2016). Studies have also shown that in some cases people do prefer products that do not have deviations. de Hooge et al. (2017) showed that people for example do not have a problem with a vegetable that has a shape deviation, but they have less acceptance for a fruit that has a colour deviation spot.

Meal planning

Studies have shown that better meal planning can reduce the amount of food that is wasted in the end (Aschemann-Witzel et al., 2015a; Janssens et al., 2019; Stancu et al., 2016). One of the aspects that result from poor meal planning, is that people don't use the food that they have bought or that thay they buy food that they already owned but weren't aware of anymore (Stancu et al., 2016). However, this behaviour of consuming more 'planned' can be inconsistent with the 'convenience foods' that are offered by retailers and the presence of marketing stimuli (Baker et al., 2009; Stancu & Lähteenmäki, 2022). This is because these things often lead to people buying products in the spur of the moment which compromises the idea that people only buy the products that they need for the weekly meals plan that they made (Baker et al., 2009; Janssens et al., 2019).

Minimizing energy use for cooking and storing

Cooking and storing foods in a more energy efficient way, can reduce the environmental impact on our eating habits. Things like having a cold basement room in the house, minimising the use of an oven or microwave and possibly the use of smart metering can reduce the energy used and saves money (Garnett, 2008).

2.3.3 Sharing practices

The third typology, sharing practices, is less obvious for the food domain. The most exemplary is to cook in bulk for more people to conserve energy use for cooking and to share leftover foods. Other options have more to do with communities, wherein people take care of their own food together. Here people share a farm or garden to grow fruits and vegetables and occasionally keep animals.

Agricultural communities
Related to buying directly from the producer, people increasingly form or join communities where they grow their own food, or support and share risks with a farmer. One of the most well-known examples are Community Supported Agriculture(CSA) initiatives (Sumner et al., 2010). In these communities, households subscribe to the harvest of a specific farm. This allows people to directly buy organic and fresh food, while providing a more secure source of income for the farmer.

In the Netherlands an example of this are the 'Herenboerderijen' where households buy a share of a community owned farm, where they can pick up weekly harvests of fruits, vegetables and animal products (Herenboeren - Samen voedsel produceren, 2024). These communities not only provide food, but also organize many group activities like farming the land together or workshops to improve the community feeling.

Urban gardening
Another example of communities and growing your own food are urban gardens (Thomaier et al., 2014). These are gardens situated in cities and can have multiple forms like open rooftop farms, greenhouses and indoor farming. These initiatives originated mostly from the desire to reconnect the consumption in cities with the production of the food (Thomaier et al., 2014).

Sharing leftovers
With food, sharing can also be taken literal, where it is considered a sustainable practice to share leftover foods with other people. One study for example examines how people could share leftover foods through social media (Hsieh et al., 2021).

Prepare food for multiple people
Another option is to try to cook for a bigger group of people. When cooking in bulk, the amount of energy you use for a meal decreases. It can therefore be beneficial to also cook for example for other household members or neighbours (Garnett, 2008).

2.3.4 Increasing longevity

For the last typology, increasing longevity, there is really only one strategy that can be employed, which is making sure the food that you buy stays good for as long as possible. For households this means using the best techniques as possible to store food.

Improve food preservation
One of the reasons of the fact that households waste a lot of food, is the level of skills and knowledge about how to preserve food (Aschemann-Witzel et al., 2015b; Priefer et al., 2016). People make mistakes in which products should or should not be stored in the fridge, prematurely removing packaging or not sealing food correctly (Exodus Research, 2007). One study shows that less food was wasted when it was a frozen food instead of a fresh or ambient food. This shows that by encouraging people to buy their food in frozen form, can reduce the amount of waste (Janssen et al., 2017).

2.4 Findings and conclusions

In this section, the findings in the literature review are discussed. One of the identified sufficiency lifestyle changes is used to further scope the project. The revised and refined project scope is explained and the accompanying research question is formulated.

2.4.1 Findings and scope

By means of the four typologies of consumption changes by Sandberg (2021) and the definition of sufficiency that was defined in the beginning of this research (e.g. bringing our consumption levels back to a more purely functional level in what and how we acquire and use), 19 consumption changes towards a sufficient lifestyle within the food domain have been explored and mapped out.

By applying as much of the identified consumption changes as possible to people's own lifestyle, the closer they will move towards a sufficient lifestyle. However, the adoption of a consumption change doesn't go overnight. A lot of drivers and barriers exist, that influence people's motivations and possibilities to transition towards a more sufficient lifestyle. In this next section we scope the project down to one of the 19 consumption changes, that we will further research in this thesis. The decision is based on where there is still a lot to win in terms of impact and where there is a possibility to add to literature.

Food waste
Although shifting from a diet consisting of a lot of meat, to a predominantly plant based diet has arguably the highest potential to decrease the environmental impact of nutrition (Lettenmeier et al., 2019; Willett et al., 2019) the reduction of food waste has also been identified as a very important way to reduce people's impact on the environment (United Nations Environment Programme, 2021). Of all food that gets produced, nearly one-third of edible food is wasted each year (Gustavsson et al., 2011). Calculated in weight, in 2021, this comes down to nearly 931 million tonnes of food waste produced by households, retail establishments and the food service industry. Of this waste, nearly 570 million tonnes was produced at the household level.

The United Nations has included the reduction of food waste in their Sustainable Development Goals (SDGs), aiming to halve per capita global food waste at the consumer and retail levels, as well as at the production stage, by 2030 (United Nations Environment Programme, 2021).

The amount of food wasted differs greatly between parts of the world. The per capita food waste of people in Europe and North-America is between 95-115 kg per year, while in sub-Saharan Africa and South(East) Asia this only lies between the 6-11 kg per year (Gustavsson et al., 2011). Globally, households are responsible for almost two-thirds of the total amount of food waste that is generated (United Nations Environment Programme, 2021). In the affluent parts of the world, most of the waste occurs at the consumption stage. For example, in Europe, more than 50% of the total amount of food waste occurs as consumption waste (Kummu et al., 2012). A lot of this food was first edible or still is suitable for human consumption and therefore the waste was avoidable (Gustavsson et al., 2011). Moreover, if the waste of food happens all the way at the end of the supply chain, all the used resources and pollution that come before it reaches the consumer, were for nothing (Figure 6) (Cucurachi et al., 2019; Schanes et al., 2018). It is estimated that 8-10% of the global greenhouse emissions has to do with food that is not consumed (United Nations Environment Programme, 2021).

Thus, for developed countries, the food waste mainly relate to consumer behaviour which means that the most important focus lies on fighting food waste at the consumer level (Kör et al., 2021). With the growing population it is even more essential to understand why people waste foods at their households and there is still a lot to win (van Geffen et al., 2020).

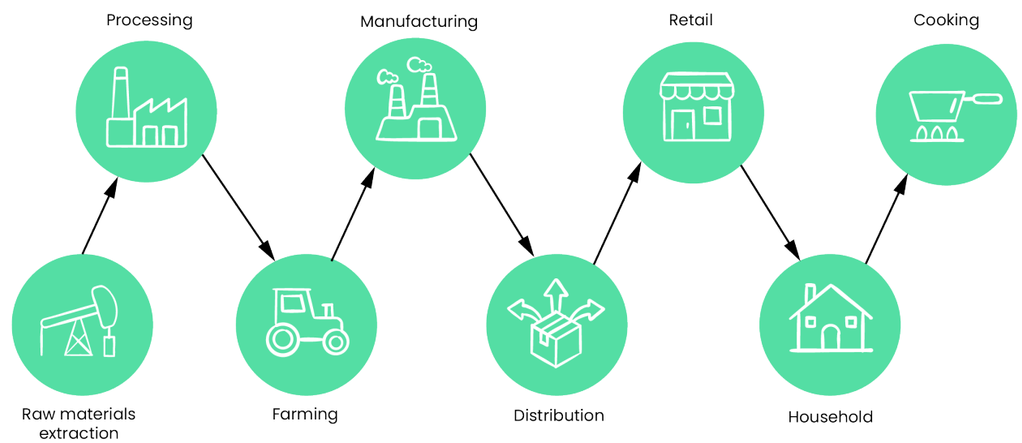

Figure 6: Overview of steps in the food life cycle.

Leftover food waste
A large body of research exists on food waste in general, but less research has been conducted specifically on food leftovers in households and is even identified as an under researched area (Andrews et al., 2018). Often studies use a broad perspective on the causes of food waste and focus on food provisioning, storage and the preparation of meals, with leftover being one small part of this (Kör et al., 2021; Stancu et al., 2016; Zeinstra et al., 2020). This is notable, since the correct use of food leftovers is identified as one of the most effective strategies to reduce food waste (Schanes et al., 2018; Stancu et al., 2016) and are therefore seen as one of the main area to focus on (Aschemann-Witzel et al., 2019; Katajajuuri et al., 2014; T. Quested et al., 2013b; Schmidt & Matthies, 2018; Stancu et al., 2016). It is therefore important to understand people's perceptions, beliefs and behaviours specifically on leftovers.

In the study done by Diaz-Ruiz et al. (2018), a connection is made between different waste management and preventative frameworks to food waste. One of the frameworks is the waste hierarchy defined by the Waste Framework Directive (European Parliament, 2008), where different preventative measures are described (Figure 7). In the article is stated that preventative measures are the strategies with the most potential to reduce impact. Meaning that it is important to reduce the generation of food waste. One of the measures in prevention of waste is to re-use. As mentioned earlier, studies exist on the prevention of food waste and the reduction at source, where the focus lies for example on shopping and planning habits (Stancu et al., 2016; Stefan et al., 2013). However, re-use has been and under highlighted and under researched measure.

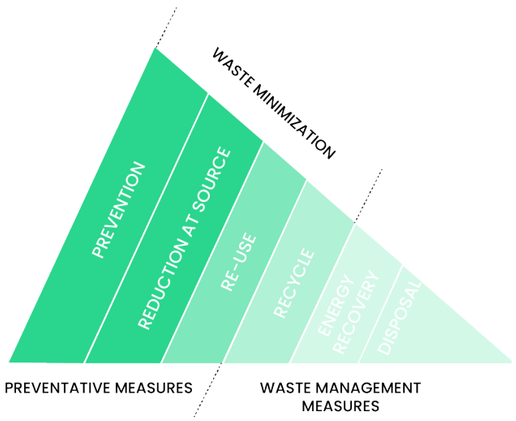

Figure 7: The waste hierarchy.

Moreover, reducing food waste and specifically re-using food leftovers is a very exemplary measure of sufficiency. On a worldwide scale, by preventing food waste, the availability of food throughout the supply chain is increased. This strengthens the opportunity to feed the entire population and in turn lower production which decreases the environmental impact (Stancu et al., 2016). This helps us move back to the safe consumption space.
On an individual level, re-using leftovers aligns perfectly with the definition of sufficiency. It emphasizes the mindful use of resources to meet needs without excess. Re-using leftovers is a practical approach that aligns with sustainable consumption principles by minimizing waste and maximizing utility from already purchased food. Leftovers still contain the necessary nutrients to feed the body and can therefore fulfil a basic need (Kowalewska & Kołłajtis-Dołowy, 2018). Why buy new food, when you already have at home? In short, it is about a conscious choice to respect and maximize the value of the resources we have, leading to the rejection of buying unnecessary new products.

To conclude, to the best of the authors knowledge, there has not been a quantitative research done specifically on the re-use of food leftovers in the Netherlands. This thesis therefore aims to better understand the factors that influence the re-use of food leftovers and complement the findings in literature.

Additionally, this research project aims to form a basis for finding opportunities to design for behaviour change. Meaning that this project will not only provide new insights for the literature, it will also provide design guidelines and examples of opportunities for interventions. This way the end results are not only a few recommendations and suggestions for action, but it will also provide a translation to actual interventions.

2.4.2 Revised project brief

Now that the subject for research has been further scoped, the project brief and goal are adapted to the more specific topic.

The revised project brief is therefore stated as:

*"Determine **drivers and barriers** and develop **design strategies** accordingly, to enable individuals to **re-use food leftovers** on a household level."*

Thus, the aim of this research is to deepen the understanding of people's intentional behaviour around food leftovers by examining the role of attitudes, beliefs, norms, awareness and the abilities of people. By using the outcomes, design strategies can be developed accordingly to enable individuals to re-use their food leftovers.

In general, leftovers have been defined as food that were intended to be used in a meal as an ingredient but were left surplus or food that has been used in a meal but were left over (Andrews et al., 2018). In this paper we also use these definitions, where we define food leftovers as a) food that was prepared for a meal, but not plated and b) ingredients surplus that were not used in the meal.

In the waste management hierarchy, re-use includes reusing the product as-is or re-use with modification (European Parliament, 2008). In this research, we define re-use as making leftovers part of a new meal where the meal partly or fully consists of leftover meals or leftover ingredients.

Research question
With the revised project goal, the main research question for this project is defined as:

*"Which **factors** act as barriers or drivers for **re-using food leftovers** and how can we design **interventions for behaviour change** to enable people to re-use food leftovers?"*

Next steps
Now that a gap in literature has been identified and the project is sufficiently scoped, a conceptual model can be build to identify the specific drivers and barriers for the re-use of food leftovers. When the factors have been identified, design strategies to overcome barriers or leverage drivers can be developed.

Chapter 3

CONCEPTUAL MODEL.

In this chapter, a literature review is written on the possible factors or antecedents that act as barriers or drivers for the intention te re-use food leftovers on an individual level.

First an exploration is done on existing psychological theories that explain how people shape their behaviour. Then a review is performed on factors that have been named in literature as possible drivers or barriers for the re-use of food leftovers.

3.1 Psychological theories

In this section a review of existing psychological theories is performed. The theories and constructs are used as a basis to formulate factors that are expected to have an effect on the intention to re-use food leftovers.

In order to understand which factors influence the re-use of food leftovers, the possible perceptions, drivers and barriers should be put in a broader theoretical framework to gain a deeper understanding of the consumer behaviour around re-using food leftovers. Traditional frameworks like the Theory of Planned Behaviour (TPB) (Figure 8)(Ajzen, 1991) have been successfully used in previous studies about food waste (La Barbera et al., 2022; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016). The model is used to predict behaviours in which people have a voluntary control over the behaviour, but that control is sometimes incomplete (Ajzen, 1991). As explained in the model, people need to have a sufficient level of confidence that they have control over the behaviour. When people have enough self-efficacy over the behaviour, the likelihood of performing the behaviour is higher (Bandura, 1977).

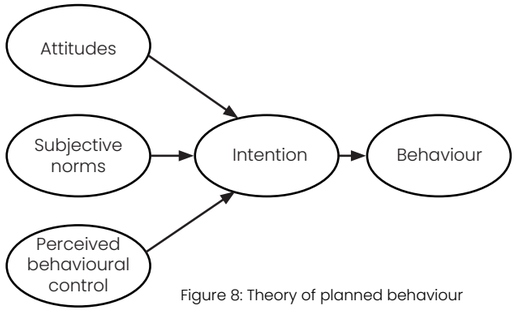

Figure 8: Theory of planned behaviour

This is also in line with another behavioural model; the Motivation-Ability-Opportunity model (MOA)(Figure 9), where it shows that people not only need motivation but also a sufficient opportunity and ability to perform the behaviour (Ölander & ThØgersen, 1995). Ability consists of knowledge and skills of people to be able to perform the intended behaviour. The MOA model has not been widely applied in food waste studies yet, but some qualitative studies show that it can explain food waste behaviour (van Geffen et al., 2020).

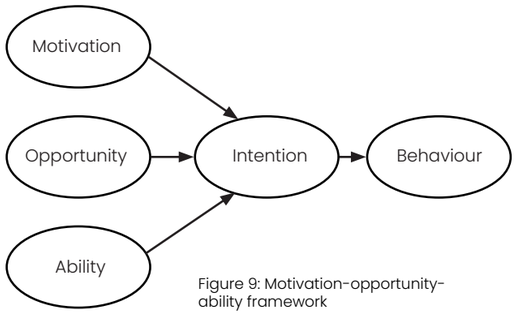

Figure 9: Motivation-opportunity-ability framework

Additionally, some studies have added factors derived from the Norm Activation Model (NAM)(Figure 10)(Schwartz, 1977). This model explains altruistic and environmentally friendly behaviour. As the name of the model shows, the theory explains that personal norms have an effect on the behavioural intention. This norm is affected by people's awareness of the consequences of certain behaviour and if they feel they have a responsibility to change their behaviour. Studies that try to explain all kinds of pro-environmental behaviour, including the reduction of food waste, have added the personal norm (Savari et al., 2023; Shin et al., 2018; Stancu et al., 2016; Visschers et al., 2016). Other studies also included awareness of the consequences in their study about food waste reduction with success (Attiq et al., 2021; Principato et al., 2015).

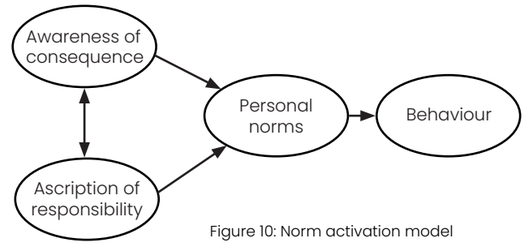

Figure 10: Norm activation model

Building on existing psychological behavioural theories, can improve the strength of the theoretical framework for explaining the intention to re-use food leftovers. Constructs of the three models described will be used as a handhold to create a conceptual model, complemented with findings from literature.

3.2 Factors of leftover re-use intentions

In this chapter a literature review is written with the factors or antecedents that were found in previous studies about food waste and other pro-environmental behaviour. These antecedents can be used to build a conceptual model that explains the re-use of food leftovers.

3.2.1 Intention to re-use food leftovers

The Theory of Planned Behaviour (TPB) states that the intention to act out a certain behaviour, is the most important antecedent of that behaviour (Ajzen, 1991). As literature shows that people generally do not like to waste food (Graham-Rowe et al., 2014; Quested et al., 2013a), their intentions are likely to drive their behaviour around re-using their food leftovers. The TPB is a social-psychological model that explains people's motivation to act out a certain behaviour. Some scholars have expressed doubts about the effectiveness of the TPB in determining someone's behaviour, since context factors often prohibit people from acting out such a behaviour even if they are motivated (Evans, 2012; Quested et al., 2013a). Things like the lack of time for cooking a completely new meal with leftovers (Cappellini, 2009; Cappellini & Parsons, 2012), having to sort and store leftovers which is space intensive (Cappellini, 2009; Farr-Wharton et al., 2014; Schanes et al., 2018) and unexpected events (Evans, 2012; Scalvedi & Rossi, 2021) may inhibit people from acting out their intention. However, studies also found that when people's intention to avoid food waste is higher, the actual amount of food that they waste is lower (Janssens et al., 2019; Stefan et al., 2013; Visschers et al., 2016). This shows that even though people sometimes are hindered in translating their intentions to action, a higher intention still leads to people performing a behaviour more often.

Therefore, there is reason to believe that the intention to re-use food leftovers also has a direct influence on the actual behaviour and that makes it very important to determine what drives people intentions to re-use their food leftovers.

3.2.2 Attitude towards the re-use of food leftovers

One of the antecedents of people's intentions towards acting out a certain behaviour are their attitudes (Ajzen, 1991). This is how people in general evaluate acting out the behaviour and whether that is favourable or not favourable. This attitude is shaped by the likely consequences or experiences of that behaviour. This means that people shape their attitude towards a behaviour based on consequences that they expect to happen or their experiences that they have had when acting out the behaviour (Ajzen, 2006). The more favourable the attitude, the stronger people's intention to act out the behaviour. For example, one of the commonly mentioned reasons why people evaluate eating leftovers as negative is that they perceive leftovers as less fresh and tasty. This decreases the desirability of leftovers and results in a decrease in food waste reduction behaviour (Aleshaiwi & Harries, 2021; Principato et al., 2015). Also, research has shown that people who have a higher level of disgust sensitivity, tend to throw away more food (Egolf et al., 2018).

On the contrary, findings also show that some food types are preferred a day after since they supposedly taste better then (Andrews et al., 2018).

Previous studies about food waste have shown that attitudes have a strong effect on the behavioural intention to reduce food waste (Graham-Rowe et al., 2014; Stancu et al., 2016). We therefore hypothesize that positive attitudes towards re-using food leftovers have a positive effect on the behavioural intention.

3.2.3 Personal norms

People's emotions have been linked to the re-using of leftovers behaviour. Studies have found that people often feel a moral obligation to not waste food (Lee, 2018; Watson & Meah, 2012). This is often accompanied with a feeling of guilt when throwing away food (Stefan et al., 2013).
Stangherlin & Barcellos (2018) and Quested et al. (2013a) even identified the feeling of guilt as one of the major motivators of food waste reduction. In a study done by Visschers et al. (2016) they found that personal norms not only have a strong positive effect on the intention to reduce food waste, but also a direct positive effect on the actual behaviour. This was also found in a study done by Parizeau et al. (2015) where people who voice more feelings of guilt, produce less food waste. One study also found that moral obligations have a positive effect on the attitude of people (Kirmani et al., 2023).

Studies have shown that personal norms play an important role in all kinds of topics related to environmental behaviour (Mondéjar-Jiménez et al., 2016; Morren & Grinstein, 2021). This implies that personal norms could play a key role in the intention to re-use food leftovers, which is also hypothesized according to the Norm Activation Theory (Schwartz, 1977). We therefore hypothesize that personal norms have a direct positive effect on the attitude and intention to re-use food leftovers.

3.2.4 Skills in processing food leftovers

In the literature is mentioned that knowledge and skills about how and when to use leftovers, is an important factor in the re-use of leftovers (Aloysius et al., 2023; Aschemann-Witzel et al., 2015a; Graham-Rowe et al., 2014; Stancu et al., 2016; van Geffen et al., 2020). The competence in evaluating leftovers, both in the manner of how to use them but also how to store them, is important (Farr-Wharton et al., 2014). This could however, be difficult. It is not always clear for people how to handle leftovers since they are in an ambiguous space between a meal and an ingredient, and between fresh but not yet spoiled (Cappellini & Parsons, 2012).

The classification of whether leftover foods or ingredients can be part of a new meal, or whether they need to be disposed of is an ongoing action and people constantly re-sort or reframe the leftover foods from potential ingredients to waste (Cappellini, 2009). This includes skills like classifying, selecting, storing and transforming leftovers into new meals (Cappellini, 2009). As Cappellini & Parsons (2012: 127) mention, food is always 'in process' meaning that the classification of food being surplus of a meal to waste, can happen at any time. Food becoming waste has to do with the fact that leftovers need to be re-used in a certain amount of time, otherwise they will decay or go rotten. This is influenced by knowledge about proper storing (Koppel et al., 2016; van Geffen et al., 2020) but also the skills of people to plan ahead when they will eat their food or leftovers (Quested et al., 2013a; Stancu et al., 2016). Therefore, material knowledge about the quality of the foods as well as the ability to think forward about the storing and use are both important (Cappellini & Parsons, 2012; van Geffen et al., 2020).

However, reasons for the leftover foods moving along this 'edible to waste process' are diverse and often context driven (Watson & Meah, 2012). Possible direct reasons could be that people forget about it (Evans, 2012), or unexpected events such as the sudden preference of ordering takeaway (Cappellini & Parsons, 2012; Scalvedi & Rossi, 2021). This implies that busy lifestyles and unexpected events can impact the plan on using leftovers (Evans, 2012), even if people declared they were skilled in using leftovers (Scalvedi & Rossi, 2021). Still, the loss of food leftovers are under significant control of household members (Stancu et al., 2016). The confidence and competence of people in using leftovers is an important factor in this. Unfortunately, in many households the recipes that are used are often fixed, meaning that they have a certain repertoire of recipes they make and this is often tied to the preferences of family members (Cappellini, 2009; Evans, 2012). This in turn results in that people only cook recipes that they have already tried before, instead of trying new recipes. Consequently, this means that people often have limited ideas for a new use for leftover ingredients, resulting in it going to waste (Evans, 2012). Clearly, the eventual throwing away of food does not always only have to do with the intrinsic value of the leftovers, but also on the ideas that a person has of the possible re-use of the foods. The proficiency and the ability of a consumer in how to handle food, shaped by what a person has learned and experienced in the past, might have a significant effect on the behavioural intention due to the fact that the confidence in their ability is higher (Stancu et al., 2016). Creating awareness and facilitating knowledge building to improve the skills of people utilizing leftover food more creatively, can help in ensuring that leftover foods get eaten before the expiration (Farr-Wharton et al., 2014). In the context of the intention to re-use food leftovers, skills to do so are specially important. We therefore hypothesize that skills in processing food leftovers has a positive effect on the intention of people to re-use their food leftovers.

3.2.5 Awareness of the consequences of food waste

Within the subject of food waste, there have been rather contradictory results about the awareness of the consequences of food waste. Many studies have found that people rarely or never make the link between food waste and environmental consequences, but rather a waste of money (Farr-Wharton et al., 2014; Graham-Rowe et al., 2014; Watson & Meah, 2012). On the other hand, there are some studies that have shown that the awareness of people and concern of the overall food waste problem, is positively related to food waste reduction intentions and behaviour (Attiq et al., 2021; Principato et al., 2015; Stancu et al., 2016) and it has been mentioned in one study as an important starting point (Aschemann-Witzel et al., 2015a). In the study of Stancu et al. (2016), the awareness of environmental and social impact was mostly significantly related to the psycho-social factors like attitude and norms, but it also had a small significant effect on food related routines about the handling of leftovers. This implies that awareness of the food waste problem can have an effect on people's overall evaluation of re-using leftovers and their attitudes. Moreover, studies about other pro-environmental and social behaviour have also found that the awareness of consequence can have a positive effect on people's attitude towards the behaviour (Han, 2014; Savari et al., 2023). Additionally, according the Norm Activated Model, awareness of consequences of one's actions when not acting pro-socially, positively affects one's personal norm towards acting out such behaviour (Savari et al., 2023; Schwartz, 1977).

The awareness of the problem of food waste and the effect on the environment, might enhance the motivation of consumers to act out anti-wastage behaviour and therefore possibly the re-use of food leftovers (Aschemann-Witzel et al., 2015a; Quested et al., 2013a; Stangherlin & Barcellos, 2018). In the Netherlands the environmental awareness has increased the past few years, where now 6 out of 10 people believe humans are mainly responsible for climate change (CBS, 2021). In a questionnaire done by the European Investment Bank, it was found that 67% of Dutch people would support the labelling of all food products with the climate footprint that they cause (EIB, 2023). This shows that Dutch people are both concerned about the environmental impact on the products they use, as well as the impact specifically caused by food production. Therefore, we hypothesize that the awareness of the food waste problem and the environmental consequences, has a positive effect on the attitude and the personal norm of people towards reusing their food leftovers.

3.2.6 Sensory appeal

Taste is of course one of the most important factors of food. These factors like smell, visual, touch and taste explain the attractiveness of the food (Teng et al., 2022).

When the attractiveness of the food is higher, it motivates people to eat it up. The perceived freshness of the leftover foods has an effect on the desirability of the food; the less fresh, the more gets wasted (Aleshaiwi & Harries, 2021; Principato et al., 2015). The attractiveness of food when it is from a day or more earlier could therefore decrease. Sometimes people perceive leftovers as unclean and have a feeling of disgust (Aleshaiwi & Harries, 2021). This happens for example when food has been touched by others already or it already has been partially eaten by someone else (Hsieh et al., 2021). Research has shown that people who have a higher level of disgust sensitivity, tend to throw away more food (Egolf et al., 2018). Research also shows that the when food has a higher sensory appeal to people, they tend to waste it less (Gaiani et al., 2018). This is also reflected in that people who find sensory appeal more important, tend to shows more dining-out leftover prevention behaviour (Teng et al., 2022). On the contrary, findings also show that some food types are preferred a day after since they supposedly taste better then (Andrews et al., 2018). Thus, research shows that the sensory appeal of food might have an effect on the intention to re-use food leftovers. We therefore hypothesize that sensory appeal has a negative effect on the attitude towards the re-use of food leftovers.

3.2.7 Perceived health risks

In light of food safety, people often perceive health risks with eating leftovers and are unsure how long they can safely eat it (Andrews et al., 2018; Farr-Wharton et al., 2014; Watson & Meah, 2012), which results in more food getting wasted (Principato et al., 2015). This also has to do with the often wrong interpretations of expiry dates (Principato et al., 2015). Generally, people who have a lower risk perception of eating leftover foods, throw away less food (Schanes et al., 2018). People judge whether the food is still edible in different ways. Some keep track of how many days the food has been sitting, others use the look, taste, texture and smell of the food (Aleshaiwi & Harries, 2021; Andrews et al., 2018). Studies also mention the behaviour of 'procrastination', where people postpone the unpleasant feeling of wasting food leftovers until they are really spoiled and no longer good to eat (Porpino et al., 2016). In line with this was the finding in the study of Andrews et al. (2018), where the description of the food when people throw it out, were very extreme. Meaning that the foods were indeed in a far state of decay and people felt justified to throw them away. This is an example that shows that people usually feel less guilty throwing away food when it has gone bad, instead of when it is still perfectly edible (Schanes et al., 2018). This is possibly because people then no longer have doubts about the edibleness, and they know they can't use the leftovers anymore. Anxiety of becoming ill can be a strong barrier for people to consume their leftover foods, since it is not always easy to determine if food leftovers are still edible. Especially when the food is in a grey area where it is old but not yet spoiled.

Although the perceived health risks are deemed as important to mention as a possible antecedent for the re-use of food leftovers, it is for now chosen to not put it in the model before the interviews. The reason for this, is that in this thesis a limited amount of factors are to be put in the model to prevent the questionnaire from becoming too long and to keep the necessary amount of responses low.

3.2.8 Socio-demographic factors

With the re-use of leftovers, there are some interesting socio-demographic factors that possibly play a role. In several studies about food waste, socio-demographic factors were used (e.g. gender, age, educational level, household income) as control variables to gain a better understanding of their effect on minimizing food waste. The results are however, rather ambiguous. To see whether socio-demographic factors have influence on people's intention, we collect the information from the sample and use it in the analysis to compare with literature.

Household size
Studies have found that the bigger the household, the more food waste is produced. Especially families with children, where parents reported that they had trouble with predicting how much food their child would be eating or which family members will eat at home (Evans, 2012). Also, because more family members mean a bigger variety of food preferences, this results in a large variety of foods that were available at home. This is strengthened by the fact that people like to be a good provider, making sure that all family members have enough to eat and that the food is proper (Cappellini, 2009; Evans, 2012). This could also have an effect on the intention to re-use food leftovers, since the amount of food leftovers would sometimes not be enough to feed the entire family and therefore people would not store or use them (Aloysius et al., 2023).

Age
Studies have shown that the skills of storing and cooking with food leftovers is moderated by the age of the consumer, where older people have more knowledge and experience with handling leftovers than younger people (Quested et al., 2013a; Roe et al., 2020). Older people also tend to be better at risk perception (Wang et al., 2020) and younger people make use of food leftovers in their meals less frequently (Roe et al., 2020).

Gender
One study done in the United Arab Emirates, reported that females tend to feel more uncomfortable in discarding leftovers than men and therefore reported to waste less leftover food (Osail et al., 2022). Also, one study in China found that women have better knowledge on how to process food leftovers than men (Wang et al., 2020). Since these countries both have a different culture than the Netherlands, the effect of gender on the intention to re-use food leftovers could be different in the Netherlands.

Education level
The level of education from consumers are important in managing food leftovers in the house, where a higher educational level is positively related to the knowledge and risk perception of handling food leftovers (Wang et al., 2020). In one study they also found that people with a higher education seem to make a stronger link between the environmental damage caused by food waste (Qi & Roe, 2016).

Household income
People or households with a higher income, might be less worried about wasting food since they have enough resources to buy new food. Studies have shown that households with higher incomes also report a higher amount of food waste (Stancu et al., 2016; Stefan et al., 2013).

3.2.9 Individual characteristics

Next to psychological constructs and socio-demographic factors, individual characteristics and personality traits might have an effect on the intention to re-use food leftovers. Two characteristics will be tested as background factors.

Environmental concern
Studies about reducing food waste have shown that concern about the environment has an effect on the motivation of people to reduce food waste (Aschemann-Witzel et al., 2015a; Stangherlin & Barcellos, 2018) and leads to behaving in a more responsible way due to the feeling of personal responsibility (Hamerman et al., 2017). Environmental concern has also shown to influence people's waste prevention behaviour, meaning that people with a higher environmental concern were more motivated to show waste prevention behaviour (Diaz-Ruiz et al., 2018). One study about the intention to share food leftovers found that environmental concern is a significant predictor for the attitude of people towards the practice of food-leftover sharing (Kirmani et al., 2023). Since re-using leftovers is also a waste preventing behaviour, environmental concern could possibly enhance people's intention to re-use their food leftovers.

Financial attitudes
Often, the concept of saving money has shown to be a powerful motivator in not wasting food (Stancu et al., 2016). This concept is multi-faceted, it could be that people do it because of the feeling of thrift (Graham-Rowe et al., 2014), or because they would like to spend the money saved elsewhere (Quested et al., 2013a). Moreover, people who are more price sensitive and conscious about their spendings, tend to waste less food because they want the money that they paid for it to be fully utilized (Visschers et al., 2016; Williams et al., 2012). This implies that people who are more conscious about the money they spend, might be more motivated to re-use their leftovers to reduce the amount of money they spend on food.

Photo taken by Cherie Birkner (2020), Retrieved from Unsplash.com.

Chapter 4

INTERVIEWS.

In this chapter the methodology and results of the interviews are described. The purpose of the interviews is to gain rich insights, collect observations and evaluate whether the conceptual model should be complemented with additional factors. First the procedure and methods of the interviews are given whereafter the results of the interviews are shown in a codescheme and an accompanying narrative.

The chapter ends with a discussion where the findings are described and compared to the literature. Additionally, the implications of the interview results for building the conceptual model are explained.

4.1 Methodology

In this section the interview procedure, methods and the sample are described. Additionally, the method for analysis is introduced and described in short.

The interviews were conducted in March and April 2024 during a course of two weeks. A total of 9 interviews were conducted, all with a duration between 30 and 55 minutes. 8 of the interviews were done at the participant's homes, 1 interview was done online. An overview of the sample together with the demographic information, can be seen in Table 2.

The recruitment of participants was done through purposive sampling, where characteristics were defined (age, gender, household composition) for which participants were recruited (Czernek-Marszałek & McCabe, 2024). The sample should at least contain one family household with children since it was shown that families with children in the Netherlands produce the most food waste (van Dooren & Knüppe, 2020). Furthermore, literature showed that there could possibly be slight differences in the attitude and behaviours between males and females when it comes to food waste (Osail et al., 2022; Wang et al., 2020) and people of older age are supposedly better at managing leftover foods (Roe et al., 2020). By trying to use purposive sampling, it was better assured that certain socio-demographic groups were interviewed, to get a more representative collection of insights and understand if some differences between these groups occur during the interviews.

The participants were contacted through WhatsApp, using a short explanation and introduction text message. Cell phone numbers were already available to the interviewer or were acquired through participants.

People were asked consent before the start of the interview through a physical consent form (appendix A). In the case of the online interview, the consent form was read to them and consent was given verbally.

The interviews were done in Dutch, to make sure people could comfortably and thoroughly explain their experiences, opinions and attitudes. The interviews were recorded with a recording device. The audio files were then transcribed through an online transcription software program and translated to English with the help of ChatGPT.

The collection of data, the data management plan and the consent form were approved by the Human Research Ethics Committee of the Delft University of Technology.

Table 2: Interview sample.

	Age	Gender	Household composition	Education level
Interview 1	25	Female	Shared household with 3	University master
Interview 2	25	Male	Shared household with 3	University master
Interview 3	24	Female	Couple household	University master
Interview 4	57	Female	Family household (including partner, one son of 17 still living at home, one son of 20 has left the house)	University master
Interview 5	63	Male	Couple household (children have both left the house)	University master
Interview 6	39	Female	Family household (including partner and three young children)	College education
Interview 7	53	Female	Family household (including partner, four children all living at home, youngest in high school)	College education
Interview 8	41	Female & male	Family household (including partner and 2 young children aged 4 and 6)	University master
Interview 9	23	Female	Shared household with 5	College education

4.1.1 Interview procedure

The interviews consisted of two parts, the first part was called a 'walk-through' interview, where the participants would show the insides of their fridge and kitchen cabinets. This walk-through part is based on the relatively new qualitative research method in design called 'contextual inquiry' (Holtzblatt & Beyer, 2017). The second part was an in-depth semi-structured interview (Mashuri et al., 2022) that was taken with the help of an interview guide.

Walk-through
The purpose of the walk-through part, was that the researcher could collect direct and possibly indirect observations in the context of people's homes. The main goal was to collect overt observations about what people consider as leftovers, which leftovers they select for re-use, how they store them and if they would be able to combine the leftover foods and ingredients that are in their fridge at that particular moment. The strength of a contextual inquiry is that people can show and explain activities in real time in the relevant context (Holtzblatt & Beyer, 2017). This results in that details and habitual behaviour that people would not always be aware of, become visible. When the interviewer is present, they can ask about what they see to the participant, who in turn can explain and even tell stories or past experiences.

To have the participant show this to the researcher, the researcher would ask three questions during the walk-through, that could be answered by demonstrating the content of the fridge and cabinets. Furthermore, the aim was to familiarise people with the contents of their fridge to make them more visually aware of what leftovers could possibly be and help them to further answer the questions in the interview.

The participants were only informed of the walk-through interview component through the informed consent form and participant instructions at the time of the interview, and not earlier. This was done so that people would not re-organize or clean out their kitchen contents before the interview would be done, compromising the trustworthiness of the findings. Before the walk-through part in the beginning of the interview, the participant was given instructions to state every thought they have out loud. This is so that the researcher understands what the participant thinks, which considerations they make and so that it could also be used for indirect observations in the transcript.

The researcher used an observation form (appendix C) where there was space to write down notes and key words for important observations. These notes were processed and written down in an online document on the same day as when the interview took place, to make sure the observations are still fresh in the mind of the researcher and they fully understood their notes.

In-depth semi-structured interviews
After the walk-through was finished, the interviewer and participant returned to the interview table to finish the rest of the interview. This was done through an interview guide which can be found in appendix B. There were 6 main questions and each main question contained 2-5 sub-questions. The interviewer would check whether all the questions and most of the sub-questions were answered.

When something was not fully answered or something interesting came up in the conversation, the interviewer would use some probing questions to gain more information from the participant.

4.1.2 Analysis method

The interviews were analysed through Thematic Analysis, according to the 6 phases described by Braun & Clarke (2006). An inductive coding approach was used to leave enough space to develop new theory from the interviews.

The researcher first familiarised herself with the data through transcription and translating them. This allowed to gain a good overview and knowledge of the data. During this phase, the researcher used memos to keep track of some ideas that emerged from going through the data.

When the data was ready, the researcher first did an initial coding round, whereafter an iterative process took place of merging, renaming or removing codes. The coding was done in the Atlas.ti software. When the final codeset was ready, the next steps of creating sub-themes took place where the researcher wrote all the final codes on post-its. This allowed for flexibility to move post-its around and adjust or create groups of codes. When the creation of sub-themes was complete, the main themes were made also by using post-its. In the final phase the results were visualised in a code scheme (Figure 11) and described in the narrative, which can be found in the results section of this report.

4.2 Results

In this next section the results from the observations and thematic analysis are described. The final themes, sub-themes and codes are depicted in a code-scheme, whereafter they are explained through a narrative.

4.2.1 Observation results

The results of the observations are written according to the three tasks that people were given during the walk-through part.

Task 1: 'Can you show me the content and leftovers that are in your fridge and kitchen cabinets?'

When this task was given, participants mentioned that they were not fully aware of what products or leftover foods they still had. These participants had to bend over and look closely at the back of the fridge and cabinets to see what products they owned. This was mostly the case when participants had shelves that were very full. In some interviews they had to move or even take out products to see what they still had at the back. This was quite a hassle.

When moving stuff out of the way, in three interviews people found a product that either had mould on it or was very far past the expiry date. In two cases people threw the product away on the spot. One participant put the products back exactly how she took them out of the fridge, including the mouldy product.

Students living in student housing had all divided the fridge. They would show that they have at least one communal shelve and the other shelves were divided amongst roommates. There was not a clear pattern found in the type of products or leftovers, or the amount of products that were on the communal shelves between the interviews. What students mentioned is that products on the communal shelve are put there when they are left over from a dinner that took place with roommates together. Leftover meals from dinner together were also stored there, since everyone joined dinner and they all have a right to still eat it.

None of the student participants showed a leftover meal or product in the freezer. The leftover meals that they had were all put in a Tupperware box in the fridge. The families however, all did have leftover meals in the freezer next to some leftover meals in the fridge. These leftover meals were amongst others a frozen pasta and frozen rice meal. One participant wrote the date on their leftover meals in the freezer, to remember when they put it in there. She mentioned that she then had to eat it within three months. One participant also had her leftover meal, a pasta, stored in the pan in the fridge.

Almost all leftover ingredients that people had were stored without any containers or in their original packages. All participants had vegetables left from cooking. They were found in the bottom drawer most often. In this drawer there was not a storing system to be seen and loose vegetables were mostly lying around all at the bottom covered by other products. They were either not stored in anything and were put there randomly, or they were put in their original packaging. Almost all participants had bags of leftover lettuce. Four participants also had leftover fresh herbs still in their original packaging.

When showing things people would mostly look at the shelves inside the fridge and not the door. Sometimes there were leftover ingredients, but these would be glass pots with sauces and other condiments. There were also eggs in the fridge door and drink cartons.

People had food stored in multiple places in the kitchen. Especially family homes had a bigger supply and stock of products. Two families had two fridges, one was all the way in the garage and one was in the basement of the kitchen. One family used the second fridge as a place where they would put products that would not fit in the first fridge or what they used less often. The other families mostly had a lot of stock foods in the cabinets and second fridge. Here they would take products that were used up so that they could resupply it.

One family had an old fridge design that opened like a drawer. Which means that you could see from the top what was in the fridge. This fridge then also contained three different drawers inside. The participant mentioned that she really likes this fridge design and she prefers this one over the new fridge designs, because from the top she has better overview of all the products in the fridge.

Task 2: 'Can you explain why you store your foods and leftovers the way you do?'

What was notable first and foremost, is that there is a big difference in how organized people's fridges are. Some people have a whole system in place, others do not have much of a conscious thought on how they organize their food but it is rather based on unconscious habits.

What did happen is that products that were used frequently were at the front and products that people did not use frequently were put at the back. Also, products that people described as products with a longer shelf-life were found at the back. This were mostly products in glass pots. One participant deliberately stored big things in the back, small things in the front. Mostly due to the lack of space so that she could still in some way keep an overview.

One participant put cling film over a vegetable to keep it more fresh. He also mentioned that they put leftover soups in the freezer so it stays good longer. Participants also mentioned that they put leftover meals in the freezer so it stays good longer and they can still eat it on a later moment in the future.

When people did think about how they store something, it was inside the fridge based on product type. They were then grouped together in compartments. Vegetables and leftover vegetables were almost always in the bottom drawer, other drawers contained groups of cheese, meat for on bread, spreads for on bread and sauces and condiments.

What was most important that people do not always have a conscious system to put the leftover foods and meals. It is mostly placed by frequency of use or product type.

Task 3: 'How would you make a meal out of the leftovers you have right now?'

When this question was asked, people would first look if there were leftover meals left in the fridge. If this was the case they would mostly say I would eat that and then I would possibly add something to it or make a fresh meal to the side. Usually by adding some bread or with a soup or salad. This was more often the case with families than people who only have to cook for themselves, since families have more people at the dinner table.

If there was no leftover meal, participants would first look for leftover ingredients that they would like to use. Two participants mentioned leftover cheese as a starting point for their meal for example. Then people would either go further through the fridge and look for leftover ingredients or they would walk over to the cabinets to find dry food like pasta and rice. Sometimes they did it the other way around. When choosing which leftover ingredients to use, people constantly evaluated if ingredients that they still had would match with each other in one dish. Often people would be able to envision a meal with what leftover food they have at home. Sometimes there would be already enough on forehand to make a meal, sometimes they would mention that they would buy something additionally in the supermarket. What was important is that most participants said that they most of the time match ingredients based on combinations they had seen before. Only two participants mentioned that they would sometimes make new meals that they have not really made before with their leftover ingredients, either by themselves or with help from a recipe.

The participants eventually all managed to make combinations of ingredients to create one meal. May it be with or without planning to buy some additional fresh products in the supermarket. The participants could fairly easily mention the combinations of ingredients without really having to search in the fridge, which was also due to the fact that they explained all the contents of their fridge beforehand. To know exactly what you have can therefore help to make it easier to build up a meal. The participants responded quite indifferent when they made the meal and it did not take them much effort or they were not really impressed by themselves. Some participants looked like they thought it was logical that they could do it.

Photo by Boxedwater (2020), Retrieved from Unsplash.com.

4.2.2 Thematic analysis results

The analysis of both the observations and the semi-structured interviews yielded three themes: (I) Difficulties of organizing; (II) Doing the right thing; (III) Ascribed value to leftover food. The overview can be seen in the codescheme in Figure 11. These three themes were based on 10 categories that shared characteristics resulting from 35 codes. The codes all contain a certain amount of quotations, hereafter written as [#qts]. The interviews are all anonymized, including the quotes that are used in the results section. The codebook can be found in appendix D.

CODESCHEME

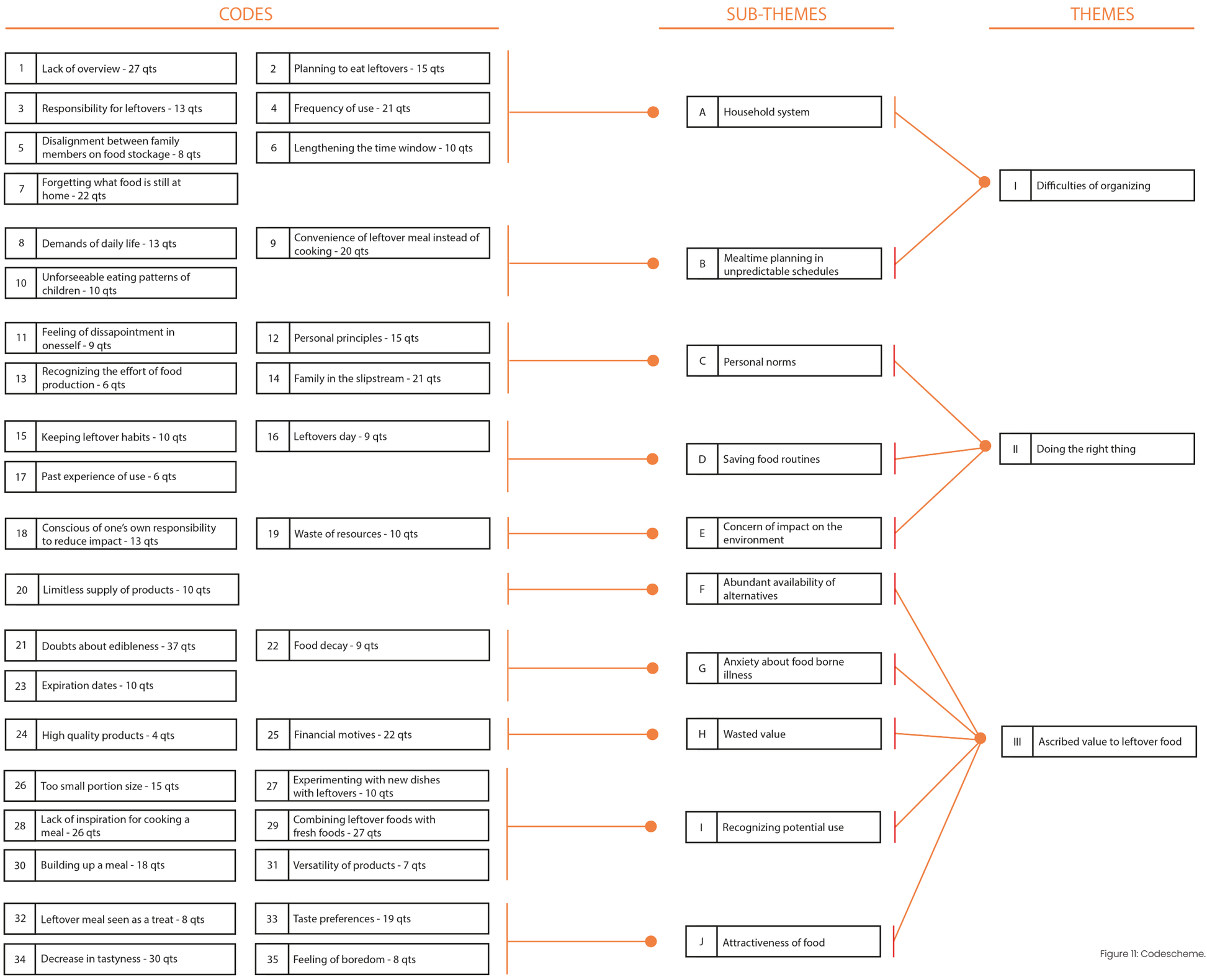

Figure 11: Codescheme.

Theme (I): Difficulties of organizing

The theme 'Difficulties of organizing' [159 qts] shows that it takes a certain amount of skills and organization to manage a household system that best supports the re-use of food leftovers, where it is also often hampered by external factors that make the management difficult.

Household system

Not having a well-organized storing system for the content of the fridge and kitchen cabinets, results in the **lack of overview** that people have of the contents. Often this is driven by the fact that some shelves are too full. This inhibits them from being able to see all the products they own and forces people to put in extra effort by having to move products or take them out the fridge.

"Because there's a lot on it and I always just throw everything on it. And then I don't know what's behind it anymore." – Interviewee 1

"Random. There's not really a thought behind it." – Interviewee 5

Especially products that are not **frequently used,** slowly but steadily move to the back of the fridge which also results in people **forgetting what they still have in stock**, preventing them from re-using their leftover products.

"We also have pots that, like many things, are placed in front and then gradually slide to the back." - Interviewee 5

"Hm, well often you just forget that you have something and it just disappears somewhere behind another product or something." – Interviewee 2

One participant on the other hand, has created a very organized system including determined positions for types of products, compartments and labels. This helps her to memorize and organize what she has, which has reduced the amount of food she wastes according to her.

"This, for example, is only for sauces and things, because otherwise, I'll find a bottle of Calvé sauce that's expired in half a year. So, I try to keep it very organized into sections, so I see what's there, and everyone knows where everything is. Otherwise, if you were looking in the fridge and then I don't see it." – Interviewee 6

The forgetting of products sometimes have to do with the **misalignment between household members in the storing of the food stockage.** This is partly due to the fact that a household member might put a leftover product somewhere else than another household member would, leading to not seeing that something is still there.

"I think I should also tell my girlfriend that I organize it this way so she doesn't mess it up. That's my system, you know, with the bigger things at the back and the smaller things at the front. Because again, what I don't see doesn't exist." – Interviewee 9

"And this is a bit mixed up right now, but that also depends on who's been in the fridge." – Interviewee 6

This also has to do with a lack of communication between household members on which leftovers are stored and the fact that someone has to take **responsibility for the leftovers**. When no one feels responsible for the leftovers, they get eaten less. In families it is often one of the parents who take the responsibility and either eat the leftovers themselves or make sure someone else eats them.

"Yes, usually I'm the one... who knows what's lying here. Kids generally don't know what's lying here." – Interviewee 4

"I can sometimes also get a bit angry when I think, there are now three good meals in the fridge. I have sometimes felt like I'm the only one who always eats those leftovers. While I do not always feel like it either." – Interviewee 4

This also clearly stands out in households where students share a fridge. The shelves are all divided between housemates and one shelve is kept as a 'communal shelve'. Here leftovers from meals or ingredients are stored to be used by anyone. This means that there is not one person responsible for the leftovers and often people only look at their personal shelve. Resulting in the fact that people are not aware of the leftovers that are there.

"I think I will first look at the bottom shelf, because I also know my housemates don't look here much. They put it down and grab it when it suits them. But it's really never that they think, oh, something is going to expire soon, let's eat it now. We just don't think about it. At least, I don't think about it. – Interviewee 9

"Or we cooked with the three of us and then it's on the communal shelf for a long time and then no one eats it and then it's there." – Interviewee 1

One important part of the household organization around eating leftovers is the ability of a person to **plan ahead for when they will eat the leftover.** When a person can foresee when they will eat a leftover, they are more likely to store it and later on actually use it. Especially when a person knows exactly when a leftover meal comes in handy, they purposefully plan it in advance.

"I think the main reason is still whether I can eat it within a few days or so. And if not, then not." – Interviewee 2

Due to the fact that it is not that easy to plan or foresee the chance that a leftover will be eaten, some participants try to optimally store leftovers to **lengthen the time window** that it can be eaten as much as possible. This includes wrapping a product nicely or storing as much as possible in a cold temperature or frozen. One participant deliberately stores a leftover meal in two separate smaller containers, to be able to take only one out if that is enough for the meal. This way she makes sure that there is not food left again which she then cannot freeze again.

"Here's a piece of red cabbage left. I put fresh cling film over it. And that red cabbage stays really good for a long time."- Interviewee 2

"Yes, those are just the potatoes when you buy a bag of 5 kilos and you don't use it right away, yes it has to lie somewhere. And here it lies cold, so here it stays good longer than if it would lie upstairs." – Interviewee 4

Mealtime planning in unpredictable schedules

Even though people would be willing to eat their leftovers and are aware of the fact that they still have a leftover meal or ingredients at home, the **demands of their daily lives** sometimes inhibit them. Cooking with leftover ingredients or thinking about how to make a full meal with leftover meals, is often not possible due to a lack of time.

"Hm... I don't really know. Maybe even more time. If I had more time for myself, with nothing.
Because when I have time, I often start cooking or...
Because that's now missing due to all the work and busyness, and then you do it less. Then it becomes more functional, so to speak. For example, last Sunday, I had time to think about what's all there and to make those sandwiches, for instance. Mainly time, yes." – Interviewee 6

This lack of time also translates in the fact that people do not have time to go home first to check what they still have lying around when they leave school or work and then end up buying new products instead of using their leftovers.

"Because of, I think, maybe laziness to go home first and check what you have. Or lack of time, lack of time can also be because sometimes I just don't have time to check, so I buy it in advance. And then afterwards, I see it and think, "Oh yeah, shoot." remember for next time." – Interviewee 3

Last minute changes in dinner plans, often inhibit people from eating their leftovers. Even if they were very willing to eat them and already had planned to eat them as well.

"Yes, it sounds silly, but just less chance of suddenly changing meal plans during the day.
So actually, I shouldn't accidentally run into my old housemate who says, "Hey, come eat with us tonight." If I don't run into them, so my social contacts go down, then there's a greater chance that I'll eat everything neatly." – Interviewee 3

These last minute unexpected changes also occur within families, where the **eating patterns of children are not always foreseeable**. The preferences of children cannot be easily predicted and whether they eat at home or not.

Also, the one week they like to eat a leftover before they go exercise, but the other week they do not. It is also occurs that children do not like to eat leftovers, because they do not like to eat the same thing twice or do not like the taste of it.

"Yes, then you have to eat something you may not feel like. Yes, it's kind of, the generation that thinks everything on demand. I don't feel like it. Like my son yesterday, then we eat at half past six and then he's just been to the kebab factory at five o'clock. Yes, then he's not hungry, because he wanted that more than, so, well, that's not so easy to steer." – Interviewee 4

"And then like, well, if someone might get hungry again soon, or feel like eating before exercising or whatever. Then maybe someone will take it out of the fridge later. Well, if it's still there after a week, yeah, then it has to go." – Interviewee 7

However, due to the busy lives of people and unforeseeable plannings, a **leftover meal is often seen as very convenient.** It is mentioned a few times that a ready leftover meal is seen as more convenient than leftover ingredients, because the convenience factor is the fact that they do not have to cook or think about what to cook. When people are tired, are in a rush or simply do not feel like cooking, they can grab a ready meal straight out of the fridge or freezer. This is on occasion even the reason why people cook more than what they need at that moment, because they know they want to eat a leftover at a later stage. In these situations, people purposefully create leftover meals.

"Cool, then I don't have to cook tomorrow, I'll just eat the rest tomorrow." Or, "Cool, I'll take it for lunch because then I don't have to make lunch in the morning, don't have to buy lunch, whatever." So, more out of convenience, really. Because usually, I might have to play hockey the next day, usually around dinner time, then I think, "Oh great, I can just eat a bit of yesterday's food before or after." – Interviewee 3

"Yes and so what I just said also to what extent it's already ready to eat. If you want to save some rice then you do have to do something with it afterward to make a meal from it. But if for example, you've just made delicious fried rice and there's a bit left then you already know of oh I can just eat that tomorrow without having to think about what else I need to do with it." – Interviewee 1

Sometimes these busy lives translate in the fact that people did not have the chance to buy groceries and for these moments leftover meals are kept as a last resort. Meaning that people sometimes keep leftover meals or products for a time when they do not have anything else left. This way the leftover meal acts as a back-up. This is also the case for when a child suddenly does not like the fresh meal and the pasta is meant as a back-up for these situations.

"And sometimes I save it for him, because, for example, we're eating something he doesn't like or doesn't eat. And then I always have pasta because he always eats that. So then I always have something on hand." – Interviewee 6

Theme (II): Doing the right thing

The second theme 'Doing the right thing' [99 qts] explains that people are guided by a strong belief that 'one shouldn't waste food' and therefore should always try to eat their leftovers. Driven by their personal norms that not everyone has access to food and their concern for the impact of food waste on the environment, motivates people to shape routines of saving and eating leftover foods.

Personal norms

When it comes to food waste, participants mention it is against their **personal principles.** People experience strong negative emotions when throwing away food. This feeling strengthens when the quantity of the food that gets thrown away is increased. If there are a few bites left, people have less trouble with discarding it then if it was a whole leftover meal that was not eaten. In the most extreme cases participants talked about quantities of food that get thrown away in restaurants or at their sports club. This elicits strong emotional feelings with people, where it is even mentioned that it 'hurts'.

"Then often food is cooked for large numbers, so I think for a hundred people. And sometimes in so much time, then a team has dish duty, so then you clean up the whole kitchen, and then you really see what's leftover and what's thrown away. And I find that... I don't know if that sounds exaggerated, but it almost hurts. When I see that." – Interviewee 9

People sometimes mention a feeling of guilt when they throw away food, because there are people on the planet who do not have food at all. Especially when a full leftover meal gets thrown away, the feeling that someone could have eaten that elicits a feeling of disliking food wastage.

"It just doesn't feel right. I just feel a bit guilty towards people who really need it. I could just throw it away myself, thinking, well, it wouldn't make my day any better or worse. But you know there are people in the world who don't have any food at all." – Interviewee 3

When people eventually did have to discard their leftovers, they often have a **feeling of disappointment in themselves** where they feel they could have done more to prevent the leftovers from being discarded. The moment of throwing the food in the bin acts as a moment of reflection, due to the fact that people visually see what they have thrown away. This also shows that people do see a certain responsibility for themselves to reduce their food waste.

"Well, I sometimes look in the green bin on the counter when there's all sorts of things in it. That goes into the green waste bin before I take it to the curbside bin, then I sometimes look at the curbside bin and think yeah it's quite full and not just with peels. So then I look at it and then you think can it be even less or something?" – Interviewee 6

"So, eh, and sometimes just irritation of damn, there were really six pans in the fridge downstairs, why didn't this get eaten or something. Yes. It still feels like you're not doing well enough." – Interviewee 4

It was mentioned a few times that the appreciation of **the effort that has gone into the production of food** plays a role. People should be conscious about the fact that someone either grew or made the food. A stronger personal connection between the consumer and the production is argued to be a motivator to put more effort in eating up all your food that you have bought.

"I think it's a huge waste. I also think that when you deal with it like that, people no longer know where it actually comes from. It's just there, we all don't know that anymore. So I'm very much for conserving as much as possible." – Interviewee 6

"For my family, it probably didn't matter that much, but for me, it does make a difference. Then I was also more motivated to look at how can I still use that? Because then I know how much effort has gone into it. I know the garden it came from. I know that farmer, so then you know how much effort has gone into it." – Interview 4

Parents that worry about the amounts of food that gets wasted, take their **family in their slipstream**. Meaning they try to incorporate their family members in improving their behaviours around food and food leftovers. This includes their children but also their partners. This way they try to convince their family members that they should also act more consciously about food wastage, sometimes even if they do not really want to. Participants mentioned that they have taken that along from their family home when they were younger, where their parents would save every bite that was left or regularly serve leftover meals.

"So all those things, eh, so talking about it and at least teaching my children, well, they are quite brainwashed whether they like it or not hahaha. But, so, to also pass on that it, that you don't get less quality of life if you waste less." – Interviewee 4

"Yes, I think so. I think so. I don't intentionally think, well, away with it, or something. And that I've also gotten a bit, [husband] is more like that, I've also gotten to the point where, if he once cleans up the kitchen and clears the table, then he knows by now that I want him to save it, so to speak." – Interviewee 6

Saving food routines

People acquire certain routines around leftover foods over time, where they develop '**keeping leftover' habits**. Things were mentioned like we always standard put leftover meals in tupperwares, or we never do. Or we always put it in the freezer. Sometimes this routine is influenced by the quantity of the food that was left, where if it is a very small amount, people would not save it. This is however mostly the case by a small amount of leftover meals. When it is a small amount of leftover ingredients, people tend to save it without much hesitation.

No yes usually I do save it. Regardless of what kind of product it is. – Interviewee 1

"No. No. At my parents' house earlier, everything was just thrown away. There it was just like, "Does anyone want to eat anymore?" No. At my parents' house earlier, everything was just thrown away. It wasn't kept. The only thing that was kept was Chinese food. If Chinese food was ordered, it was put back in those containers and then eaten again. But normal dinner was just always thrown away. Yes. That was just really standard." – Interviewee 3

What was notable, is that this routine can change over time, where people either change their habits around leftover foods due to a change in opinion about it or the other way around, where people stopped saving their leftovers because **they experienced in the past** that they eventually never use it. On the other hand, when people experience that they do always eat it, the habit is continued. One participant mentioned that she changed her opinion and routines around leftovers since she moved out of the student housing and into a home with her partner. Mostly because now she has to always take care of her food herself, where leftovers could help her reduce the time and effort she has to put in providing food for herself in her busy life.

"I think also just because I know from previous experiences if I do put it in a container then 9 out of 10 times I throw it away so that's then a sort of also the point of.....if you cook it now again and it's leftover and you already know those previous 10 times that I put it in a tub nothing was done with it so then I already throw it away now." – Interviewee 1

"And we tried that freezing for a long time, you know, and it just doesn't happen. It just goes away." – Interviewee 8

One routine that was often mentioned is leftovers day, where people organize a **leftovers day** every once in a while. On this occasion, people eat all the leftover meals that are still in the fridge or in the freezer. This was sometimes due to that people do not feel like cooking, lack the time for cooking or simply have the opinion that they should be used up at this time.

"Yes. Basically, anything I can freeze that's leftover, I freeze. And once in a while, we have a container day, and I thaw everything, and then everyone can choose." – Interview 6

*"But from nature, I also learned it from home. On Thursdays, we always had just leftovers.
Then we ate what was left." – Interviewee 2*

Concern of impact on the environment

In almost all interviews, people mention the impact that food has on the environment as one of the reasons why they do not want to waste food. Where they often mention the fact that many **resources are wasted** that have already gone into the production of the food, at the moment when they have it at home. Loss of water and energy is mentioned most often.

"Well, it's a shame to throw things away. And a waste of the process that went into it. So, everything that was needed to make it." – Interviewee 7

"And it's all been produced already, so there are also a hundred steps that have gone into it. Then I think, well, then I just have to use it as much as I can." – Interviewee 3

The participants also acknowledge that their own behaviours and decisions have an effect. They seem **conscious of one's own responsibility to reduce impact on the environment**. Participants believe that it has to do with the fact that you do not need to use up more than you need and that you need to be frugal about the stuff that you did already buy to also prevent the volume of waste created.

"Yes, one hundred percent. Yes, I also think if I exhibit the behavior every day that I had with my parents when I still lived there, so that every day all the food was thrown away, then I think we could almost fill a whole garbage bag per week with food that was thrown away. Just everything. And now I don't have that whole bag. So imagine that per family, it would save a whole bag of waste per week. Well, that's 52 garbage bags per year for one family. Well, there's not just one family on this planet, so that saves a lot of bags of waste." – Interviewee 3

"Then I wonder if I'm doing it frugally enough, so to speak, or if I can't make it more functional, so that you waste even less. Because I actually think that I contribute to that, I don't know, a part of it." – Interviewee 6

Theme (III): Ascribed value to leftover food

The third theme 'Ascribed value to leftover food' [260 qts] explains that driven by the perception of how valuable the leftover food is and the level of potential that they see in it to use it, people are more inclined to save leftover foods as well as use it up.

Abundant availability of alternatives

In the Dutch society nowadays, people always have quick and easy access to new products. Supermarkets offer a large variety of foods that are available all year round. For example, most supermarkets are even opened 7 days a week, from early in the morning until late in the evening. This means that people have a **limitless supply of products** and always have easy access to alternative new food, which reduces their motivation to use up their food leftovers. This also results in that people often have a lot of food lying at home, which makes it even easier to not eat the leftover foods but eat a fresh meal instead.

"Eh, if there's a war I definitely want to do that. But, but now I think. It's just too much hassle for me, it costs me too much time." – Interviewee 4

"I usually throw that away because I have so much extra of something else somewhere." – Interviewee 3

"But while I, suppose I make a lunch, where I need bread, avocado, egg, cheese, something like that. Then I think, oh man, it's just a few things, when I'm in the supermarket for example, oh it's just a few things, I forgot to look in the fridge, well, I'll just get it all." – Interviewee 9

Anxiety about food-borne illness

Not surprisingly, food that has been standing for a while, raises the uncertainty with people whether they can still use it. It is not always easy for people to see if they can still eat something. People have **doubts about the edibleness** of products when they are at a tipping point. It is this grey area where the products have either been lying around long, do not look perfect anymore, but they do not show clear signs of not being edible anymore. It seems as that people are not always able to determine the edibleness and therefore distance themselves from the products and put them back. This way they postpone the thinking efforts but also the emotions that come with throwing the product out. When people have doubts about the edibleness, they employ all kinds of strategies to determine whether it is still safe to use. Some people determine their own measures that they always follow, for example a specific amount of time that it has been standing in the fridge. This time span is often based or influenced by their past experiences of how long that specific product stayed edible. Some people always smell and taste the food. People differ in how quickly they are afraid of becoming sick, also between partners.

"Yes, that kind of for me. I just think a sort of measure in my head is just okay. If it's been in the fridge for a week then I have to throw it away. After that, I'm not going to eat it anymore."- Interviewee 1

"He's quicker to fear food poisoning or whatever. Whereas I think, well, let me taste it, it might be fine." – Interviewee 7

Expiration dates are also used to employ as a point in time that people can determine the edibleness on. It differs between people how sensitive they are to these dates. One participant mentioned that he knows that companies do that to prevent lawsuits from people that got sick from food, and that you can still eat it after. One person said he always throws it out once the expiration date has passed. Others do not really use the date and only rely on their senses.

"But I always think, I deliberately leave those things behind. Really, because I have the perception with it of, uh, yuck, that's not going to be good anymore tomorrow. It makes no sense, huh. But, um, just give me the latest best-before date, so to speak. I then search for it at the back of that, uh, compartment." – Interviewee 8

"But for the rest, yes. But here, for example, I see, oh well, it's a bit more than ten days, two weeks past its date. This I could still smell and possibly taste. So I wouldn't throw it away immediately, no." – Interviewee 9

Interviewer: "What do you do with expiration dates?" Participants: "Oh those, yes, I smell everything." – Interviewee 6

Not uncommonly, people find food in their fridge that has gone bad. **Food decay** is naturally the point where people draw the line. At this point, the food has lost all its value and people feel no doubt about throwing it away. On occasion, when the food is no longer suitable for human consumption, participants give the food to animals.

"And it doesn't fit in the sauce basket, so it disappears somewhere out of sight. And then I always find it with a layer of little plants on it. Yes well that has to go then. So I stopped doing that." – Interviewee 6

"Or I put it in the bird house. You know, so I try to find as much destination for it as possible. But, but spoilage is, eh, yes, that's really, eh, then it's just thrown away." – Interviewee 4

Wasted value

The fact that people don't like to waste food, has a lot of time to do with **financial motives.** Very often mentioned was the fact that people find it a waste of money when they did not use up their food leftovers. The more money it cost, the more people are inclined to put in an effort to use it all. Not only did people mention that money would be wasted by not using the product they bought, they also mentioned that by using leftover foods they did not have to buy new food which saves them money.

"Maybe things that also cost more. That are more expensive. If I have expensive meat at home, then it's either used up or I.... it doesn't get thrown away, so to speak. I almost never throw away meat." – Interviewee 6

"Well yes, it saves money if you use things you already have. Just make a cheaper meal by eating what you still have at home." – Interviewee 1

"Thriftiness, because that was, well I do not know, my parents had a period when things weren't going so well financially. And then we did eat....then really every bite was saved and everything had to be eaten."- Interviewee 4

One of the participants also mentioned that since she was the one that does the groceries, she knows better how much it all costs and how that increases her awareness to not waste the food. Since the other family members don't really have an idea on how expensive the weekly groceries are, they don't worry about the money that is wasted when throwing it out, according to her.

"Yes, I think it also has to do with buying it yourself. That you realize what you have to pay for the groceries too." – Interviewee 6

It is clear that people don't like to waste food, because the waste money and that this is even more the case with food that is more expensive. However, this is also the case with **high quality products.** Food that is perceived as qualitatively better is a reason for people to put more effort in re-using the food.

"And that it's just qualitatively very good food. And then, yes, I do have extra trouble throwing it away. " – Interviewee 4

"Additionally, I know that when it's of high quality and maybe more expensive, then I definitely never throw anything away." – Interviewee 9

Recognizing potential use

What stands out is that it is important that people have knowledge or inspiration about what they can do with the leftovers. **The lack of inspiration** can be an immediate barrier to re-use food leftovers. Especially with leftover ingredients it is very important that people almost immediately have an idea about what to do with it, otherwise the thinking step is perceived as too much effort and people end up not using the ingredients.

"So with such a half.....? I struggle more with that because then I still have to make something myself. So then that creativity is sometimes missing." – Interviewee 9

"But if I have to cook something new, then it stays for a bit longer. Then I have to make that extra thinking step again of, "What am I going to make with this now? Does it fit? Yes, I actually have three HelloFresh meals left. Why would I make a whole new meal with those other carrots?" So that just stays for a bit longer." – Interviewee 3

"Also because then the threshold, yeah, was just a bit higher to make something nice out of it, I think or something, and yeah, potato isn't, I do not know, potato is quite nice, but maybe not every day or something, I do not know. I wasn't really inspired to say, oh I'm going to make this now or something from it, no. You have to sort of have an idea of, oh then I'll make this from it or something." – Interviewee 2

When thinking of making a meal with leftover ingredients, people tend to try and see matches between what they have left. They try to **build up a meal** in their head where they first look for a basis of the meal and then see whether remaining ingredients could be matched and added. This is sometimes done purposefully, but it also occurs that people per accident open the fridge and see a leftover ingredient that they could add to a freshly bought meal.

"So for example, I see wraps lying there. Then I think, oh, that's a very good base. That makes me think, oh, that's enough for a meal for me, you know. Suppose those wraps weren't there. Then I'd think, ooh, that's going to be difficult for a meal. Because well, I have quite random things. I have fresh tuna salad, I have soy milk, I have veggie filet, I have an avocado....." – Interviewee 9

The participants mostly make something with leftover ingredients in dishes they are already familiar with. However, some participants sometimes try t**o experiment with new dishes with the ingredients they have left** and even see it as a fun challenge.

"It's sort of the syndrome of, you have so much choice in the supermarkets, so you just buy what you know or something, you know. While, now with that fridge, it's a bit limited. Then it's sort of a game of, okay, what am I going to do now, I have this, this and this, you know. Okay, well, that's quite a fun challenge." – Interviewee 2

Seeing the potential of an ingredient is also based on the **perceived versatility** of the product. When an ingredient can be used in many different types of dishes that the person knows, they are more inclined to save them but also to cook with it. One participant mentioned that lettuce for example, can be used in many meals and therefore always gets used.

"But if I'm indeed talking about the leek and the... well, those kinds of things. Then it's just not that common." – Interviewee 7

"And... Look, this is always here, bacon. And it always gets used, like, once. It's of course good until 20/4, so it's long-lasting. And it's something I didn't specifically buy to make something, but I think, oh, if I want to make pasta sometime, for example, then I can use this. And I'll use it sometime, in the coming weeks. And that's therefore longer-lasting." – Interviewee 7

A problem with leftovers is that people often find the **portion size too small** and they do not see the use of saving it, because it would not cover a whole meal. This sometimes even prevents them from saving the leftover in the first place. One participant mentioned that especially in their large family household, the leftover is not enough to feed everybody, and since she already has to go the supermarket to buy the meal, she would buy enough food for everyone so the leftover meal does not get used.

"Yes, if we have a lot of leftovers, then I sometimes make it leftovers day. But it's not like I use it to make another meal the next day or something. We're just too many for that." – Interviewee 7

To help overcome this problem, participants mention that they **combine the leftover foods by adding fresh products**. Most often this is done by making a separate dish with fresh products and then serving it alongside the leftover meal. It also occurs that people add leftover ingredients to fresh ingredients or less common, that people add fresh ingredients to a leftover meal. This is done to make sure there is enough food for everybody

Participant: A kind of side dish, yes.
Interviewer: That happens most often?
Participant: I think so, in my case. I can't speak for my wife, but in my case, that usually works, yes. Because it's easier to prepare. You see, one is already prepared, and the other needs to be cooked because it's still fresh, so you just do them separately. – Interviewee 5

"My husband made a big pot of pasta on Sunday evening and then almost no one was hungry, so a lot was left over. And yesterday, I thought it's just not enough for three of us. So we eat this and I buy some fresh pasta and then I put some pesto and cheese on top. And then I make a salad with it." – Interviewee 7

Attractiveness of food

A very important factor that influences people decisions to use leftovers, is how attractive they still find it. It was mentioned many times that people find leftovers less tasty than freshly made food. This **decrease in tastiness** of the food is cumulative, where the more days pass, the less tasty it gets. Often it has to do with the change of the texture of the food and this differs between food types. Most often people find pasta fine to eat a few days later, but things with puff pastry for example, not. This is sometimes the reason why people make a fresh dish aside it, to make the experience of the whole meal better but still be able to eat the leftover meal. Moreover, it was mentioned that people do not often use ingredients that were leftover but cooked. Things like potatoes, pasta and rice were often mentioned as something that people do not save or re-use once it was cooked.

"I, uh, I just find it tastier when it's all new and fresh and then there's such a small piece or so in the fridge. And then, uh. Yes, then I'm less inclined to eat it." – Interviewee 8

"Ah, yes, I'm trying to think of an example. There are many things that are still fine to eat the next day or two days later. So a pot of pasta with red sauce. It's fine. Eh, but there are also things that, eh, things with puff pastry for example, that's usually not so tasty the next day.
So that already plays a role. Eh, if things have been left in the fridge for too long." – Interviewee 4

People's **taste preferences** about food in general play also an important role. If people simply liked the food when it was cooked, they would more likely re-use it. If a meal did not taste good, people mentioned they did not save it or no one really eats it when it did get saved. When a meal tasted very good, naturally the leftover meal gets eaten and people even make extra effort for it. In family homes sometimes someone did not like the meal and it gets stored and eaten on a later moment by someone else who did like the meal. One participant sometimes tries to make meals from leftover ingredients, but it is not always successful since the children do not always like it.

"Ooh good question. Definitely whether I liked it when I ate it. If I didn't like it anyway, then I just throw it away. Because then I'm definitely not going to eat it." – Interviewee 3

"No, from the day before yesterday, it was pasta I had cooked. It was a pasta with salmon and it was very tasty so I was really like I have to eat that leftover because it's a shame if I let it sit for a week and then haven't eaten it." – Interviewee 1

This also translates in the fact that people sometimes see **leftover meals as treats.** Especially when it can be eaten for lunch. In the Netherlands, people mostly eat bread for lunch and not a warm meal. It was mentioned a few times by participants that they dislike eating bread and are therefore very happy when they can eat a leftover meal as lunch. It was also mentioned that due to the fact that people now work home more, they are better able to eat leftovers for lunch because they are at home and they do not have to bring the leftovers or forget to bring them to work.

"Because then it's usually a leftover from dinner and I love warm food. I'm not so fond of bread. So I'm always like yes it's just a win-win situation. Then you have your leftover which is just nice warm food and it's not bread." – Interviewee 1

Sometimes participants mention that leftover food is less attractive since family members or themselves **feel that it is boring** to eat a meal or ingredient more than once.

"Yes, experience has taught us that we just don't feel like eating the same thing the next day." – Interviewee 8

4.2.3 Practical behaviour insights

From the interviews, some practical behaviours around the use of food leftovers were identified. These insights had to do with (1) the ways of how people incorporate their food leftovers in new meals and (2) the moment in the process of organizing a meal when they decide to use food leftovers.

(1) Leftover food incorporation

In the interviews, participants mentioned a few different ways in how they would use their leftover foods in a new meal. An overview was made in Figure 12, where these different types of incorporations are visually shown.

The first manner is where people would have a leftover meal still at home and they would add fresh unused products to the leftover meal. Although two participants mentioned that when they have a sauce left from a meal, they would cook new pasta or rice with the sauce and one participant mentioned that they would sometimes bake for example a fresh sausage and put that with the leftover meal, this option was not something that was very logical for participants.

When the researcher asked if people ever put fresh ingredients in a leftover meal, participants would say that they usually do not do this because they think that the leftover meal is already a whole meal in itself.

The second option occurred when participants would think of a meal they want to cook and then look for ingredients that they might already have left at home or later on accidentally bump into something they can add. With these two combined, a new meal could be made.

In the third manner people would cook a meal only with leftover ingredients. One participant mentioned that he sometimes looks for new recipes with the leftover ingredients he still has at home. However, this option was not mentioned often. Participants would say that they would use leftover ingredients but then buy fresh ingredients with it. One participant said that it can be difficult to use these leftover ingredients since she would not know what to make with it. The ideas that people have on possible combinations between ingredients were important, where participants would try to envision a dish. This was usually something they had eaten or seen before. Since people have to take an extra thinking step about what to do with the leftover ingredients, it was mentioned by some participants as more effort.

The fourth and fifth were mentioned by almost all participants, where only leftover meals were eaten or with a separate freshly made meal. The fourth manner was mentioned a lot by families, since the leftover meal alone would not be enough food to feed the entire family and they would make a separate dish next to the leftover meal. This was also done to make the overall enjoyment of the meal better, since leftover meals are not always perceived as the most tasty.

The last option was mentioned by participants as 'leftovers day'. This is a meal where only leftover meals were put on the table, either to empty the fridge and freezer or because there was little time to cook. Only eating leftover meals would also happen with just one meal, when a participant just have to make dinner for themselves.

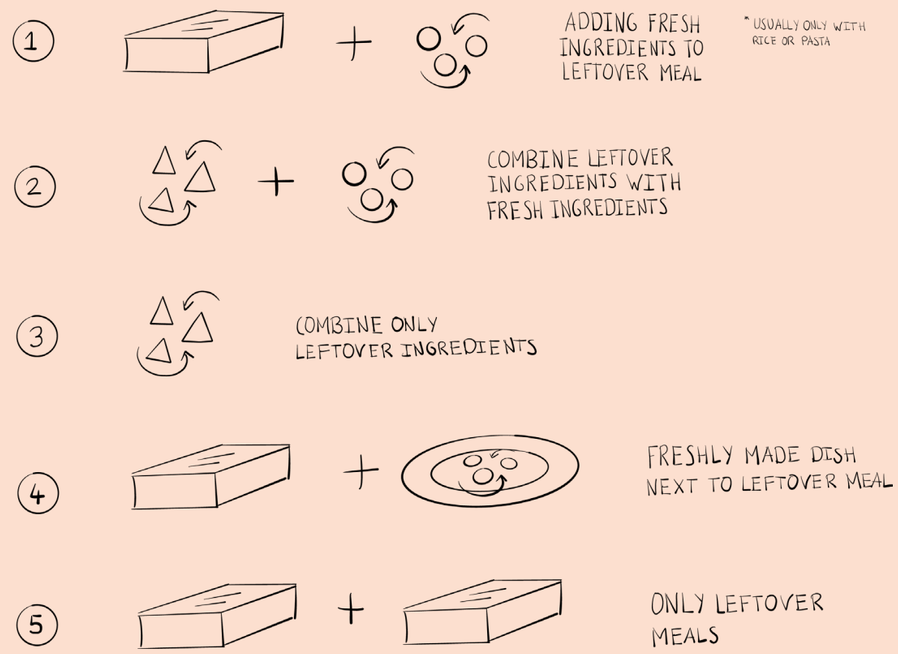

Figure 12: Leftover food incorporation.

(2) Food leftovers in the meal decision process

In the process of making a meal with food leftovers, participants mentioned different moments in the process where they would think of integrating leftovers in their meals. An overview was made in Figure 13 where these three moments in the process are visualized.

In the first option, participants say that they would think of what they want to eat and then check if they still have ingredients left that are or could be part of the meal. The remaining ingredients needed were bought at the store.

In the second option, participants would first check the fridge to see what food leftovers they still have at home. Then based on these leftovers they would think of a meal and if necessary get fresh ingredients from the store if they do not already have it.

The last option is where participants would think of what they want to eat and get everything they need for the meal form the store. Then at home they would either consciously look in the fridge if there is anything that they can also add to the meal or they would bump into something unplanned.

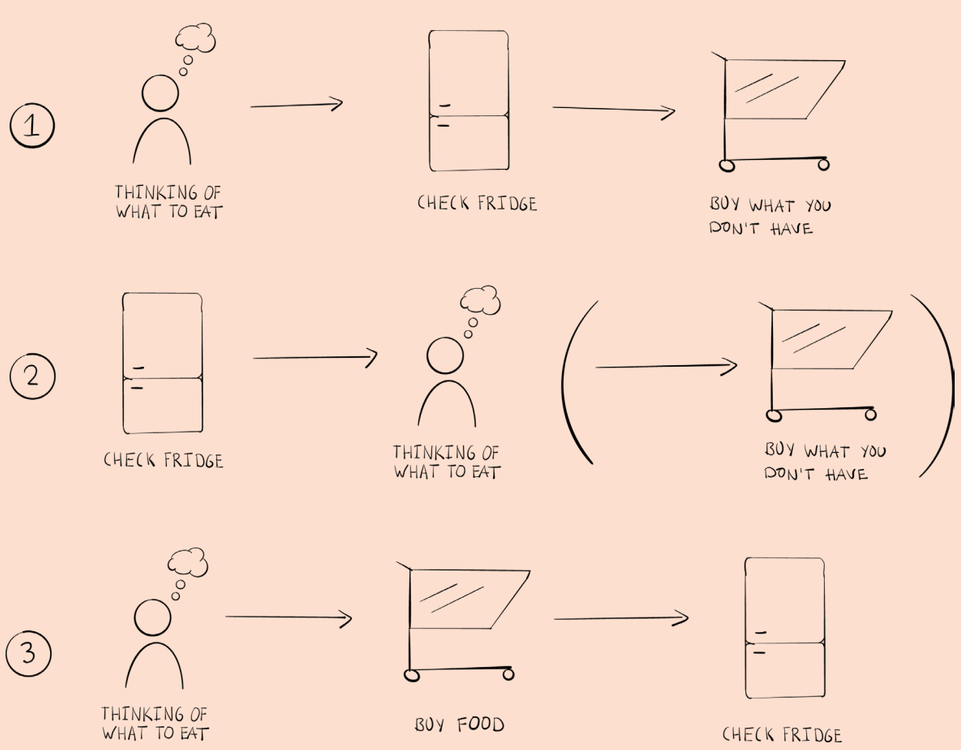

Figure 13: Food leftovers in the meal decision process.

4.3 Discussion

In this next section the discussion of the results of the interviews is described. This includes a comparison with the literature and a description of new insights that were found that add to the literature.

The qualitative coding procedures identified three overarching themes that relate to barriers and drivers of re-using food leftovers. One theme highlighted the key motivations for people to re-use their food leftovers, which was a general feeling of the fact that wasting food is not good and a desire to 'do the right thing'. In some families eating leftovers is even made as a sort of tradition, where for example a standard day in the week is made leftovers day. The meals are then all saved in the fridge for that particular day. In these families, the parents make an effort to make eating leftovers as a standard family thing, which is for example one thing that has been mentioned in a study before (Aschemann-Witzel et al., 2015a). Another theme showed that the organization behind households and food leftovers ('difficulties of organizing') can be inhibiting when done wrong, but helpful when done right. Like mentioned in previous studies, when people do not have a clear storing system for example, and randomly place products somewhere they get lost and eventually are not eaten (Farr-Wharton et al., 2014). During the interviews at least four people found products in the back with mould on it that they had forgotten and had to discard it. The last theme described the perceptions of people where the decreased value that people ascribe to leftover foods, keeps them from re-using their food leftovers. The fact that people think the tastiness decreases, they are scared to become sick and there is always a store with new food in the area, leftover foods are not seen as valuable and are therefore more easily discarded (Aschemann-Witzel et al., 2015a). Moreover, due to an extra thinking step in what to make with leftover ingredients and the lack of inspiration and time, leftover ingredients do not get used and people buy new food instead. The extra effort that people have to do to come up with something to make has been mentioned before as a barrier to cook with leftovers (Cappellini & Parsons, 2012; Farr-Wharton et al., 2014). People fall back on what they know or have cooked before, and combinations of foods that they have seen before. However, when they do not succeed to do this and they do not see a potential, the leftovers are not used. The findings of the interviews in this study are mostly in line with previous qualitative studies performed in other countries about food waste (Aschemann-Witzel et al., 2019; Cappellini, 2009; Evans, 2011, 2012; Farr-Wharton et al., 2014; Graham-Rowe et al., 2014; Watson & Meah, 2012).

What stood out is that in previous studies, participants rarely or never made the link between food waste and the environmental implications (Evans, 2012; Graham-Rowe et al., 2014; Quested et al., 2013a; Watson & Meah, 2012). Which has also been mentioned as a possible reason for why there is a weak relationship between environmental concerns and food waste reduction (Schanes et al., 2018). However, in this study almost all participants mentioned the loss of resources and effort that have gone into making the food, as one of the first reasons why it is bad to waste food. This implies that in this sample, participants are well aware of the environmental consequences due to the fact that resources like energy and water are lost when food does not get eaten. There could be multiple reasons that explain this difference. One reason could be the characteristics of the interviews sample, where all participants are higher educated. One previous study found that higher educated people make a stronger link between environmental consequences and food waste (Qi & Roe, 2016), which could also be the case here. Another possible reason could be that this study is performed around 10 years later than these previous studies. The past decade the general awareness and concern about the environment has increased worldwide, which could also explain that in this study performed in 2024, the participants did make the connection between environmental damage and food waste.

Some smaller new findings were found in this study that contribute to literature about the re-use of food leftovers. Firstly, some participants in the interview sample were students that live in student housing. These students share a fridge with their roommates and therefore divide the shelves between the members. One of the shelves is a 'communal shelve' where food gets stored that can be eaten by anyone in the house. What was interesting is that two participants mentioned that people in the house only look at their personal shelve and do not regularly look at the communal shelve where the food leftovers from dinner get stored. Since it is a communal shelve, there is not really one person where the responsibility lies for eating the leftovers. This possibly results in the food leftover not being eaten. This is different in comparison to family homes, where it was clear from the interviews as well as previous literature, that at least one of the parents always makes an effort to make sure the food leftovers get eaten (Cappellini & Parsons, 2012).

Secondly, it was mentioned by many participants that they eat leftover meals from dinner as lunch in the days after and two participants mentioned that they themselves or their children even see it as a treat. It is possible that this is due to the Dutch culture, where it is common to eat bread for lunch. The participants that mentioned that they really enjoy eating leftover meals for lunch, also mentioned that they did not like to eat bread. Therefore a leftover meal is sometimes even made on purpose to not have to eat bread for lunch the days after.

Thirdly, one participant mentioned that working from home allows her to eat leftover meals for lunch more easily. Since she is already at home, she always has access to leftover meals and mentions she regularly eats small amounts of leftover meals during the week at home. Moreover, she said that she would not take leftover meals to work since she does not always know whether there is going to be a microwave. Moreover, participants often mentioned that they forget what they have at home and therefore do not use the leftover foods or take them into account in a new meal. These findings could be an indication that working from home allows people to eat more of their leftover meals.

Lastly, leftover meals are sometimes kept as a back-up. Participants said they would store leftover meals in their fridge for when they run out of food or when a child does not like the freshly made dinner. The idea is that they always have a meal at hand at home for when these moments occur.

4.4 Conclusions and implications

In this next section the findings from the interviews are compared to the factors in the initial conceptual model from chapter three. Consequently, the changes that were made to the model are explained.

The main purpose of the interviews was to see whether the identified factors for the conceptual model from the literature, should possibly be complemented or adapted by important themes from the interview results. The second purpose was to gain rich insights on the perceptions, beliefs and behaviours of people around food leftovers to better understand the subject and to use as inspiration for designing interventions in a later stage of the project.

When we look at the results from the interviews, we see a good overlap between the second and third theme and the factors for the conceptual model. This not surprising, since the second and third theme are mostly about people's motivations and that has an effect on the intention, which is what the model seeks to explain. The first theme cannot really be found in the conceptual model, since this theme is more about contextual factors that inhibit an individual from acting out their intentions. These findings would therefore be placed outside of the conceptual model, between the intention and the actual behaviour. They are one of the causes of the attitude-behaviour gap, so to speak.

When we look at the sub-themes, the one that seemed most important in the interviews can also be found in the conceptual model. First of all, in the second theme, 'Doing the right thing', the sub-themes 'personal norms' and 'concern of impact on the environment' are reflected in the factors personal norms and awareness of the consequences of food waste in the model. Especially since 'concern of impact on the environment' seemed to be an important motivator for not wasting food in the interviews, it is also likely to be important in the model. A habit or routine factor was not added to the model, since the 'saving food routines' seemed to play less of an important role towards people's intentions in the interviews than the other sub-themes. Also, only a limited number of factors could be added in the model, to prevent the questionnaire from being too long and to keep a realistic number of necessary responses. The 'saving food routines' was therefore not added to the model.

In the third theme, 'Ascribed value to leftover food', the sub-theme 'attractiveness of food' is reflected in the sensory appeal factor and the attitude factor. The sub-theme 'wasted value' is also reflected in the attitude factor. The sub-theme 'recognizing potential use' can be found in the skills factor. The 'abundant availability of alternatives' is not literally present in the model. However, since this sub-theme is about the thankfulness and appreciation of food, it is to some extent reflected in the personal norms factor. This is because when people are more thankful for their food and see it as something very valuable or scarce, their personal principles against wasting it might be strengthened. This in turn strengthens their personal norms. The sub-theme 'anxiety for food-borne illness' was not in the conceptual model.

Changes to the initial model

When creating the initial conceptual model, a consideration was made between sensory appeal and perceived health risks. Since the model could only have limited factors, to prevent the questionnaire from becoming too long and to keep the number of required responses low, only one of them was chosen to proceed with. Eventually, it was decided to put sensory appeal as the antecedent of attitude in the model before the start of the interviews. However, what stood out is that anxiety about food borne illness seemed to play a bigger role in the interviews than expected. Although, the attractiveness of leftovers was mentioned by the respondents, it didn't seem as strong of an influence on whether people eat their leftovers or not as the perceived health risks. Even for people who do find eating leftovers attractive, when they have doubts about whether it is still edible, they will not re-use the leftover. It thus seemed as a really important tipping point for all the respondents.

Moreover, since in a later phase of this thesis, design interventions will be created for the factors in the model, perceived health risks seem to be a better option. Designing interventions for perceived health risks is more easily done than for sensory appeal. Although this was not the main reason for why perceived health risks was chosen over sensory appeal, it did form an extra argument.

Since the findings in the interviews confirm the literature about perceived health risks and the anxiety about food borne illness was deemed very evident in the interviews, it was decided to replace the sensory appeal factor with the perceived health risks factor. We therefore hypothesize that the perceived health risk affects the attitude of people towards making a meal with food leftovers.

In conclusion, after making the change to switch sensory appeal with perceived health risks, the results from the thematic analysis show good overlap with the factors in the model. Thus, the model seems to capture the most important factors that influence people's intention to re-use food leftovers. The configuration of the model is therefore used to test in statistical analysis.

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Chapter 5

QUESTIONNAIRE.

In this chapter, the conceptual model that explains the intention to re-use food leftovers is presented, along with the hypotheses derived from the model.

Furthermore, the method and analysis of the questionnaire to test the conceptual model is described. First the method and creation of the measurement items is explained, whereafter the results from the PLS-SEM analysis are shown. This includes the validity and reliability of the model and the hypotheses testing.

The chapter ends with a discussion of the results and the comparison to the findings in literature.

5.1 Conceptual model and hypotheses

In this section the conceptual model is presented. In this model the relationships between the constructs and the dependant variable are visualised along with the corresponding hypotheses.

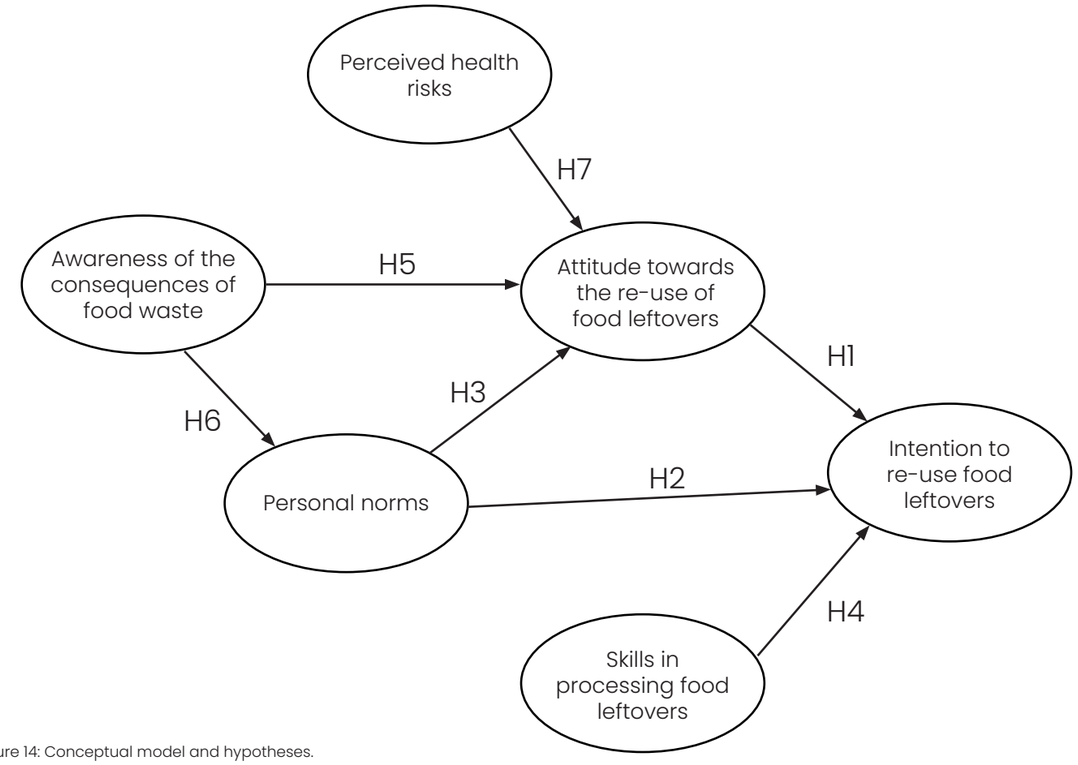


Figure 14: Conceptual model and hypotheses.

Following the literature and the results from the interview, the conceptual model was build which is visualised in Figure 14. The relationships between the factors were constructed based on the psychological behaviour theories and findings from existing studies. Derived from the model, seven hypotheses were developed, which will be tested in the statistical testing.

The seven hypotheses are formulated as:

H1: Positive attitudes have a positive effect on the intention to re-use food leftovers.

H2: Personal norms have a positive effect on the intention to re-use food leftovers.

H3: Personal norms have a positive effect on the attitude towards re-using food leftovers.

H4: Lack of skills in processing food leftovers has a direct negative effect on the intention of people to re-use food leftovers.

H5: Awareness of the consequences of food waste has a positive effect on the attitude of people towards the re-use of food leftovers.

H6: Awareness of the consequences of food waste has a positive effect on the personal norms of people towards the re-use of food leftovers.

H7: Perceived health risks has a negative effect on the attitude of people towards the re-use of food leftovers.

5.2 Methodology

In this section the method for the questionnaire to test the hypotheses is described. It includes an explanation about the questionnaire design, sample and analysis method.

Data was collected in May 2024 for a period of two weeks, by means of a web-based questionnaire using the online survey software from Qualtrics. The measuring items were taken and adapted from existing literature. Before the data was collected, a pilot test with 15 Dutch people was conducted to support the questionnaire design. The participants in the pilot test were asked to provide feedback on the questionnaire in terms of wording, if they understood all the questions and any other things like the looks and duration of the questionnaire. With nine of the pilot test participants, the researcher sat next to them to observe any difficulties and to directly receive feedback. The modified version of the questionnaire was eventually sent to collect responses for the research.

The collection of samples was done through a combination of convenience sampling (Golzar et al., 2022) and snowball sampling strategy (Johnson, 2014). The questionnaire was first randomly distributed through a link to potential respondents in the personal network of the researcher, who were then asked to forward it to family and other acquaintances. Next to that, the researcher posted an invitation for the questionnaire on their LinkedIn page. The post had an introductory text about the questionnaire and a link to the questionnaire. The post was written both in Dutch and English.

Participants did not receive an extra incentive or reimbursement for filling in the questionnaire.

5.2.1 Questionnaire design

The online questionnaire had an introduction text about the study, where it described the purpose and context of the study. Additionally, it described how this study defines food leftovers. The participants gave consent to use their data by starting the questionnaire. All data that was collected was anonymous.

Development of the measurement model

The questionnaire consisted of 43 questions and took approximately 10 minutes to complete. Each latent variable in the conceptual model was measured by 4-5 items. All measuring items were gathered from existing literature, mostly from the psychological and social disciplines, and small adaptations were made where needed to fit this study. The studies where the measuring items were gathered from were mostly about food waste reduction and other pro-environmental behaviours. For example, the factor intention to re-use food leftovers was adapted from Visschers et al. (2016) and Stancu et al. (2016). In these studies, the determinants for consumer food waste are studied. For the factor intention to re-use food leftovers, we adapted three items based on the intention not to waste food and the leftover reuse routines from Stancu et al. (2016). Two items from leftover reuse routines were combined into one and reformulated as an intention question. The fourth item in intention to re-use food leftovers was adapted from the intention to avoid food waste factor from Visschers et al. (2016). Additionally, all the intention measuring items in this study were formulated using the word 'always' to capture more nuance and to make the items less susceptible to socially desirable answers.

The personal norm factor was also based on the two studies mentioned before. Three measuring items were adapted from Visschers et al. (2016) and two items were adapted from Stancu et al. (2016). Here we borrowed the idea that people's principles and feelings of guilt against other people and the environment when wasting food, positively influences the intention to reduce food waste generation.

The attitude factor items were constructed using the guidelines provided by Ajzen (1991, 2006) and adapted from the study from Han (2014) about travellers intentions to visit green lodging hotels. In this study they also use The Theory of Planned behaviour as a base for a conceptual model combined with the Norm activation Model.

Skills in processing food leftovers are mainly discussed in qualitative studies, although there are a few studies about food waste that have used measuring items to reflect people's skills in handling food leftovers. One item was taken from the perceived behavioural control factor in the study of Visschers et al. (2016), where they have the idea that when people perceive difficulties with some household skills, the intention is lower. A second item was adapted from the leftover reuse routines in the study of Stancu et al. (2016). In this study they show that people's routines around leftovers negatively affect the reported amount of food waste, which means that people with good leftover re-use routines actually re-use their leftovers more often. The other two items were adapted from Scalvedi & Rossi (2021), where they found associations between different behavioural indicators (including personal ability) and levels of food waste. These last two items were about cooking skills and the ability to evaluate if food is still safe to eat.

The first four measuring items for the perceived health risks factor were directly taken from Visschers et al. (2016). We followed the idea from this study that people who perceive fewer risks when consuming leftovers, show a higher intention to reduce food waste. The fifth item was taken from the level of concern about food related issues factor from Principato et al. (2015).

With the awareness of consequences of food we focussed on the idea that people who are aware of the loss of all the resources that have gone into the food production and who consider food waste to be a major problem, are more motivated to reduce the amount of food they waste. The measuring items were directly taken from studies who also used this idea in their research (Attiq et al., 2021; Principato et al., 2015).

Lastly, the measuring items for environmental concern were taken from the New Ecological paradigm scale (Dunlap et al., 2000). For the financial attitudes items we were looking for measuring items that reflect conscious spending behaviour. These items were taken from the money attitude scale of Rousseau & Venter (1999) and Lay & Furnham (2018), and from the importance of money scale from Franzen & Mader (2022).

An overview of the measuring items and the original sources where the items were adapted from, can be seen in appendix D.

Additionally there were questions about people's demographics. Apart from the demographic questions, all questions were answered through a 7-point Likert scale ranging from (1) strongly disagree to (7) strongly agree.

The questionnaire had one attention check question halfway, to be able to evaluate in the analysis whether people were carefully filling in the questionnaire. This helps to improve the quality of the data by identifying inattentive or disengaged respondents. Responses who failed to answer the attention check correctly, were eliminated from the sample. This was done to increase the reliability and validity of the results from the questionnaire.

5.2.2 Sample

A total of 301 responses were collected. After removing the responses that were incomplete and the participants that failed the attention check questions, a sample of 244 responses was left for the analysis (see Table 3).

In the paper of Hair et al. (2022), they describe that the minimum sample size should be calculated according to minimum path coefficient (P_{min}) that is significant and the significance level. The model was tested with a significance level of 5% and the P_{min} amounted to -0.143. Taking the absolute value of P_{min} , it lies in the range of 0.11-0.2. With the significance level of 5%, the minimum sample size should be 155. The sample collected in this study was a total of 244 and therefore the sample size is well over the minimum required responses.

The sampling method that was used, unfortunately allowed for little control over the variety of people in terms of the different socio-demographic characteristics. This resulted in a slightly uneven distribution between the categories in some characteristics. The sample consisted of more females than males (69% vs 30%), the biggest share of respondents was above the age of 55 (47,9%) and most respondents were higher educated (85%).

Table 3: Socio-demographic and background characteristics of respondents (N = 244).

Category	Sample (N)	Sample (%)
Gender		
Female	169	69,3
Male	73	29,9
Other	2	<1
Age		
Under 18	1	<1
18-24 years old	35	14,3
25-34 years old	36	14,8
35-44 years old	20	8,2
45-54 years old	35	14,3
55-64 years old	75	30,7
65+ years old	42	17,2
Education level		
Primary school diploma	1	<1
High school diploma	5	2
MBO but no diploma	2	<1
MBO diploma	13	5,3
HBO but no diploma	13	5,3
HBO diploma	70	28,7
University but no diploma	12	4,9
University Bachelor's degree	33	13,5
University Master's degree	87	35,7
PhD	7	2,9
Occupation		
Full-time work (30 hours per week or more)	119	48,8
Part-time work (less than 30 hours per week)	40	16,4
Retired	34	13,9
Student	41	16,8
Unemployed	3	1,2
Other	7	2,9
Household composition		
Single person household	35	14,3
Shared household (student housing, home sharing)	40	16,4
Married or partnered without children	100	41
Married or partnered with children	62	25,4
Single parent with children	2	<1
Household income		
Less than 25.000 Euros	45	18,4
25.000-49.999 Euros per year	34	13,9
50.000-99.999 Euros per year	70	28,7
100.000-199.999 Euros per year	52	21,3
Prefer not to say	43	17,6

5.2.3 Statistical analysis

In this section, we present the method that was used to test and evaluate the proposed research model. Empirical research was done to examine which factors influence the intention of people to re-use their food leftovers. In this study, the partial least squares structural equation method was applied (PLS-SEM) using the software Smart-PLS. This method enables researchers to estimate complex cause-and-effect relationships in path models involving latent variables. Moreover, the method has both an explanatory and a predictive power (Hair et al., 2018).

Additionally, PLS-SEM allows the researcher to measure the relationship between the observed data and latent variables and the relationships between latent variables. The method is able to do all this with a relatively small sample size, but also works really well with larger sample sizes (Hair et al., 2018). The analysis consists of two parts, first the measurement model is tested and secondly the structural model is tested. The testing of the measurement model is done by evaluating the convergent validity and the discriminant validity. The structural model testing consist of assessing the model according to the quality criteria and finally hypothesis testing.

5.3 Results

In this section, the results from testing the measurement model and the structural model are described. To test the mesurement and structural model, the software Smart-PLS was used to run a PLS-SEM algorithm. First the validity and reliability of the measurement model are described, whereafter the hypotheses are tested.

In this section, the results from testing the measurement model and the structural model are described. To test the hypotheses shown in the model in Figure 14, the software Smart-PLS was used to run a PLS-SEM algorithm on the model.

To test the measurement model, it is important to assess whether the model has adequate construct validity (Thoma et al., 2018). This means that the items or measures should indeed measure the construct of interest. The validity of a reflective measurement model is assessed by two types of validity. The first is convergent validity, which assesses whether an item measures the same thing as the other items in the construct. The second is discriminant validity, which describes the extent to which an item does not measure other unrelated constructs (Thoma et al., 2018). In the next sections, we describe the two types of construct validity and what the results are for this model.

5.3.1 Convergent validity and reliability

Factor loadings
The first step in PLS-SEM is evaluating the results from the measurement models. For a reflective model, the first step is to assess the factor loadings (Hair et al., 2018). Factor loadings show how well an individual item explains the variance of a construct. The factor loadings lie between -1 and 1. High factor loadings, that lie close to -1 or 1, indicate that the item strongly influences the construct. Loadings above the threshold of 0.708 are recommended, however, values above 0.6 are also acceptable if the composite reliability of the factor is at an acceptable value (Hair et al., 2011). In this study, all items but three loaded into their respective factors. Three items (AC1, AC2, AC3) were removed from further analysis due to low factor loading. The remaining items that were used for the analysis can be seen in Table 4.

Table 4: Items descriptive statistics, composite reliability, internal consistency, reliability, and convergent validity.

Construct	*Items*	*Mean*	*Factor Loadings*	*Std. dev*	*T-statistic*	*a^a*	*CR^b*	*AVE^c*
Intention to re-use food leftovers	INT1	5.951	0.839	1.230	19.713	0.898	0.900	0.766
	INT2	6.086	0.869	1.107	24.838			
	INT3	5.943	0.911	1.289	55.293			
	INT4	6.053	0.876	1.163	32.071			
Attitude towards the re-use of food leftovers	ATT1	6.533	0.682	0.875	8.273	0.840	0.851	0.611
	ATT2	5.828	0.795	1.077	21.960			
	ATT3	6.020	0.758	0.989	14.370			
	ATT4	6.443	0.816	0.850	18.279			
	ATT5	5.844	0.826	1.167	39.110			
Personal norms	PN1	4.398	0.669	1.682	12.148	0.826	0.849	0.590
	PN2	5.189	0.781	1.562	21.714			
	PN3	5.709	0.842	1.300	42.162			
	PN4	5.184	0.701	1.545	15.569			
	PN5	5.033	0.827	1.604	27.899			
Skills in processing food leftovers	SKL1	2.975	0.861	1.632	30.415	0.764	0.824	0.583
	SKL2	2.574	0.716	1.657	12.098			
	SKL3	3.049	0.801	1.616	19.758			
	SKL4	2.717	0.634	1.413	7.384			
Perceived health risks	PHR1	3.061	0.845	1.474	34.436	0.829	0.840	0.592
	PHR2	2.496	0.766	1.292	16.918			
	PHR3	2.217	0.754	1.039	16.914			
	PHR4	2.541	0.776	1.392	18.469			
	PHR5	2.799	0.680	1.475	11.939			
Awareness of the consequences of food waste	AC4	5.176	0.890	1.333	36.135	0.752	0.754	0.801
	AC5	5.180	0.899	1.261	36.764			

Note: [a] Cronbach's alpha; [b] Composite reliability; [c] Average variance extracted.

Internal consistency reliability
The next step is to assess the internal consistency reliability. This refers to how well a questionnaire actually measures what you want it to measure by looking at the consistency of the scores that the items deliver in a test. Often the composite reliability (*CR*) is used for this. In general, higher values of the composite reliability indicate higher levels of reliability. For more exploratory researches, values between 0.60 and 0.70 are considered "acceptable", values between 0.70 and 0.90 are considered "satisfactory to good" (Hair et al., 2018, p. 8) . If there are any reliability values above 0.95, it is considered problematic and the items are then considered not useful (Hair et al., 2018). This is because these values might suggest 'straight lining' which is an undesirable response pattern and could trigger inflated correlations between the items in a construct (Hair et al., 2018). In this study, all composite reliability values lie between 0.750 and 0.900 (Table 4), which indicates that the measurement model has a high reliability.

A second measure to assess the internal reliability of latent variables is the Cronbach's alpha. This measure lies between 0 and 1 and the rule of thumb is that the Cronbach's alpha should exceed a value of 0.7 (Bland & Altman, 1997). Generally, Cronbach's alpha produces lower values than the Composite reliability, because all the items in a construct are unweighted an thus assumes that all items are equally reliable. Therefore, opposed to the Composite reliability where the items do get weighted according to their individual factor loadings, the Cronbach's alpha test is less precise (Hair et al., 2018). As seen in Table 4, the Cronbach's alpha is above 0.7 for all the constructs, which indicates a good internal consistency reliability of the measurement model.

Convergent validity
Convergent validity assesses whether the items that are supposed to measure the same construct, are indeed related to each other. This means that the items in the same construct should have high correlation with each other. In this study, we used the Average Variance Extracted (AVE) to measure the convergent validity of the constructs. The AVE is calculated by taking the square of each item in a construct and then taking the mean of it. An acceptable value for the AVE is above 0.5, since this means that the construct explains at least 50 percent of the variance of its items (Hair et al., 2018).

As seen in Table 4, all constructs in this study exceed the recommended threshold of 0.5 for the AVE, which means that the constructs have a sufficient level of convergent validity.

5.3.2 Discriminant validity

The discriminant validity assesses the extent to which a construct is distinct from the other constructs in the model. To measure the discriminant validity, this study used two measures: the Fornell-Lackner criterion and the Heterotrait-monotrait ratio.

Fornell-Larcker criterion
The Fornell-Larcker criterion is a widely used measure in structural equation modelling. A model passes the criterion if the square root of the AVE of a certain construct is higher than the correlation of that construct with the other constructs in the model (Hair et al., 2018). The Fornell-Larcker measurements can be seen in Table 5. As can be seen, all correlations between the constructs amount to a lower value than the square root of the AVE for the constructs. This indicates that according to the Fornell-Larcker test, the model fulfills the criterion and thus owns sufficient discriminant validity.

Heterotrait-monotrait ratio
Recent literature has placed some doubts on whether the Fornell-Larcker criterion is always suitable for measuring the discriminant validity in SEM methods. They therefore suggest to also use the Heterotrait-Monotrait ratio (HTMT) measure, to assess discriminant validity (Henseler et al., 2015). This test compares the average correlations between items in the same construct against the average correlations between items across constructs that measure different phenomena. Higher values indicate a problem with the discriminant validity. Henseler et al. (2015) suggest that the HTMT should be below 0.90 as a more liberal value. The more conservative value is suggested to be 0.85. Both have shown to reliably detect discriminant validity issues, however, the 0.85 threshold slightly outperforms the 0.90 threshold.

This study followed the recommendation and therefore also performed the HTMT test. The results are shown in Table 6. All values are well below the recommended conservative threshold of 0.85, which means that according to the HTMT test the model has sufficient discriminant validity.

Concluding, the measurement model scores well on the construct validity and reliability and can therefore be used to test the structural model. In the next section, the results from the structural model and hypotheses testing are described.

5.3.3 Structural model analysis results

Explanatory power
The explanatory power of the model is measured by the coefficient of determination (R^2). The R^2 measures the variance that is explained in each of the endogenous constructs in the model, and ranges from 0 to 1. The higher the value, the more variance is explained and therefore the more explanatory power the construct has (Hair et al., 2018). In general, R^2 values of 0.75, 0.50 and 0.25 for endogenous constructs are considered "substantial", "moderate" and "weak" respectively (Hair et al., 2018, p. 11; Hair et al., 2011, p. 147). However, the target values of R^2 differ between research disciplines. In disciplines such as consumer behaviour, which is the case of this study, results of over 0.20 are considered high (Hair et al., 2011). Moreover, the more constructs a model has, the bigger the explanatory power of the model. Therefore, the R^2 should always be interpreted in relation to the context, related studies and models that have a similar complexity (Hair et al., 2018).

PLS-SEM was used to test the hypotheses shown in Figure 14. To assess the model's goodness of fit, the standardized root mean square residual (SRMR) was used as a measure. According to Hu & Bentler (1998) a value below 0.10 is considered a good fit. In this study, the model reached a SRMR value of 0.089 for the estimated model. The model therefore has a good fit.

A bootstrapping algorithm was applied to generate the path coefficients significances. The results are shown in Figure 15. The dependent variable, Intention to re-use food leftovers, is explained by over 52% of the variance. In comparison to related studies (Kirmani et al., 2023; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016) and the fact that the research discipline is consumer behaviour, this number is relatively high and the model has quite good explanatory power. The other endogenous constructs, personal norm and attitude, are explained by 17,4% and 26% of the variance respectively.

Table 5: Correlation among constructs and the square root of the AVE for each construct (highlighted in bold).

	Attitude towards the re-use of food leftovers	Awareness of the consequen-ces of food waste	Perceived health risks	Intention to re-use food leftovers	Personal norms	Skills in processing food leftovers
Attitude towards the re-use of food leftovers	**0.782**					
Awareness of the consequences of food waste	0.232	**0.895**				
Perceived health risks	-0.399	-0.240	**0.770**			
Intention to re-use food leftovers	0.630	0.236	-0.412	**0.875**		
Personal norms	0.411	0.417	-0.282	0.564	**0.768**	
Skills in processing food leftovers	-0.229	-0.096	0.443	-0.310	-0.181	**0.764**

Table 6: Heterotrait-monotrait ratio matrix (HTMT).

	Attitude towards the re-use of food leftovers	Awareness of the consequen-ces of food waste	Perceived health risks	Intention to re-use food leftovers	Personal norms
Attitude towards the re-use of food leftovers					
Awareness of the consequences of food waste	0.285				
Perceived health risks	0.456	0.293			
Intention to re-use food leftovers	0.721	0.285	0.468		
Personal norms	0.465	0.519	0.312	0.635	
Skills in processing food leftovers	0.264	0.136	0.582	0.353	0.234

Hypothesis testing
Figure 15 shows the results from the structural model testing.
Table 7 shows the results from the hypotheses testing.

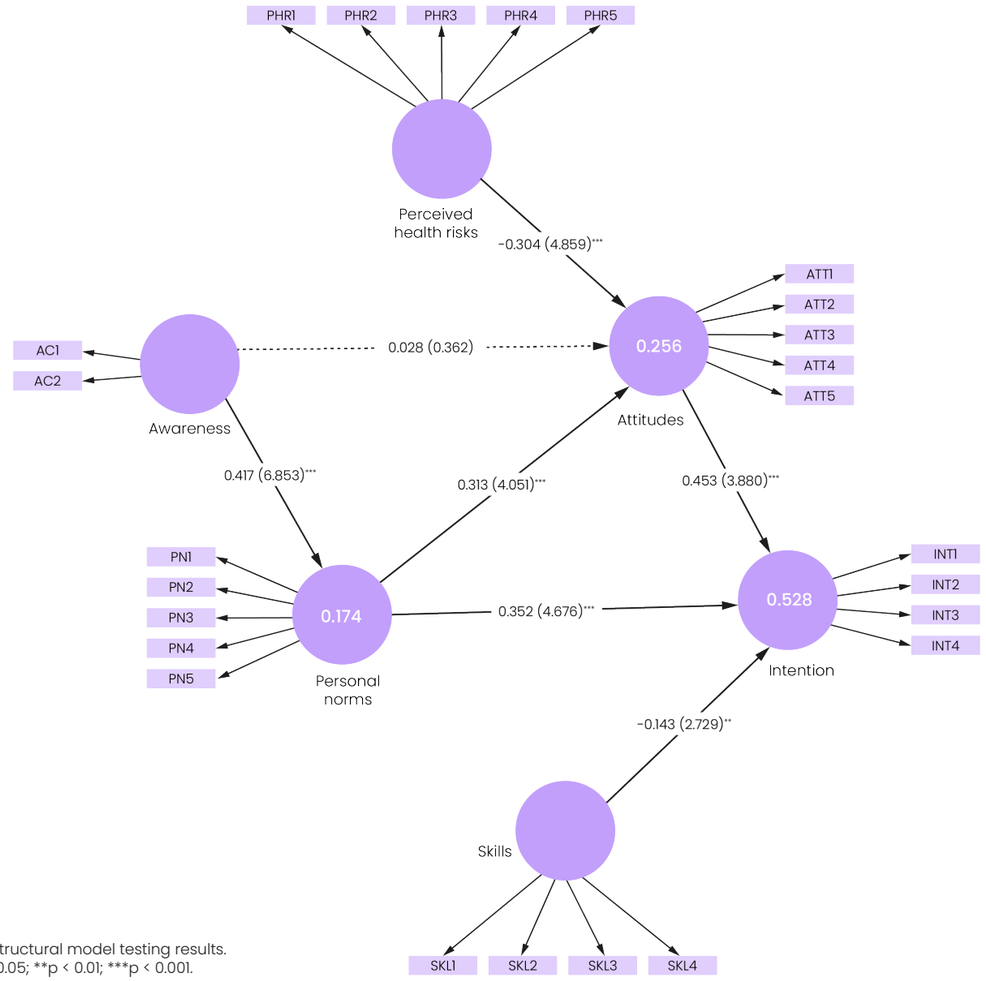


Figure 15: Structural model testing results.
Note: *p < 0.05; **p < 0.01; ***p < 0.001.

Table 7: Hypotheses and results.			
#	*Path coefficients*	*T-statistic*	*Results*
H1: Attitudes --> Intention	0.453	3.880	**Supported**
H2: Personal norms --> Intention	0.352	4.676	**Supported**
H3: Personal norms --> Attitudes	0.313	4.051	**Supported**
H4: Skills --> Intention	-0.143	2.729	**Supported**
H5: Awareness --> Attitudes	0.028	0.362	*Rejected*
H6: Awareness --> Personal norms	0.417	6.853	**Supported**
H7: Perceived health risks --> Attitudes	-0.304	4.859	**Supported**

The results show that attitude towards the re-use of food leftovers and personal norm both have a strong positive effect on the intention to re-use food leftovers with significant path coefficients: (β = 0.453, t = 3.880, p < .001) and (β = 0.352, t = 4.676, p < .001) respectively. Personal norm also has a strong positive effect on the attitude (β = 0.313, t = 4.051, p < .001). This means that the first three hypotheses (H1, H2, H3) are supported by the model. The results also show that the lack of skills have a moderate negative effect on the intention to re-use food leftovers (β = -0.143, t = 2.729, p < .01). Thus, H4 is also supported by the model. The results also show that awareness of the consequence of food waste does not have a significant effect on the attitude (β = 0.028, t = 0.362, p > .05) and is therefore rejected. Awareness of the consequence of food waste has a very strong effect on the personal norm (β = 0.417, t = 6.853, p < .001) and is therefore supported. Lastly, the results show that perceived health risks have a strong negative effect on the attitude (β= -0.304, t = 4.859, p < .001) and is therefore also supported.

The control variables environmental concern and financial attitudes did not have a significant effect on the intention to re-use food leftovers: (β = -0.015, t = 0.258, p > .05) and (β = 0.040, t = 0.860, p > .05).

Mediation effects
Next to the testing of direct effects, mediation tests were also performed. We tested the mediation effect of personal norm and attitudes on the intention, and we tested the mediation effect of personal norm on attitude. The results are shown in Table 8.

The results show that attitude mediates the relationship between perceived health risks and intention (β = -0.138, t = 2.557, p < .05) and between personal norm and intention (β = 0.142, t = 3.447, p > .01). The results also show that personal norm mediates the relationship between awareness of consequence and the attitude (β = 0.130, t = 3.442, p > .01) and between the awareness of consequence and the intention (β = 0.147, t = 4.016, p > .001). Finally, the mediation effects of both personal norms and attitude on the relationship between awareness of consequence and intention was found (β= 0.059, t = 3.004, p > .01).

5.3.4 Multigroup analysis

A multigroup analysis (MGA) was performed on a selection of the demographic characteristics. The objective was to see whether gender, age, household income, occupation and education level had any effect on the results. The control variable Household composition was left out of the analysis, due to the uneven distribution of the sample between the variable groups. Education level was also left out of the analysis, due to the fact that the sample for the largest part consisted of higher educated people (approximately 87% had at least attended HBO) and therefore a statistical significant comparison between lower and higher educated people could not be made.

For the control variables gender, age and household income, an MGA was performed. Firstly between age groups. To make sure the sample sizes per age group were sufficiently large, some groups were merged together. Three age groups were formed, which were under 18-34, 35-54 and 55-65+. Between age groups, one statistical significant difference was found between the youngest and oldest group in the path between skills and intention. Where there was a significant relationship between skills and intention in the youngest group (β = -0.358, t = 4.701, p < .05), there was no significant relationship found in the oldest group (β = -0.028, t = 0.399, p > .05). This indicates that with the youngest group, their level of skills in processing leftover foods does have a significant effect on their intention to re-use food leftovers. Possibly, the younger group has less experience in cooking with leftovers or cooking in general, which leads to people being less inclined to re-use leftovers. Additionally they might also be less confident in their skills for recognizing if something is still edible or not. To make sure the MGA could be performed, a MICOM test was done to assure validity of the results. Both configural and compositional invariance are established, which means that partial measurement invariance was confirmed. Therefore we could proceed with the MGA analysis for the difference between the youngest and oldest age group.

No further statistical significant differences were found in the MGA analysis.

Table 8: Mediation test results			
Specific indirect effects	*Path coefficients*	*T-statistic*	*p-value*
Perceived health risks --> Attitudes --> Intention	-0.138	2.557	0.011
Personal norms --> Attitudes --> intention	0.142	3.447	0.001
Awareness --> Personal norms --> Attitude --> Intention	0.059	3.004	0.003
Awareness --> Personal norms --> Attitudes	0.130	3.442	0.001
Awareness --> Personal norms --> Intention	0.147	4.016	0.000

5.4 Discussion

In this section, the results from the structural model testing are described and compared to what was found in prior studies.

The results from the statistical testing show that the combination of the TPB and NAM, accompanied by the ability construct of the MOA, explains the intention to re-use food leftovers fairly good.

As expected by theory, personal norms have a strong direct positive effect on the intention. Meaning that people with stronger ethical concerns and principles against wasting food, are more inclined to re-use their food leftovers. Contrary to the study of Stancu et al. (2016) where personal norms did not have an effect on the intention to reduce food waste, but in line with the studies of Stefan et al. (2013) and Visschers et al. (2016), this study found that people are affected by a feeling of guilt and obligation. What is notable, is that the effect of awareness of the consequences of food waste on personal norms, is one of the strongest in the entire model. This shows that people who are aware of the loss of natural resources and the pollution caused during the life cycle of food, feel a stronger moral obligation to not waste their food leftovers. This confirms what we also found in the interviews in this study, where people often mentioned the loss of resources as one of the major reasons why they feel bad when wasting food. Although in many studies is mentioned that motivating people to reduce food waste by appealing to their concern for the environment would not be effective because people do not make the link between environmental impact and food waste (Schanes et al., 2018), this study shows otherwise. There is one study where this was also found, which was performed more recently (Attiq et al., 2021). This underlines that the difference in the year when the study was performed, might have something to do with it. The fact that respondents in this study experience emotional feelings of guilt when throwing away food, could also explain the significant positive effect between personal norms and attitudes. Due to the internalized ethical believe of someone to not throw away food, a certain feeling of satisfaction might occur when people re-use their food leftovers, which reflects in their attitudes.

The results also showed that attitudes have a significant positive effect on the intention to re-use food leftovers, which was expected by the TPB. This means that when people enjoy to re-use leftovers and they evaluate re-using as good and pleasant, they are more inclined to re-use their leftovers. The results also show that these attitudes are strongly negatively affected by the perceived health risks, which is in line with prior studies (Visschers et al., 2016). This makes sense, since people will not evaluate re-using leftovers as something they like to do when they expect to get sick from it. This in turn shows that people who are more scared of becoming sick, also have a less positive attitude towards re-using of food leftovers.

Contrary to what we expected and what other studies about pro-environmental behaviour and one study about food waste found (Han, 2014; Savari et al., 2023; Stancu et al., 2016), in this study the awareness of consequence does not have an effect on people's attitudes. This means that although the awareness of consequence provides important cognitive information, it might not be sufficient to change attitudes.

In other words, awareness of the consequences does affect people's principles, but the knowledge of the consequences does not necessarily make re-using food leftovers a more enjoyable experience. A possible reason for this could be that the experiential and emotional aspects of the behaviour like food enjoyment and fear of food poisoning, weigh stronger than the cognitive components of people's attitudes. Even more so when the leftovers have been lying around for a longer period of time. This difference between prior studies could be explained by the fact that prior studies were about different behaviours, that possibly have fewer negative emotional or sensory experiences. With the prior study about food waste, the difference could be that this study is specifically about re-using leftovers and not just reducing food waste in general, which makes the sensory and emotional aspects of the attitudes weigh stronger.

The skill factor shows a significant effect on people's intention to re-use leftovers and therefore confirms what is mentioned before in qualitative studies (Farr-Wharton et al., 2014; Graham-Rowe et al., 2014). The results show that when people lack skills in cooking and handling food leftovers, they are less inclined to re-use their food leftovers. The results also show that this is mostly the case for younger people, which indicates that experience is an important factor. Other studies that were focused on reducing food waste in general, also showed that household skills have significant effect on the amount of food waste (Stancu et al., 2016; Stefan et al., 2013). These skills however, were mostly focused on shopping and planning routines. This study complements this by showing that creative cooking skills and the ability to assess if something is still good to eat, are also important skills that influence the intention to reduce food waste and more specifically on re-using leftovers.

Contrary to what was expected, the results showed that financial attitudes did not have a significant moderating effect on the intention to re-use food leftovers. Meaning that people who are conscious about spending their money and follow a careful budget, are not necessarily more inclined to re-use their food leftovers. Many studies showed that saving money was one of the key motivators for people to reduce their food waste (Graham-Rowe et al., 2014; Quested et al., 2013a; Visschers et al., 2016), this motivation however, does not seem to be stronger with people who are more conscious spenders than people who are not, in the context of re-using leftovers. This is also in line with another study where household income does not seem to have an effect on the intention to reduce food waste (Visschers et al., 2016), which was also not the case in this study.

Photo by Tamara Malaniy (2021), Retrieved from Unsplash.com.

Chapter 6

DESIGN.

In this chapter, the design process for developing interventions is described, followed by the visualization and explanation of the final design concepts.

The chapter begins with the ideation approach, goals, and methods. Next, it summarizes what the findings from the empirical research imply for the design phase and outlines the resulting design opportunities. Thirdly, it presents the structure and results of a creative ideation session.

Finally, the chapter showcases the design intervention concepts that emerged from the research and ideation sessions.

6.1 Ideation approach

This section describes and visualises the approach and steps taken to go from the results from the empirical research, to design intervention concepts.

6.1.1 Ideation process

Following the project brief, the end result of the thesis is a set of design strategies and guidelines for designing interventions for behaviour change. Additionally, the goal is to provide a few examples of intervention concepts to act as inspiration and to give a more tangible idea of what interventions could look like. To reach this goal, ideation activities took place from the start to the finish of the project. An overview of the process from research to strategies and ideation is visualised in Figure 16.

Individual ideation
Throughout the entire length of the project, the researcher kept memos and notes with ideas for possible interventions that could be conceptualised later on. Spontaneous ideas occured during the literature review, the interviews and the creation of the survey. The creation of ideas was not structured and no methods were used. By gaining new insights from the interviews in particular, ideas would occur spontaneously. The ideas of the researcher all had a different focus and barrier they could tackle. They were added to the ideas that were being generated in the session, whereafter the participants were able to pick the researchers ideas for further conceptualisation.

From empirical research to design strategies
All results from the interviews and the questionnaire were synthesized and used as pointers to form six different design opportunities. These design opportunities describe specific focuses or 'areas' for which interventions can be designed. Five of them are directly taken from the results from the statistical analysis and are therefore based on a psychological construct. These design opportunities can therefore be used to strengthen a certain construct or reduce barriers. The sixth design opportunity is based on the interviews. This design opportunity focuses more on contextual inhibiting factors, for which interventions could be designed to support the user to carry out their intentions.

Since the design opportunities are rather general and abstract, two to four design strategies were formulated for each opportunity to give the designer more handhold and direction to design for. These strategies were formulated based on the rich information that participants gave during the interviews and the items from the measurement model.

From design strategies to intervention concepts
In order to develop design interventions that can act as examples for future designers, a creative session was held. In this session a group of design students looked at the six design opportunities with a few accompanying strategies to come up with as much ideas as possible. A selection of ideas was chosen to conceptualize in more detail. At the end of the session there were six concepts, one for each design opportunity. The process, methods and results of the ideation session are described in more detail in section 6.4.

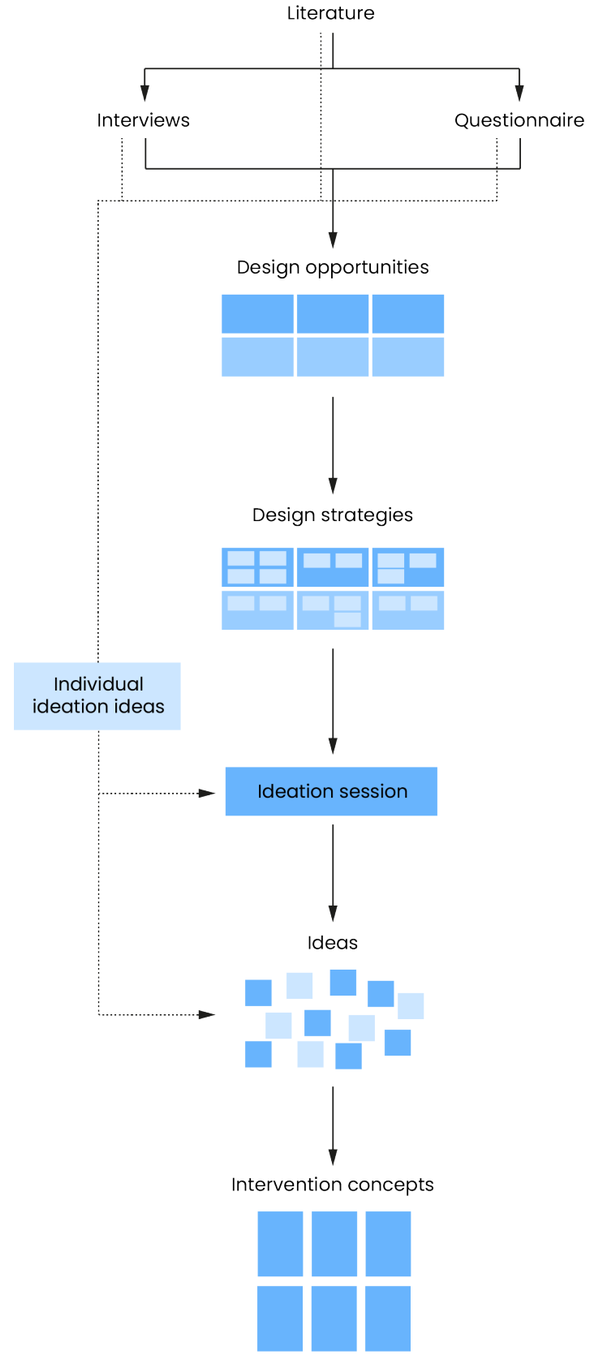


Figure 16: Ideation approach

6.2 Project brief and research implications for design

In this next section is described how the design part fits the project goal and how the research implications led to the final design strategies.

As a result from the literature review, the project goal was specified and defined as:

*"Determine **drivers and barriers** and develop **design strategies** accordingly, to enable individuals to **re-use food leftovers** on a household level."*

The project goal can be separated into two chronological parts. The first part is to identify factors that either push and motivate or withhold people towards the targeted behaviour. The second part focuses on translating these factors into design opportunities, wich are the used to formulate guidelines and strategies for designing behaviour interventions. Additionally, to inspire and give an idea of what kind of interventions could be created out of the design strategies, examples of concepts for interventions are created in a last step.

Figure 17: Steps of the project goal and end result.

In the first step, the drivers and barriers for re-using food leftovers are found through empirical research which included both qualitative and quantitative methods. The results from the statistical analysis provide clear results which factors have an influence on the intention to re-use food leftovers. This means that through the conceptual model, 5 different drivers and barriers are identified that influence people's intentions. These are directly translated into 5 design opportunities, which are the first five factors depicted in Figure 18.

A sixth design opportunity 'Household organization', retrieved from the interviews, is also added. This was not put in the model as a separate factor due to the fact that these are inhibiting contextual influences which prevent people from acting out a certain behaviour. This implies, which was also mentioned by the participants themselves, that although people have the intention to do something, they are not always able to. It should therefore be placed outside of the intention model, which is what the conceptual model in this study is, between the intention and the actual behaviour. Since the actual behaviour was not measured in this study, it was not possible to test household organization as a factor. However, although it was not tested in the model, it did play a significant role in the interviews where every participant at least one time mentioned that they lack an overview of what they have at home or that they forget wat leftovers they still have. Therefore, it was also identified as a design opportunity.

Design opportunities

Figure 18: The six design opportunities.

6.3 Design opportunities and strategies

In this next section the six design opportunities are further explained. Furthermore, for each design opportunity two to four design strategies are defined that form the starting point to design interventions for behaviour change.

The empirical research thus provides six different design opportunities to use a starting point for designing interventions. By looking at the path coefficients of the effects that exist on the model, an extra guideline is derived based on the effect size. The results show that the top three factors have more influence on the intention and therefore more priority than the bottom three factors (Figure 18). This is highlighted by using a darker colour. Although a difference in the strength of the effects exist and can be used as a guideline, the other opportunities should not be ignored. To achieve as much intention with consumers, it is essential to tap into as much factors as possible. For example, if people's personal norms against wasting food leftovers are strengthened but their attitudes towards re-using food leftovers are not strengthened at all, they might eventually not re-use their leftovers. People can feel as though not wasting food is wrong, but if they really don't like to re-use leftovers, chances are they will eventually still throw the leftovers away. Same goes with skills for example. When people are very willing to act out a certain behaviour because they think it is good to do and they would like to, but they don't have the capability to do it, chances are they will eventually not perform the behaviour.

Therefore, since all the design opportunities have shown to be effective, it is recommended to combine or use all of the opportunities to strengthen the behaviour change that can be achieved by the interventions. It is also good to note that the design opportunities that were identified as most effective, are also quite likely to be the hardest to achieve through design interventions. Although there are possibilities for design to intervene in these areas, these factors might also need to be influenced by governmental campaigns or education.

Based on the literature, psychological theory, the rich findings in the interviews and the measuring items from the questionnaire, design strategies are defined for each design opportunity. An overview is provided in Figure 19. A more detailed description of the design opportunities and strategies is given in the next section, as well as an explanation on how they are created based on theory and empirical findings.

Figure 19: Overview of design opportunities and strategies.

Attitudes
Attitudes of people refer to the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question. In simpler terms, it concerns whether a person likes or enjoys to perform a certain behaviour. According to Ajzen (1991), the attitude is shaped through two components, the evaluative or cognitive judgment and the affective judgment. The evaluative judgment is based on the perceived costs and benefits of performing the behaviour. Meaning the believes about the likely consequences that people expect to happen when performing the behaviour. The affective judgment component are more shaped by emotions. It is based on the beliefs of the positive and negative feelings that will be derived from the behaviour. This is often also influenced by people's past experiences of that behaviour.

The results of the empirical research in this study showed that with re-using food leftovers, the awareness of the consequences of food waste did not have a direct significant effect on the attitude. This implies that either the cognitive component is unaffected by the awareness of the consequences, or that the affective component plays a more crucial role in shaping attitudes in this context.

This shows that when we aim to increase people's intention to re-use food leftovers by the attitudes, the affective component might need to be addressed the most. When we look at the results from the interviews and questionnaire, the emotional feelings with re-using food leftovers are mostly mentioned as thinking leftovers are less tasty, become soggy and a feeling of anxiety for getting food-borne illness. To battle these perceptions it is important to have people belief that eating leftovers is nice and good by making sure people have as much enjoyable experiences with eating leftovers as possible. It is therefore first important to give people incentive to try out re-using food leftovers by creating an expectation that eating leftovers could possibly be very enjoyable.

The first design strategy is therefore described as *'Actively trying to change negative perceptions about leftovers being undesirable or of lower quality. Providing evidence and examples of high-quality, delicious meals made from leftovers and success stories from other people.'*

Secondly, it is important that when people in fact try re-using food leftovers, the experience itself is as enjoyable as possible. This can be achieved by making sure people are enabled to make the food tasty, the process of re-using is easy and enjoyable and the overall experience is perceived as fun.

The second design strategy is therefore formulated as *'Providing tools and inspiration, coupled with rewarding incentives, to enhance the fun and flavour of cooking with leftovers and encourage repeated engagement.'*

Additionally, the results showed that attitudes are influenced by people's personal norms, which could mean that people who have strong personal norms do enjoy to re-use food leftovers more. Meaning that people experience positive emotions when they re-use leftovers, because it is in line with their beliefs that they should perform the behaviour.

The third design strategy is formulated as *'Encourage the re-use of leftovers by making people reflect on or anticipate a feeling of pride and satisfaction, enhancing a peace of mind.'*

Lastly, although awareness of consequence did not have a direct effect, other cognitive components were mentioned in the interviews that did seem to have effect on people's attitude. The results have shown that people do evaluate food leftovers as convenient and that re-using leftovers can save money.

A last design strategy is therefore described as *'Highlighting the benefits of re-using food leftovers like convenience, saving money and tasty lunch.*

Awareness of consequences of food waste
The results indicate that when people are aware of the negative consequences of food waste on the environment, it deeply affects their personal norms against food waste which in turn affects their intentions. This aligns with the Norm Activation Theory, where it is posited that an individual must first become aware of the potential consequences of their actions on others and on the environment.

The awareness of the consequences are twofold. First it is important to highlight that food waste is a widespread and large problem amongst the whole population and the individual is part of it. Second, people should be made more aware about all the resources that get lost when they waste their food which in turn affects climate change.

The first strategy is formulated as *'Creating awareness on the size of the food waste problem, that it is widespread amongst the population and that reducing food waste would bring many benefits for the environment and for the individual.'*

The second strategy is formulated as *'Creating awareness on the resources needed to grow, transport and store food by making it more evident, understandable and tangible. Possibly evoking more emotional engagement by storytelling or visual imagery.'*

Personal norms
Personal norms are the internal standards and rules that individuals hold, guiding their behavior based on their personal sense of right and wrong In other words, it is a sense of moral duty or obligation that someone feels to perform a certain behaviour (Schwartz, 1977). Individuals with weaker personal norms may be more susceptible to peripheral cues, whereas strong personal norms help protect individuals from failing to perform behaviors they believe are morally correct.

Personal norms are often influenced by cultural backgrounds, certain values in upbringing or when people are made aware of certain ethical aspects about the subject through information provisioning. These influences shape people's internal values, which in turn guide their behaviour by setting expectations for themselves (Schwartz, 1977).
According to the theoryeory and the empirical research findings, personal norms are often manifested as feelings of guilt when individuals act contrary to their values. For example, when wasting food leftovers, respondents frequently reported feelings of guilt towards the environment and others who lack food. This guilt, especially when linked to environmental concerns, is strongly associated with personal norms. Consequently, exposing people to information about these ethical aspects can therefore effectively influence their personal standards.

The first strategy is therefore formulated as *'Providing information on ethical concerns about food waste to establish a strong internalized feeling that wasting food leftovers is wrong.'*

Secondly, both in the interviews and in the questionnaire, it was made evident that when people had an upbringing where re-using food leftovers was part of their everyday routines, they were more likely to accept the behaviour later in life. Due to continual reinforcement, the behaviour gets more deeply rooted in what a person's feels they are supposed to do. Moreover, studies have shown that parents who educate their children on food and food waste have a positive influence on the habits of children (Kowalewska & Kołłajtis-Dołowy, 2018).

The second strategy is therefore formulated as *'Establishing a strong personal belief at a young age that one should eat their leftovers by making eating leftovers more accepted and celebrated in the culture of a family.'*

Thirdly, the literature and interviews highlighted the existence of a distance between food production and consumption. This distance leads to e general unawarenes of the effort involved in food production. Due to the fact that people don't buy directly from a farmer and that there is always plenty of food available nearby, the valuation of food decreases.

The third strategy is therefore formulated as *'Increasing people's perception of value and a feeling of thankfulness for food by creating a stronger link between food production and consumption.'*

Perceived health risks
The perceived health risks have shown to be a major influence on people's attitude. Although it is reasonable that people might experience anxiety when eating leftovers, often leftovers are still good to eat. Mostly the uncertainty that people experience when leftovers have been stored for a while and the inability to be certain that it is still good to eat, hold people back from re-using their leftovers.

In the interviews came forward that people often have trouble with recognizing if something is still edible. Therefore improving people's knowledge about when a certain food is not good anymore, could increase their confidence in eating the leftover. This is also highly dependable on how people cooked and stored the leftover, which is what people often don't know.

The first strategy is therefore formulated as *'Enhancing people's ability to identify when food has gone bad by teaching them to recognize the signs and assess the likelihood that a specific food is no longer safe to eat.'*

Sometimes it is not easy to recognize if something is still edible or people don't remember how long they have stored the food for. It could therefore be handy if they have external tools that could assist them in making these decisions or to act as a memory support.

The second strategy is therefore formulated as *'Developing tools to act as a guide or memory support in assessing the edibility of leftover foods.'*

Skills
With re-using leftovers, there are certain abilities that have an effect on the intention. The research results showed that re-using leftovers take a certain amount of cooking skills, primarily with leftover ingredients. In the interviews people mentioned a lack of inspiration on what recipes to make, how to combine certain ingredients and that they find it difficult which turns into the perception that it takes too much effort to cook with leftover ingredients.

The first strategy is therefore formulated as *'Providing inspiration or options for meals with leftovers and enhancing the perceived versatility and potential of ingredients.'*

Secondly, the results confirmed that people often don't actually know how they should properly store leftover meals and ingredients. This is a good opportunity, since proper storing could lengthen the time that leftovers stay fresh and good to eat.

The second strategy is therefore formulated as *'Provide information and resources for optimal storing of leftover meals and ingredients.'*

Lastly, in the skills factor was also shown that people have trouble with recognizing if leftovers are still good to eat. Which is in line with the strategies for the perceived health risks and is therefore not mentioned again under skills.

Household organisation
In the interview results, there is strong evidence that people often lack an overview of what they have at home. People often don't have a conscious or effective system for storing. This results in people finding products in the back of the fridge, which they couldn't see or didn't use regularly and therefore had to be thrown out.

The first strategy is therefore formulated as *'Providing tools and knowledge for improving people's storing system to create a better overview of all the products in the fridge and cabinets.'*

Secondly, people often mentioned that they forgot what they have at home when they were not around and didn't have time to go home before going to the store. Additionally, it was mentioned regularly that not all household members are always aware of the fact that there are leftovers. This is due to lack of communication, differences in storing preferences and lack of ascribed responsibility. This is with leftover meals as well as with leftover ingredients.

Therefore the second strategy is formulated as *'Providing tools to help all household members remember what leftovers they still have at home at any time.'*

6.4 Ideation session design

In this next section the ideation session structure is described, including the participants, goals, methods and results.

6.4.1 Approach

The overall goal of the session was to create viable solutions that are detailed to a sufficient level for each of the design opportunities, so that it could be further developed in the future. This was achieved by letting the resource group (RG) first come up with as much ideas for intervention designs as possible, whereafter a selection was made to further detail.

To assure that these goals were achieved, the session design is based on the Content Finding sub-process (Heijne & Van der Meer, 2019) of the Integrated Creative Problem Solving framework (Buijs & Van der Meer, 2013). The first diamond: Defining the problem, was addressed to some extent in the session. The second diamond: Generating and selecting options and the third diamond: Improving the options, were fully addressed in the session.

The session was conducted in a closed meeting room in the faculty of Industrial Design Engineering at the Delft University of Technology, and was intended to take approximately 2 hours. The session was done analogue, with paper and post-it's. The results were photographed and digitally processed by the researcher after the session to use as further inspiration or to conceptualize in more detail.

A day before the session, the participants were provided with a session brief that explains the purpose of the session, the subject and what was expected form the participant. The date, time and location were also written in the brief. The purpose of the session brief is to familiarize the participants with the subject and to inform them on the activities that were going to take place.

Participants
Seven participants had agreed to participate in the ideation session. At least six were needed to assure every design opportunity had two people to work on. Unfortunately, due to two last minute cancellations there were only five participants. To make sure the session could continue as planned, the researcher joined the RG. The participants were recruited based on their study background in design. An overview of the participants can be found in Table 9.

Table 9: Resource group.

	Study	Occupation
P1	Msc. Strategic Product Design	Graduate student
P2	Msc. Integrated Product Design	Master student
P3	Bsc. Industrial Design & Msc. Industrial Ecology	Recently graduated
P4	Msc. Design for Interaction	Graduate student
P5	Msc. Design for Interaction	Master student
P6	Msc. Strategic Product Design	Graduate student (me)

6.4.2 Session structure

An overview of the three phases of the session and the corresponding methods are shown in Figure 20. Before the start of the session, the subject and purpose of the session were repeated for all the participants to make sure everyone understood it correctly. Additionally, the participants were given the opportunity to ask questions.

Problem finding
The purpose of the problem finding diamond is to ensure that everyone in the RG understands the question to be answered and everyone is engaged to solve the problem (Heijne & Van der Meer, 2019). This is usually done by restating the Problem as Given (PaG), which is the initial question given by the Problem Owner (PO). However, since the research question is already set by the project and the group will answer more specific How Might We's in the idea finding diamond, restating the problem was not performed.

To assure that the RG got familiarized and engaged with the subject, Flower Association (Heijne & Van der Meer, 2019) was used as the main exercise in the first diamond. This exercise is used to get the RG in a diverging mindset and to get an overview of the subject. Moreover, it is important to distance the RG group from the subject to widen the solution space. This is done by exploring key elements of the subject, which in this case was 'leftovers' and writing down all the associations that the RG has with this key element. Before the start of the exercise, the rules of diverging were explained to the RG.

Idea finding
The idea finding diamond was the main part of the session. In this diamond the RG is asked to come up with as much ideas as possible to solve the problem. The method used for this was Brainwriting (Heijne & Van der Meer, 2019). Brainwriting is a fluency technique where all the members of the RG write down their own ideas on post its. The group was divided in three smaller groups and each group worked initially on two different design opportunities. The method uses predefined 'How might we?' (HMW) questions to stimulate a variety of ideas. For each design opportunity a main HMW was written on a poster in the middle. Around the main HMW, more specific HMW's were formulated based on the strategies per design opportunity. An example is shown in appendix F.

Before the exercise started, the RG was reminded of the rules of diverging to stimulate a fluency of ideas. The groups would start ideating on one design opportunity and after some time, switch to the second one. They started together on one poster to discuss what they thought about the HMW's and to use each other's ideas to build further upon. When the fluency of both the posters dropped, group members were allowed to help ideate on HMW's of design opportunities from the other groups.

The brainwriting was combined with a Creative Confrontation technique (Heijne & Van der Meer, 2019). The technique chosen for this session was Direct Analogies (Heijne & Van der Meer, 2019; Van Boeijen et al., 2013). These 'flexibility' techniques are used to tap into the imagination of the RG and generate options beyond the obvious. All design opportunities had a smaller poster hanging below where a predefined analogy HMW was written. The RG was asked to analyse how the problem is solved in that situation. After a few minutes the RG was asked to force-fit the things they had written down with the analogy to the corresponding design opportunity. By looking for elements or techniques used in the analogy, the RG was able to find some more ideas for the design opportunity HMW. After the fluency dropped, the RG was invited to move to another design opportunity to work on.

Reverging was done by Spontaneous Clustering (Heijne & Van der Meer, 2019). Here the resource group went back to their original design opportunities and formed groups of post it's that were similar on the poster. They wrote labels on the groups to clarify what this cluster represented. This is done to create a good overview for all the members of the RG.

After the clustering Hits or Dots (Heijne & Van der Meer, 2019) were used to select the ideas that the RG liked the most. Every member was allowed to stick three dots and one hit on each of the design opportunities poster. The RG was encouraged to follow their hedonic response and look for ideas that were 'on target'. Some examples of the idea finding poster results can be found in appendix F.

Solution finding

At the start of the solution finding diamond, the RG went through all the posters one by one together and discussed which ideas and clusters were made. At each poster the RG was allowed to pick one idea or two that could be combined, to further conceptualize in the next exercise.

The ideas are further detailed using the Interactive Brainsketching technique (Heijne & Van der Meer, 2019). Each member of the RG started with sketching one idea on an A4 paper. After a few minutes the paper gets rotated to the next member, who could then sketch more on the paper and build further upon what they previous member had drawn. When the exercise ended the group would discuss the concepts together and explain which ones they liked the most and why. Some of the end results can be found in appendix F.

The researcher took the final concepts and all the ideas that were left on the poster along to create the final intervention concepts for each of the design opportunities.

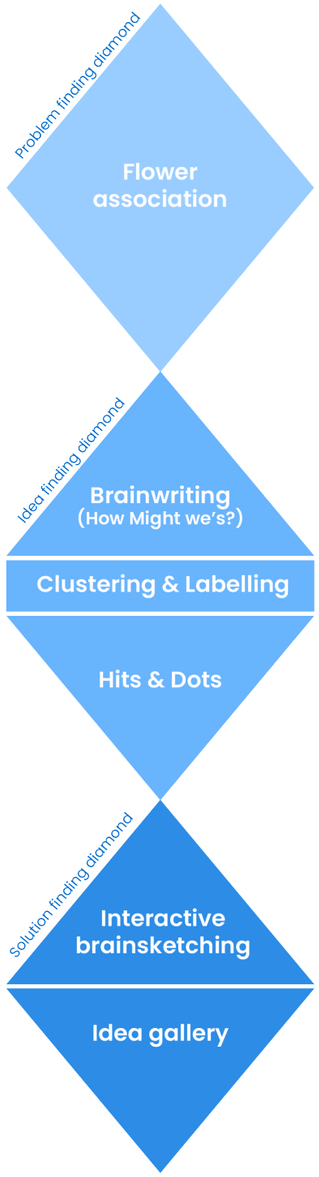


Figure 20: Ideation session structure.

6.5 Design interventions concepts

In this section six design intervention concepts are explained and visualised in detail. For each of the design opportunities, one intervention was designed to inspire and be exemplary of how interventions could look like.

Following the exploration of design strategies aimed at enabling the re-use of food leftovers and the insights gained from the ideation session, this section presents six concrete design interventions. These interventions are conceptualized to address the key barriers and drivers identified in the conceptual model and interview results and translate strategic ideas into actionable solutions. Each intervention aims to foster sustainable behavior change, reduce food waste, and promote the creative and efficient use of leftovers within households.

The primary purpose of these design interventions is to empower individuals and families to make the most of their leftover food, thereby minimizing waste and contributing to a more sustainable food system. By addressing common obstacles such as lack of awareness, organizational difficulties and perceived health risks, these interventions aim to make leftover re-use an integral and enjoyable part of everyday life.

In the following sections, each design intervention will be presented in detail, including a short explanation, key features and strengths and further recommendations. Through these interventions, we aim to inspire and enable people to embrace the re-use of leftovers as a valuable and rewarding practice.

Attitude towards the re-use of food leftovers.

Intervention concept 1

In short:

The leftover challenges is a social media page (for example on Instagram and TikTok) where every week a 'challenge' is posted that followers can take. A list of some examples of these challenges is described in Figure 21. The main purpose of these challenges is to have people use-up their leftovers more often by taking small steps and habit changes.

Followers are asked to send photo's and an accompanying story of leftover meals they created, how they experienced the challenge and what they changed in their daily habits due to the challenge. The user with the best story gets posted as an inspiration for others and can win a reward. This can be things like kitchen sets, dinner coupons, cookbooks, etc. Once in a while a challenge gets presented by a celebrity like influencers and chefs who took the challenge themselves.

The focus of this intervention lies on getting people to start with re-using leftovers by using the power of succesfull example stories and a fun and enjoyable experience. By leveraging visual content, community engagement, and celebrity influence, you can inspire more people to join the movement and change their attitudes towards leftovers.

Strenghts of the intervention concept:

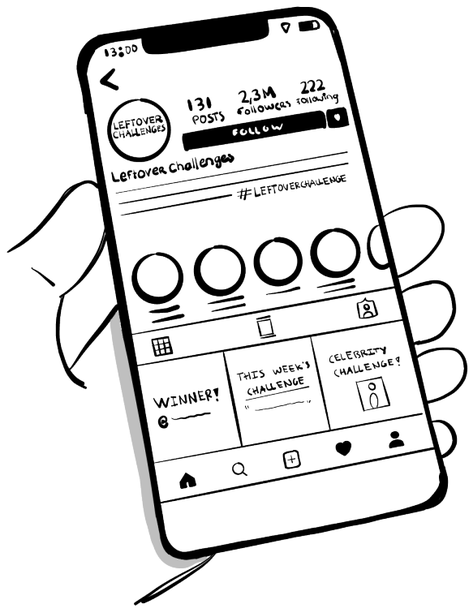
• Visual Appeal: Social media platforms like Instagram and TikTok are visually-driven platforms, which can be perfectly used for for sharing attractive images and videos of creative leftover dishes and challenge completions. This makes re-using seem more enjoyable and fun to do.

• Large outreach and possibility to hook on 'viral trends': Videos, photos and accounts can become very popular in a short time, spreading rapidly accross the internet. This can be accomplished by using fun hashtags (#LeftoverChallenge, #FoodHeroes, #ZeroWasteCooking) and the possibility to share and comment on posts.

• Community building: by posting user-generated content and growing the followers base, a strong community can be build to encourage collaboration and inspiration.

• Celebrity endorsement: When celebrities participate and challenge each other, it can significantly boost visibility and engagement. Celebrity engagement, when chosen right, can enhance credibility and attract a larger audience.

Recommendations
The most important thing with social media accounts is that it should have an attractive look and that there is regular content posting. Engagement grows with more activity on the channel. Make sure that the creativity and benefits that people experienced with the challenges are highlighted under the posts.



EXAMPLE CHALLENGES

'Zero Grocery Week': Don't buy any groceries for a whole week. Use only what you have at home.

'Fridge Shuffle': Store all products usually at the back of your fridge in the front and vice versa.

'Surprise Ingredient': Add a 'surprise' leftover ingredient to your meal every day this week.

'Meal Prep Master': Plan all your meals for the week using leftovers as the main ingredients.

'Creative Leftovers': Create a completely new dish using only leftovers.

'Waste Audit': Track all food waste for a week and find ways to reduce it.

'Recipe Sharing': Share your favorite leftover recipe with friends or on social media.

'Stock photo': Take a picture of the content of your fridge every morning this week.

WEEKLY CHALLENGES

WINNER WITH SUCCES STORY FEATURE

CELEBRITY ENDORSED CHALLENGES

Figure 21: Visualisation of concept 1, 'The leftover challenges'.

Awareness of the consequences of food waste.

Intervention concept 2

In short:

The food journey shop sign is a large billboard that is installed on top of the (fresh) food sections. The sign is meant to raise awareness on the impactful process involved in bringing food from the farm to the table. The sign illustrates each step of the food production journey including planting, harvesting, processing and transportation. By highlighting the large amounts of resources needed at each stage, such as water, energy and labour, the sign aims to educate shoppers on the importance of valuing and utilizing their food efficiently.

Strenghts of the intervention concept:

• Visual appeal: by equipping the sign with appealing visuals and colours, the sign stands out and catches people's attention. Clear visuals make the information better accessible for all types of audiences.

• Storytelling power: by cutting up the process into clear parts, the story becomes better understandble. By engaging people in the story, the sign seeks to elicit a deeper appreciation for food and motivate consumers to adopt more sustainable practices, ultimately contributing to a reduction in household food waste.

• Call to action: the signs shows a clear call to action which gives a sense of urgency to prompt a quick response and reinforcement of the message and objectives of the sign.

• Sustainable reputation: By emphasizing the environmental benefits of reducing food waste, the sign aligns with broader sustainability goals and can enhance the store's reputation as a responsible business.

Recommendations
To prevent the sign from becoming 'part of the furniture' and not standing out anymore, it is good practice to take the sign down or replace it with different one every once in a while. It is also important to make sure the sign is good visible and to hang it in places where people often walk or look. Lastly, the sign could optionally be made a digital screen to make sure the content can change more easily and to be able to roulate and also show pictures of for example the farms that work with the supermarket.

FOOD JOURNEY SHOP SIGN

CREATING AWARENESS OF THE REQUIRED STEPS AND RESOURCES TO CREATE FOOD
With the sign, people get reminded of the energy and effort that is needed to get food ready to eat to the supermarket. It stimulates a moment of realization and brings the production of food closer to the consumer, ideally leading to a stronger feeling of thankfulness.

VISUAL STORYTELLING
Because the journey of food is depicted in a visual and light way, the message is friendly and not that heavy. It also makes it easier to understand. However, in combination with the supporting text, it also creates a sense of urgency and importance.

POSSIBILITY TO FIND MORE INFO, TIPS AND TRICKS
The sign also contains a QR code that brings people to websites for more info about food waste, but also about tips and tricks to prevent your food from turning bad before you were able to use it. This way people can immediately become actionable towards the good cause.

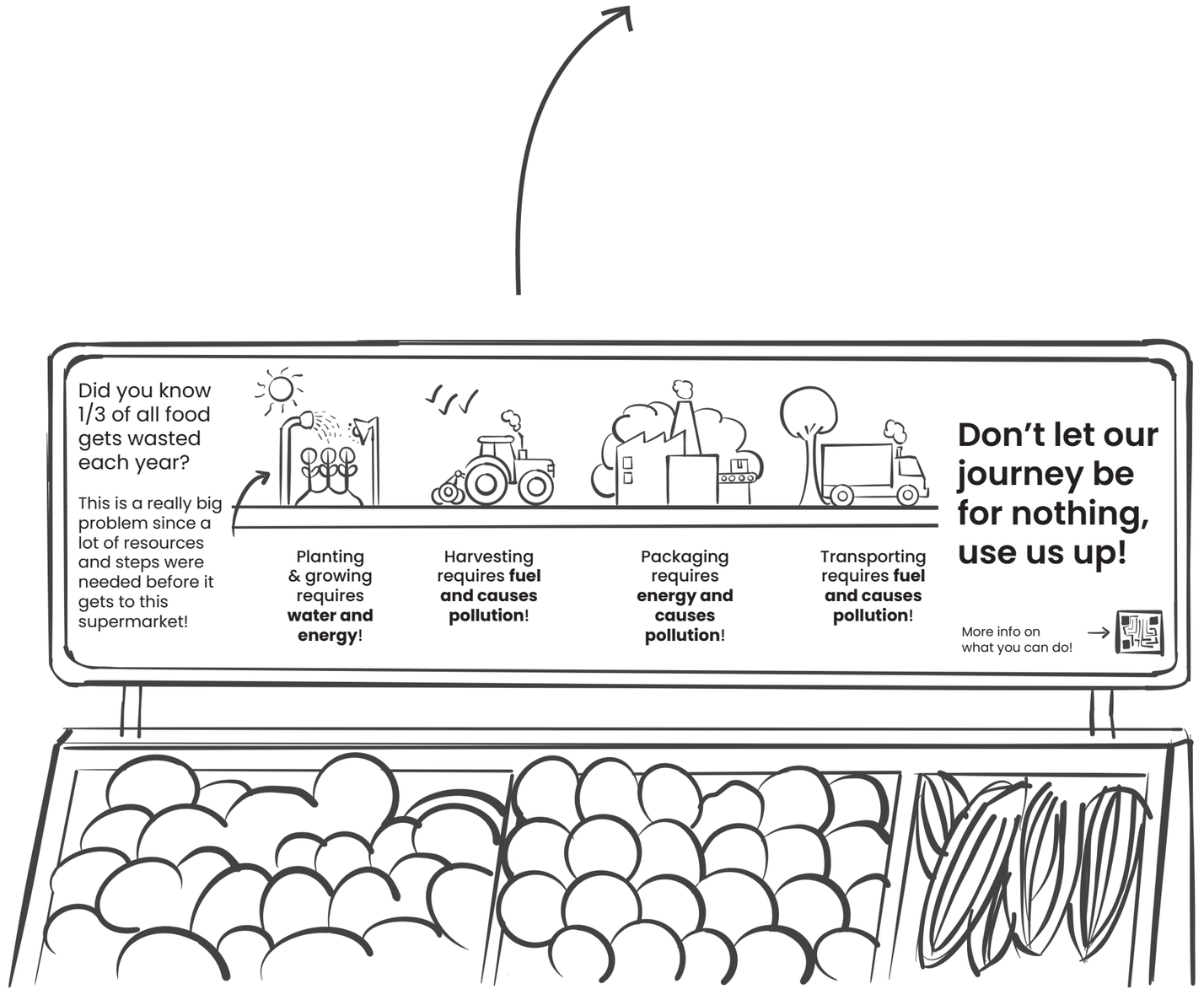


Figure 22: Visualisation of concept 2, 'The food journey shop sign'.

Personal norms.

Intervention concept 3

In short:

'Max the leftover hero' is a friendly and fun children's book designed to educate children about reducing food waste through storytelling and attractive illustrations. The story follows Max and his grandmother as max learns the exciting journey of food from the farm to the kitchen from his grandma.

The book aims to learn children how food can be saved and creatively re-used into delicious meals, through max and the leftover hero jar. The book emphasizes the value of food, the effort involved in its production and the importance of not letting it go to waste. By personifying the leftovers as heroes, the book aims to change children's ethical beliefs from a young age and inspire parents to integrate the practice of eating leftovers into the family culture.

Strenghts of the intervention concept:

• Visual appeal and storytelling: the story captures children's attention, trying to make the message more memorable and inspirational.

• Early ethical development: by targeting young children, the book helps install sustainable habits and ethical beliefs against food waste from a young age. Reading the book more often can can strengthen these internalisations by constant endorsement of the message from the book.

• Parental involvement: the book allows and encourages parents to promote sustainable practices within the family, making food waste reduction behaviour normalized and routinized.

• Positive associations: by personifying the leftovers as heroes, it creates a positive association with re-using food leftovers, making it a more enjoyable practice for children.

Recommendations
To keep children engaged and to be able to endorse the message continuously, a series of books about 'Max the leftover heor' can be made. The books could be sequels, expanding the story and using different storylines and types of leftovers. An important aspect of this, is to make the characters relatable for the children so that they can connect and empathise with them.

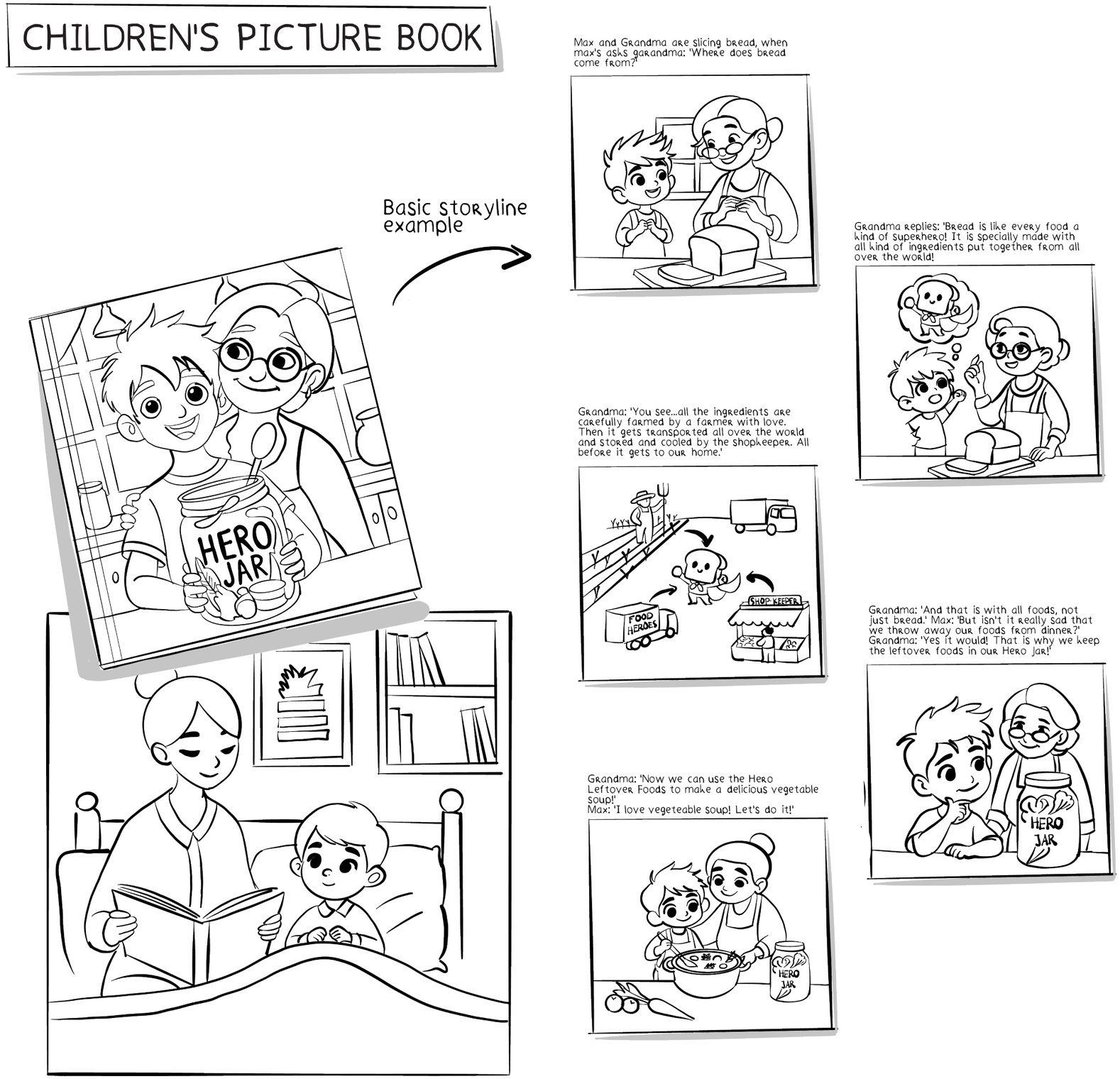


Figure 23: Visualisation of concept 3, 'The childrens' picture book'.

Intervention concept 4

In short:

'The leftover check app' is designed to help users determine whether their leftovers are still safe to eat. The app uses the possibilities of modern technology and the latest food safety guidelines to provide an extensive advice on the safety of a specific leftover that the user wants to gather information on. Based on the type of food, the way of cooking, the storage conditions and duration, the app provides guidelines on the edibleness and the actions to take. Furthermore, it provides more information of optimal storing ways and food safety guidelines. They key is to provide a user friendly experience and clear advices that builds confidence and fosters a positive attitude towards re-using food leftovers,

Strenghts of the intervention concept:

• Educational value: the app educates users about safe food handling and storing practice, cooking methods and signs of spoilage. This way it raises awareness about the factors that contribute to foodborne illness, helping users make more informed decisions.

• Confidence building: the app provides reassurance by giving evidence-based advice, reducing the fear of getting sick from leftovers. It builds trust in the safety of re-using food through reliable and consistent advice. This way it encourages re-use and reinforces positive behaviour by showing users that many leftovers are safe to eat when handled properly.

• Accessability: the app is an easy to use platform that can be accessed anywhere anytime. It breaks down the assessment proces into simple questions making the use very easy and straightforward.

• Updated database: the features and information database can be continuously updated, keeping the app up to date on the newest food safety guidelines and technological options.

Recommendations
Since it is not possible for the app to give entirely accurate advice, it is important to make users aware that the decision to eat the leftovers is entirely their own responsibility. A message should be clearly written that the app is not to be held accountable for any illnesses caused by the advice given by the app. Users should take the advice with caution. Additionally, the app should always encourage people to use their senses in the advice text that the app provides. Another recommendation is to give the possibility for users to provide feedback on the understandability and accuracy of the advice. With users' feedback the app can learn and imprive itself.

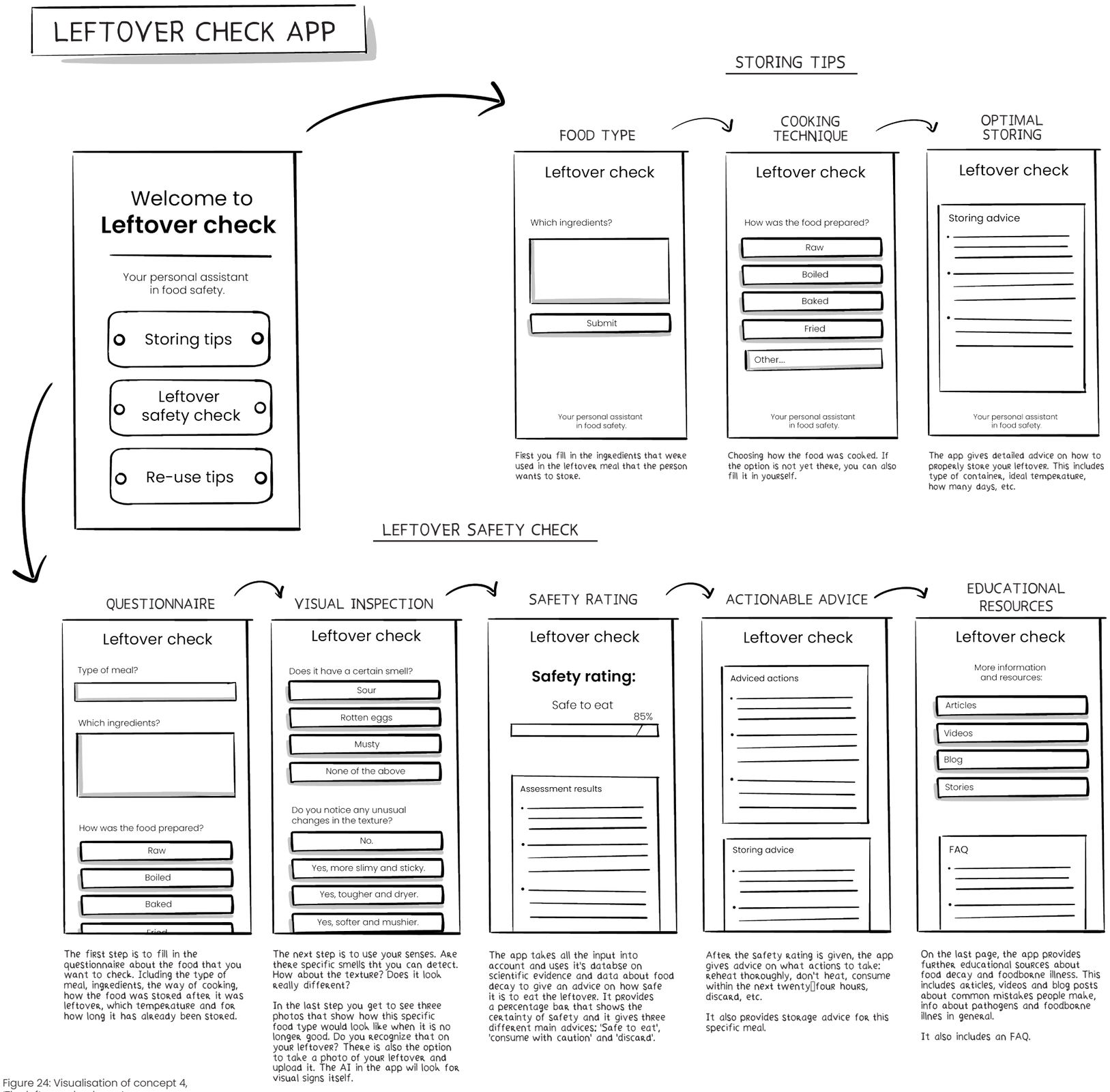


Figure 24: Visualisation of concept 4, 'The leftover check app'.

Skills in processing food leftovers.

Intervention concept 5

In short:

'The use-up app' helps users create meals based on the ingredients they already have at home by allowing them to input the ingredients and the quantities. Based on this information and the number of people that join dinner, the algortihm matches avalaiable ingredients with a database of recipes. It then provides a list of recipes with a percentage bar showing how much of each recipe can be filled with the ingredients that users already have at home and how much they still need to get from the store. This page is also equiped with a filter function where people can fill in their preferences. The app also offers to keep an online shopping list and a weekly meal planner. The app is effective because it simplifies meal planning and reduces food waste by ensuring that users make the most of their available ingredients. The main purpose of the app is to help users reduce their food waste and save money by using the ingredients they already have. Furthermore, by consistently cooking recipes with leftover ingredients, people learn about new combinations and possibilities for each ingredient, growing their creatibve cooking skills.

Strenghts of the intervention concept:

• Skill development: cooking the recipes helps users become more creative and confident in cooking with their leftovers. They learn to make the most out of what they have and make meal preparation more efficient and fun.

• Improved planning: by making use of the shopping list and weekly planner, people can keep better overview of what they need to get from the store and on what day they will finish their leftover ingredients. By keeping track of a plan it is better assured that all the ingredients are indeed used up.

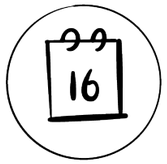
Recommendations

The app can be expanded by adding video tutorials and educational tips and tricks about cooking and storing. This makes the app more engaging and even more educational. The app can also be expanded with a user forum and feedback options, to make sure recipes with good ratings come up higher in the list and recipes that are bad can be less recommended.

USE - UP APP

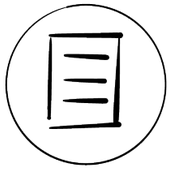
PROVIDING RECIPES FOR CREATIVE LEFTOVER COOKING

• Generate a recipe just for today, based on a selection of products that you have left at home.
• Generate recipes for the whole week, based on all the products you have left at home.
• Option to click on an ingredient in the recipe to get more info on its regular uses, possible substituting ingredients, often used prepping techniques, etc.



POSSIBILITY TO PLAN MEALS FOR THE WEEK

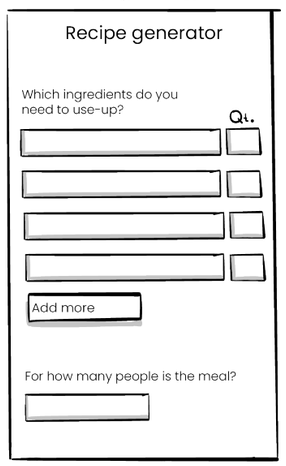
• Whenever you have chosen a recipe to make, you can add the recipe to your meal calendar for the week. You can click and drag to any day your prefer.
• When you have used the function to generate recipes for the whole week, you can automatically add all the recipes to your calendar for that week.



AUTOMATICALLY ADD ITEMS TO SHOPPING LIST

• When you have chosen one of the recipes to make, you can add the ingredients that you don't have yet to your shopping list in the app.
• The shopping list can be organised by ingredient or by recipe.

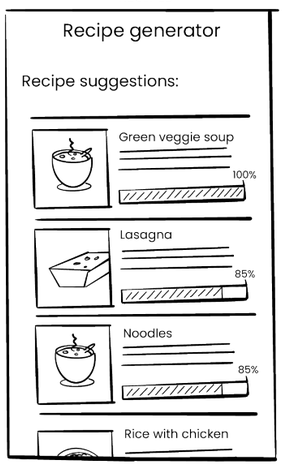
SUBMITTING INGREDIENTS AND QUANTITIES



To generate recipes, you can choose to only generate one recipe for the day, or generate a bunch of recipes to use up all the leftovers you have at home during the week.

You fill in the ingredients you want to use up and the quantities you have. Additionally, you provide the number of people that you want to cook for.

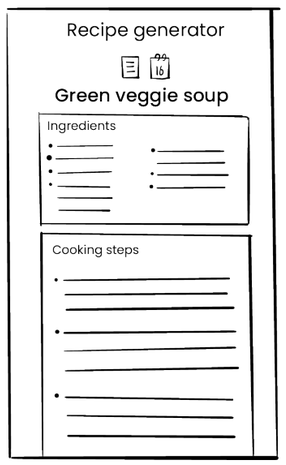
GENERATION OF A LIST OF RECIPES



The app provides you with ten to fifteen recipes that contain your leftover ingredients. The recipes are equipped with a percentage bar, that shows how much of the ingredients in this recipe you can fill with your leftovers and how much you still need to buy.

The app can generate recipes based on your preferences. You can filter on the type of world kitchen, vegetarian or vegan, allergies, etc.

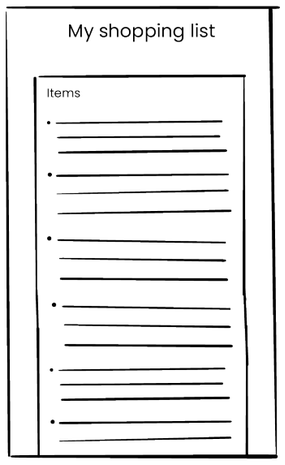
INGREDIENTS AND COOKING STEPS OVERVIEW



By clicking on a recipe you get the overview of the ingredient list and the cooking steps. In the ingredient list is highlighted what is still needed from the store, if that is the case with this recipe. By clicking the shopping list icon, you automatically add these ingredients to your shopping list.

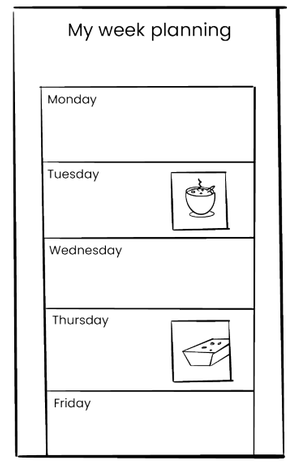
Also, by clicking on a specific ingredient, you get more info on how you can substitute this ingredient with something else. It also provides info on how this ingredients is used most often and with which other ingredients it combines well.

SHOPPING LIST TO KEEP TRACK OF WHAT YOU NEED



In the app you can keep track of everything you need to get from the store based on the recipes you plan to cook.

OVERVIEW OF MEAL CALENDAR FOR THE WEEK



There is also the possibility to improve your planning skills by making use of the weekly meal calender. Here you can keep an overview of when you plan to eat which meal, to use up all your leftovers. The calendar is flexible and you can click and drag the recipes to any day you like.

Figure 25: Visualisation of concept 5, 'The use-up app'.

Household organization.

Intervention concept 6

In short:

'The automatic leftover tracker' is a system that helps households manage their leftovers efficiently using NFC tag equipped tupperware containers and a companion app. The system includes an NFC reader in the fridge and freezer that automatically detects the addition of a new leftover. When users place the container inside, the leftover meal gets added to a list of leftovers in the app. People immediately get a notification asking to fill in what the leftover contains and the portion size. The list keeps track of the date the leftover was put in the fridge and provides a notification after a certain time has passed. The main purpose of the app is to make sure all leftover meals are eaten and the responsibility and awareness of the presence of leftovers is divided more between household members.

Strenghts of the intervention concept:

• **Memory support:** The system helps users remember what leftovers are available at home and tracks how many days have passed since each leftover was stored. This provides better control over consuming leftovers before they spoil and allows for more accurate judgment on whether the meal is still safe to eat.

• Automatization: with the use of automatic NFC driven functions, the effort that needs to be provided by the users gets lowered significantly. By automatically adding the leftovers to the list and a notifictaion, the user canot forget to fill it in.

• Meal planning: the list of leftovers and their quantities allows for better meal planning. The planned time to consume the leftover can be based on how many portions are needed, how long a certain meal can be stored and the preferences of the users.

Recommendations
The system can be expanded by adding functions to the leftover list, like claiming meals and assigning meals to users. Additionally, a rewards or competition feature can be added to encoursge the re-use the leftovers.

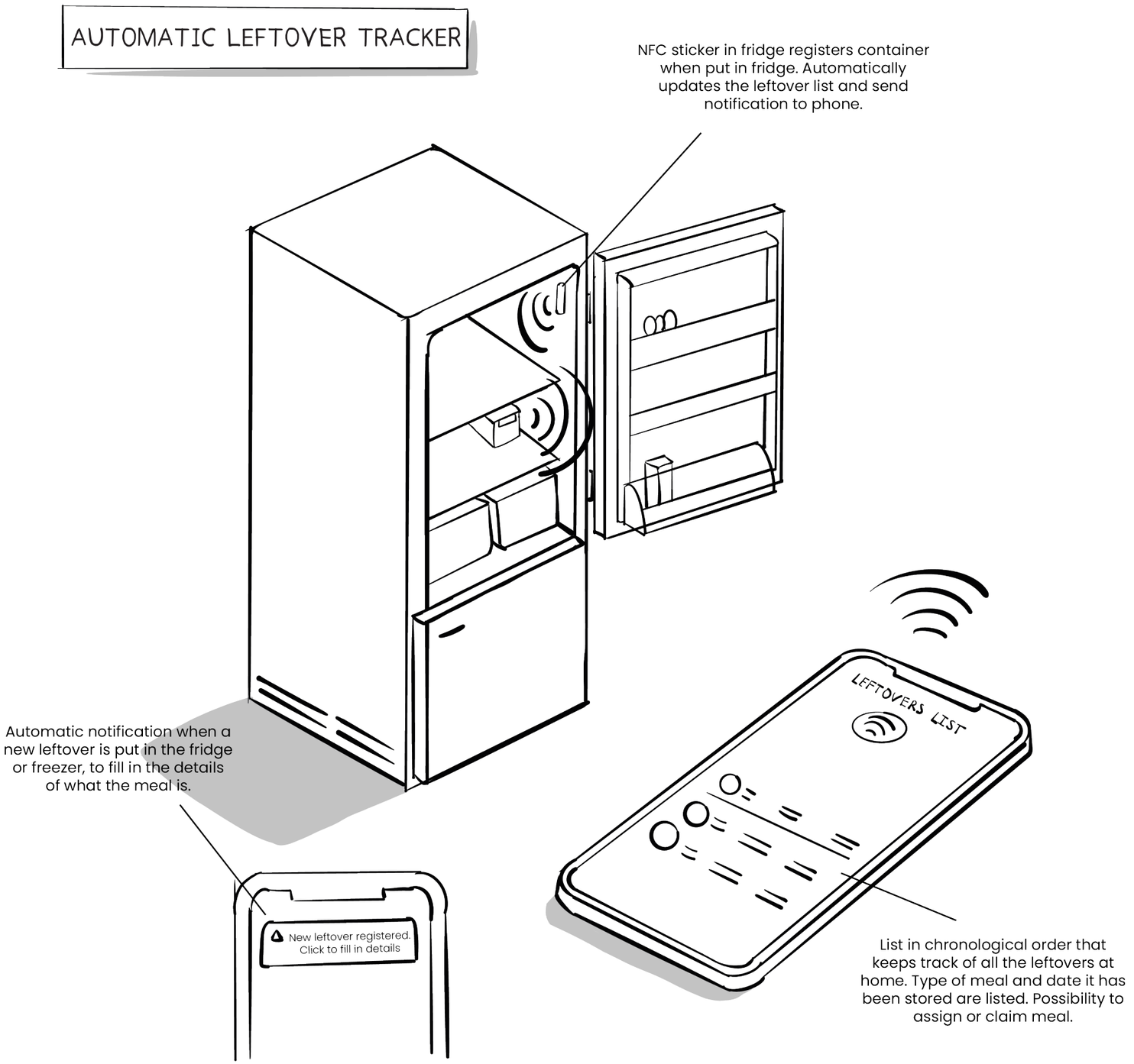


Figure 26: Visualisation of concept 6, 'Automatic leftover tracker'.

Chapter 7

CONCLUDE.

This chapter is the ending chapter for this thesis. It includes the conclusion, limitations and recommendations.

Additionally, a personal reflection of the researcher is written where the process and the epxeriences of making this thesis are written.

7.1 Conclusion

This project answers the research question *'What factors act as barriers or drivers for re-using food leftovers and how can we design interventions for behaviour change to enable people to re-use food leftovers?'*.

The main objective of this thesis is to build a comprehensive conceptual model that explains a large part of the variance of people's intention to re-use food leftovers, which is a specific food waste reduction behaviour. The conceptual model was built based on literature and adjusted according to the results from the interviews that were conducted.

The thematic analysis of the interviews yielded three main themes: (1) Difficulties of organizing, (2) Doing the right thing, and (3) Ascribed value to leftover food. The results from the interviews showed good overlap with the initial conceptual model. Only one factor, Sensory appeal, was replaced by Perceived health risks as it was deemed more important.

The model was tested using the statistical analysis method PLS-SEM. The results show that a combination of constructs from the Theory of Planned Behaviour, the Norm Activation Model and the ability factor of the Motivation-Opportunity-Ability model can explain a large portion of the variance of the intention to re-use food leftovers. This implies that the re-use of food leftovers is at least partially explained by psychological reasons. The model shows that people who have a more positive evaluation of re-using leftovers and have stronger ethical believes against food waste, are more inclined to re-use their food leftovers. Also, a lack of skills in processing food leftovers has a negative effect on the intention. Meaning that improving people's skills in cooking with leftovers, optimal storing and the ability to assess the edibleness increases the intention to perform the behaviour.

Additionally, attitudes mediates the perceived health risks, which means that people's evaluation of the behaviour is affected by the level of anxiety they experience for food-borne illness. Increasing people's confidence in that leftovers are most of the time safe to eat, could therefore increase the intention. Lastly, the awareness of the consequences of food waste is only mediated by personal norms and not attitudes. Implying that awareness raising does positively affect people's ethical concerns and beliefs, but it does not affect people's evaluation or (dis)like of the behaviour. Implying that attitudes are more strongly shaped by affective components and not cognitive. However, there is a mediation of personal norms between awareness and attitude, meaning that there is possibly a feeling of satisfaction or pride when people re-use their food leftovers.

The results of the model show possible entry points for which we can start to positively influence people's intentions to re-use food leftovers. Through testing the model, five barriers and drivers were identified for the intention to re-use food leftovers: (1) Attitudes, (2) Personal norms, (3) Skills, (4) Awareness of the consequences, and (5) Perceived health risks. These barriers and drivers were translated into five design opportunities. One additional design opportunity, Household organization, was found in the interviews, resulting in six design opportunities.

A total of 15 design strategies were formulated from the design opportunities, serving as a starting point for designing interventions for behaviour change. An ideation session was organized to gather potential intervention ideas from the design strategies, resulting in six design intervention concepts—one for each design opportunity—demonstrating how interventions could take form. The concepts were visualized and supported with explanations on their workings, key strengths, and design recommendations.
Food leftovers play a major role in food waste, and this thesis specifically explores which factors drive or inhibit people from re-using their food leftovers. The thesis contributes to the food waste literature by developing a conceptual model of people's intention to re-use their food leftovers, combining constructs from existing behavioural theories. To the best of the author's knowledge, a conceptual model with this configuration to quantitatively test people's intention to re-use their leftovers has not been done before.

Furthermore, the development and conceptualization of design interventions is scarcely found in food waste literature. By illustrating how interventions could look like, the results of the empirical research become less abstract. Additionally, the visualized intervention concepts show how the research results can be applied, making them more concrete and actionable. Lastly, the interventions can inspire creative thinking about possible solutions for tackling the food waste problem, demonstrating that there are many different ways to approach and solve this issue, which is one of the unique strengths of the design field.

7.2 Limitations

There are several limitations that come with this thesis. First, the theoretical models that were used have their boundaries in explanatory power. The Theory of Planned behaviour is especially suitable for behaviours that are under complete volitional control, which is usually, but not always the case for the re-use of food leftovers. As mentioned in the research, occasionally there are contextual factors that inhibit people from acting out their intentions which could cause an attitude-behaviour gap. Moreover, questionnaires are often subject to biases due to socially desirable answers given by respondents, which would lower the trustworthiness of the responses.

Secondly, the samples of both the interviews and the questionnaire are not fully representative of the Dutch population. Especially due to the sampling strategies that were used for collecting responses for the questionnaire, there was not much supervision and control over the distribution of the different demographic categories. This occasionally resulted in an unbalanced division in response of each group, which for example resulted in a slightly higher educated sample than what would be representative.

Thirdly, the questionnaire was constructed based on measures from studies that were written in English. Since this study is performed in the Netherlands, the questionnaire was translated to Dutch to assure language familiarity and comprehensibility. Although the translation was performed with caution, it was not done by a professional translator. Therefore, possible biases or difference in nuance cannot be fully excluded.

Additionally, the term 'leftovers' was not specified in types of foods. Considering that respondents in the interviews occasionally indicate that their re-use intentions would depend on what kind of meal or ingredient the leftovers was, the questionnaire responses could slightly differ between types of foods. Since, this was not taken into account, the results of the conceptual model could be different once it is tested for specific food groups.

Lastly, there was no opportunity to bring the design interventions further than concept level. Due to time constraints the concepts have not been through iterative cycles of testing, evaluating and improving. This means that the concepts are only detailed to a relatively superficial level and the effectiveness of the interventions have not been measured.

7.3 Recommendations and future research

Based on the identified limitations and findings in this thesis, there are a few recommendations for future research.

First and foremost, it is recommended to further design, detail and most importantly test the interventions that were created in this thesis. By conducting research through design, user's evaluations and opinions on usability, desirability and effectiveness of the interventions could drastically improve the concepts. Additionally, it is recommended to do more ideation sessions where there is more time to focus on one specific design opportunity. By spending more time on one direction, the resource group can go deeper into that specific subject and pass more waves of creativity to end up with more innovative and functional concepts. It is also recommended to diversify the resource group. A combination of behavioural experts, psychologists and design professionals could for example improve the quality of the end results of a session.

Secondly, this thesis was mostly focussed on the intention and motivational side of re-using food leftovers. Although there was some attention to inhibiting contextual factors, more attention could be given to other yet unidentified factors that can cause an attitude-behaviour gap. Possibly, the actual behaviour can also be added to the conceptual model to test the relationship between intention and behaviour. Only is it recommended to do this in a rigor way with direct observation or diaries, since self-reporting behaviour is not always reliable.

Moreover, since this thesis was built on psychological constructs, the behaviour could also be approached from a social theory perspective. By looking further than solely individual focused psychological theory, the findings could be enriched by factors or influences that have more to do with meanings and social-cultural contexts.

Third, it might be interesting to test if possible differences exist between types of leftovers. The first option is to evaluate the differences between leftover meals and leftover ingredients, where you use the same conceptual model but divide the response group into two. A second possibility is to test if there are differences between specific food groups. This can be for example vegetables and animal products or fresh products and products in a jar or can.

7.4 Personal reflection

In this last section of my thesis, I get the chance to look back on the past 5 months. As you might have noticed, this thesis is a very research oriented project. Meaning that designing only took place in the last small part of the project. Although I was very happy to have done a more scientific project, it did feel a bit counter intuitive. At the time when all the research was done and the results were layed out, I felt like I could finally start my graduation project.

However, doing a more research oriented project did give me the chance to learn a lot and improve my abilities. Something that I am very happy about and proud of. Thinking about the steps that I took in the project, I can say that I enjoyed the literature review the least. It is easy to get lost in the literature and to keep an overview is really a challenge. I can say that I am quite happy that I will probably not have to do that again in the future.

Conducting the interviews and especially analysing it was my favorite part of the entire project. The satisfaction and pride I felt when I finally put my codescheme and narrative together, made it feel very enjoyable. Making the questionnaire, which came after that, was less enjoyable and was a lot more difficult than I expected. However, once that was done and I collected enough responses, doing the analysis was something that I really enjoyed again. I guess that this shows that I am more of an analysis person.

When I look back at the final design part, I can say that I am very proud of the design strategies that I formulated. I experienced that making the translation from the empirical results, the conceptual model in particular, to designing is very difficult. You have to go from very abstract to very concrete. I think the design interventions that resulted from the strategies are fun, hopeful and diverse, and they provide inspiration to further think about possible solutions. However, I am a bit dissapointed that there was very little time for designing. I didn't get any chance to iterate or test the designs, nor was there any time to evaluate the concepts with people. I am sure that if there was a chance for this, the intervention concepts would have been even better.

Personal ambitions

When reflecting on reaching my personal ambitions, I believe I have fulfilled all of them. First of all, working on this project all by myself has forced me to improve my project management skills. I have been able to succesfully estimate what would be possible to deliver in the project and I have finished all tasks to my satisfactory level. Additionally, I followed a structured planning throughout the whole project which helped me keep track of when I needed to get things done. Creating and constantly updating this planning helped me to structure my work but also leave room for some flexibility.

Secondly, although I think that my stakeholder management and executing effective meetings is not yet perfect, I did gained a lot of experience through this project. I have practiced in keeping people updated on my progress and always trying to stay one step ahead. I also improved my ability to better prepare for meetings and to be more conscious about what I want to get out of it.

Thirdly, the most important personal ambition, is to perform an extensive quantitative research. I had very little experience in doing quantitative research and analysis before I started this project. I wasn't happy with this, since I think it is very valuable to have knowledge about the principles of quantitative research and how to perfrom it. Moreover, I felt unsatisfied that I was about to graduate scientific education without having proper knowledge about quantitative research. This project allowed me to change that and I can confidently say that I have gained a significant amount of knowledge and understanding about the workings of survey testing. I was a bit worried at times that everything would go right and it took me a while before I dared to push the analysis button, but the results were better than I could have hoped for.

Fourth, I have gained a lot of knowledge and understanding about how human behaviour is shaped. I have learned many psychological theories and how a conceptual model can be build based on the constructs. I notice that now in daily life I sometimes try to analyse people's behaviour by taking these psychological theories into mind.

Lastly, next to a quantitative part, I have also gained experience in doing a qualitative research and analysis. By conducting nine interviews, I noticed that I had enough time and chances to gain confidence and skills throughout the process of conducting the interviews. I became better at noticing when I had enough information form an interview or whether I needed to ask about certain topics more. I also got better and more confident at probing, which resulted in more fluent and interesting conversations. Additionally, I am very happy with how the thematic analysis turned out. Performing the analysis all by myself was a bit scary at first, but it only reminded me that I really enjoy to do it and that it results in very rich and extensive content.

Reflection on my study journey

Now that I have reflected on the content of my thesis, I also like to look back on my years as a student at this faculty. I now recognize that everything that I have learned through my study came together in this one project. Recently, I came accross one of my reports that I handed in at the end of my first year as a student. Any doubts that I had about whether I have grown in my abilities since then, were immediately taken away.

Although all the years of studying have prepared me to succesfully finish a graduation project, writing this thesis sometimes felt like a rollercoaster. Whenever I had succesfully tackled a challenge in the project, the next climb was just around the corner. Leading to an alternation of feelings of anxiety and relief. I am not sure if there are many other students who would describe the experience in a similar way, however, for me it didn't come as a total surprise. After ending several other challenging individual projects including my bachelor end project, I realised that working on important projects all on my own is just not for me. This bit of self-knowledge took a little edge off the joy and excitement of starting my master's, as I was remembered from time to time that a master's degree eventually means facing the infamous graduation project. And this is a project that you do individually.

However, although I was a bit scared at first to start my thesis, the experience was nowhere near the daunting experience that I imagined it to be. The chance to delve into a subject that I enjoyed and to step by step put a project together, often caused feelings of satisfaction and pride. Looking at all the new things that I learned, challenges that I have overcome and the end result of my work, I can only say that I improved the confidence in myself and that I am proud of the end result.

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APPENDIX.

Appendix A: Informed consent form

Informed Consent Form

Title of research Study:
Enoughness in Food Consumption: Design Strategies for Achieving Sufficiency.

Principal Researcher:
Heleen Sinnige

You are being invited to participate in a research study titled: **Enoughness in Food Consumption: Design Strategies for Achieving Sufficiency**.

This study is performed by **Heleen Sinnige** from the TU Delft. The research is supervised by Dr. L.B.M. Magnier and Dr. S. Nikou.

Food waste constitutes one of the most significant problems of the food system today. Of all food that gets produced, nearly one-third of edible food is wasted each year. The purpose of this research study is to understand the behaviour and perception of people around leftover food waste. The interview will take you approximately **1 hour** to complete and with your consent also involves a walk-through component where you show the content of your fridge and kitchen cabinets with regards to food leftovers. The data will be used to complement a theoretical framework that can be used to identify opportunity spaces for designing interventions for behaviour change. The results will be used in a master graduation thesis, performed and written by Heleen.

We will be asking you to explain your attitudes, use, discarding and intentions to re-use food leftovers. In this study, **food leftovers are defined as** a) food that was prepared for a meal, but not plated, b) food that was made and put on a plate, but not eaten, c) ingredients surplus that weren't used in the meal and d) leftovers from restaurants, takeaway or online ordered food.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by anonymizing the data that you submit and by storing the data in a secure TUDelft server where only the main researcher and supervisors have access to. Lastly, the interview audio files will be deleted after the study is finished which will be no later than the end of September 2024. The transcripts, observations and further results of the study will be anonymized.

The research results will be published on the TUDelft repository at the end of the study. All data used in the reports are anonymous. In case the project will result in the publishment of an article, the data and results will also all be anonymized.

Your participation in this study is entirely voluntary and you can stop the interview at any time.

If you have any further questions during or after the survey, you can contact the researcher at H.S.Sinnige@student.tudelft.nl.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated ……../……../……., or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: participating in an interview where the conversation will be recorded and later on transcribed.	☐	☐
4. I agree to participate in a walk-through component of the interview where I will explain the content of my fridge and cabinets with regards to leftovers. The aim of this component is for the researcher to make observations that can be used in the analysis of the interview.	☐	☐
5. I understand that the study will end when the research project is finished, which will be no later than the end of September 2024.	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study involves the following risks: in case of a walk-through interview, mental discomfort or a feeling of awkwardness when showing the contents of my fridge and kitchen cabinets. I understand that these will be mitigated by the possibility to stop the walk-through at any given point in time or setting boundaries in which parts of the kitchen I am willing to show.	☐	☐
7. I understand that taking part in the study also involves collecting personally identifiable research data (PIRD) including age, gender, educational level and household composition, with the potential risk of my identity being revealed.	☐	☐
9. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: the transcripts will be anonymized and the informed consent form is scanned and securely stored in a safe online environment where only the main researcher and supervisors have access to. The physical signed consent form will be destroyed as soon as it has been scanned. The audio files will be permanently deleted after the end of the study, which will be no later than September 2024.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
12. I understand that after the research study the de-identified information I provide will be used for the master thesis project report, with a possibility of the publication of a research article.	☐	☐
13. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
16. I give permission for the de-identified data that I provide to be archived in the TUDelft repository so it can be used for future research and learning.	☐	☐
11. I understand that access to this repository is open. Only the project report with accompanying appendices will be uploaded. All data is anonymized.	☐	☐

Signatures

_____ _____ _____

Name of participant [printed] Signature Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____ _____ _____

Researcher name [printed] Signature Date

Study contact details for further information: Heleen Sinnige, H.S.Sinnige@student.tudelft.nl

Appendix B: Interview guide

Interview guide intentions to re-use food leftovers

General information questions:
Could you shortly describe yourself?

- Can you state your age and gender?
- Can you state you highest achieved educational level?
- Can you state the composition of your household?

Interview questions:

1. What is your opinion on food waste?
    - Do you sometimes think about the amounts of food you waste?
    - Do you take actions to reduce the amount of food you waste?

2. Do you sometimes have leftovers? Can you describe what these leftovers usually are?
    - How do you decide what leftover foods to keep for later use and what not to keep?
    - Is the production of leftovers on accident?

3. Do you ever consciously re-use your food leftovers? Why?
    - Do you plan when to re-use your food leftovers? Are you able to stick to that plan?
    - What motivates you to re-use leftovers when you choose to do so?
    - Are you more motivated to re-use certain types of leftovers than others? Why?
    - Do you feel like you should always re-use food leftovers? Why?
    - In which context would you be likely to use leftovers? Which not?

4. Would you say you are able to make a good new meal out of food leftovers? (for example with the ones you have in the fridge now)
    - Do you sometimes experiment with new recipes with your leftovers? Why or why not?

5. Which associations do you have with leftover foods?
    - Can you describe how you compare preparing and eating food leftovers compared to eating newly made foods?
    - Are you used to eating food leftovers? Did you often eat leftovers when growing up?

6. Do you ever throw away food leftovers? What were the reasons that you threw away the leftovers?
    - How did you feel (which concerns) when you had to throw out your leftovers?
    - Can you describe the factors that kept you from re-using your food leftovers?
    - What do you think that needs to change in order to re-use your food leftovers more often?
    - What would make it more attractive for you to re-use your leftovers?

7. Do you believe that reusing leftovers contributes to sustainable food practices? Why or why not?
    - Would you consider yourself aware on the amounts of food that you waste?
    - Do you ever think about where your food comes from and the energy resources needed to produce the food you eat?

8. Do you think there is something that I missed or that I should have asked in this interview?

Appendix C: Walk-through interview protocol

Walk-through

Instructions:
I would like to start this interview with a walk-through component. In this component I would like you to take me through your fridge and kitchen cabinets, according to a few questions that I will ask you. Please state every thought that you have out loud.

Fridge and freezer:

1. Can you show me the leftovers that you have in your fridge now?

2. Can you explain why you store them the way you store them?

3. Can you show me how you would make a new meal out of these leftovers?

3. Can you show me how you would make a new meal out of these leftovers?

Walk-through

Cabinets:

1. Can you show me the leftovers that you have in your cabinets right now?

2. Can you explain why you store them the way you store them?

3. Can you show me how you would make a new meal out of these leftovers?

Appendix D: Codebook

Theme 1: 'Difficulties of organizing'		
Sub-theme	Code	Sample of quotations
Household system Household system describes that a well-organized home system fosters the re-use of food leftovers. This includes a structured way of planning, storing, keeping an overview and a shared understanding and communication between household members.	Lack of overview – 27 qts	Uh, I actually think, oh yes, I do think about that now that you mention it. It goes very subconsciously. Uh, it's not always that spacious. And I find it very pleasant when I can see the things, for me it works like, what I don't see doesn't exist. So, well, when I look then I see, hey, I didn't see this. This is a container with one tomato and half an onion. Normally I think, oh nice, I'll add it to my egg or my guacamole, but I didn't see it. [#9] I'll ask my wife later. Yeah, you know, there's also a random bottle of beer lying there. So it's not all that organized. No. The level of organization in our refrigerator policy is moderate. [#5] But, like all drawers in this entire household, it's far too full. [#5] Because there's a lot on it and I always just throw everything on it. And then I don't know what's behind it anymore. [#1]
	Planning to eat leftovers – 15 qts	And then I plan it for the days. I receive it on Monday, then we eat it. Monday, Tuesday, Wednesday, for example. And then the rest of the week leftovers or something else. But sometimes I pause it because then I want us to eat everything we have first. [#6] Sometimes, yes, because, for example, sometimes I know I'll be late from work and that [husband] needs to thaw things or. He doesn't cook. He does a lot, also in the house, but he doesn't cook. So, for example, last night I had a first aid course at my work until 5:30 PM. Then I'm late home and then I either made sure there's a ready meal or took containers out of the freezer in the morning. So he just needs to warm it up, so to speak. [#6] And then I also order an extra large portion, so anything leftover I can eat for lunch the next day because we usually have nothing in the house on Monday. [#3] I think with a whole meal, I actually always keep it now, and I also coordinate well that I eat it. So that's pretty good for me. [#3]
	Responsibility for leftovers – 13 qts	I think first look at the bottom shelf because I also know my housemates don't look here much. They put it down and grab it when it suits them. But it's really never that they think, oh, something is going to expire soon, let's eat it now. Yeah. We just don't think about it. At least, I don't think about it. [#9] They are also really past their date. Interviewer: Are communal items often past their date? Participant: Yes. I think so. [#1] Yes, I don't know why. Also because he doesn't like carrots, so it's actually up to me. I have to eat them. That's actually just the conclusion. I have to deal with it. [#3] Yes, I wasn't aware of the fact that, then I think, oh there's a leftover. I didn't feel addressed at all. Why? No idea. That I thought, well, for my parents, maybe they want to do something with it. You know. I'll leave it. And now, definitely on my own shelf, that's really my own responsibility. And I know that. [#9]
	Frequency of use – 21 qts	Look, this is always here, bacon. And it always gets used, like, once. It's of course good until 20/4, so it's long-lasting. And it's something I didn't specifically buy to make something, but I think, oh, if I want to make pasta sometime, for example, then I can use this. And I'll use it sometime, in the coming weeks. And that's therefore longer-lasting. [#7] This all does, because [son] drinks this daily, but this is hardly ever used. Actually only, yes, hardly ever. [#7] So this is what is open. But not yet finished. And what we therefore regularly uh, use. [#4]
	Disalignment between family members on food stockage – 8 qts	Those are leftovers. Let's see. I don't know. It's on the communal shelf, but I don't know what it is. *opens the container* Oh, it's ragout. Ooh, I don't know if this is still good. It contains meat. I didn't know it was there. [#9] Participant: Yes, this is of course... You have to imagine this is a drawer that is filled by both my wife and me, and things are also shuffled around. [#5]
	Lengthening the time window – 10 qts	Well, if it stays fresh longer. So when I think of a product indeed, then I think of something that can keep your stuff fresh longer. That would help. [#7] You know also jars, things that are not finished yet but can still be used. And it's in the fridge so it stays fresh longer. [#4]

		So if I take a container of macaroni out of the freezer that's not completely finished, then I shouldn't freeze or save the leftovers again. Then it has to go. So I also do, if it's a large meal, I put the leftovers in two containers. Then I can also take one out. [#6]
	Forgetting what food is still at home – 22 qts	And then I forget when I have to make food or whatever. I also often forget to look in the fridge, what do I still have. Yes. I forget that too often. [#9] Hm, well, often, often, you often just forget that you have something, or something. And it just disappears somewhere behind another product or something. [#2] I often have that I, um, come back from uni and I think, oh yeah, I'd like to make this. And then I think, yeah, but did we still have this? And then it's, yeah, I don't really know. I'll just buy it anyway.[#2]
Life's unexpectancies Life's unexpectancies describes that people live a demanding and dynamic daily life for which leftover meals can be a convenient alternative to cooking. However, although people might have the intention to re-use their food leftovers, this life also inhibits them from eating their leftovers.	Demands of daily life – 13 qts	Hm... I don't really know. Maybe even more time. If I had more time for myself, with nothing. Because when I have time, I often start cooking or... Because that's now missing due to all the work and busyness, and then you do it less. Then it becomes more functional, so to speak. For example, last Sunday, I had time to think about what's all there and to make those sandwiches, for instance. [#6] Yes, it sounds silly, but just less chance of suddenly changing meal plans during the day. So actually, I shouldn't accidentally run into my old housemate who says, "Hey, come eat with us tonight." If I don't run into them, so my social contacts go down, then there's a greater chance that I'll eat everything neatly. Be less busy because I also have to train hockey three times a week in the evening. Yes, sometimes you just don't make it with time. [#3]
	Convenience of eating leftover meal instead of cooking – 20 qts	And something of pasta was left over. And we thought, well, let's put it in a small container, because then we'll eat something different tomorrow and then Bo can still eat it and we'll warm it up. Yes. Yes, kind of convenience. Then we don't have to cook for him again. [#8] And sometimes I save it for him points to youngest son, because, for example, we're eating something he doesn't like or doesn't eat. And then I always have pasta because he always eats that. So then I always have something on hand. [#6]

		And then I don't have to cook, I just have to heat it up. So I keep that. [#4] A big difference for me. Because if I've already cooked it, then I find it easier because I find that convenience factor important. Then I almost always do it, then I'm sure it gets eaten because it's just easy. [#3]
	Unforseeable eating patterns of children – 10 qts	Often they are small leftovers, because we try to cook as much as we use. So that nothing is left over. But of course, that's not always possible, because especially those teenagers, one time they're very hungry and the next time they're not very hungry, because they've been to the snack bar. [#4] Something like a piece of meat that we've made extra of, so because, well, someone's not eating at home again, then I have six pieces, I don't know, chicken burger. [#7]
Theme 2: 'Doing the right thing'		
Personal norms Personal norms describes that people have strong principles against wasting food, which leads to feelings of disappointment when they do they waste food and the act of passing along principles to their household members.	Feeling of disappointment in oneself – 9 qts	That it happens so easily. And in myself too. [#9] So, eh, and sometimes just irritation of damn, there were really six pans in the fridge downstairs, why didn't this get eaten or something. Yes. It still feels like you're not doing well enough. [#4] And then I do feel really bad for about five minutes, like, "Did this really have to happen?" [#3] Disappointed. Yes. Just disappointed. Not that I've disappointed the world, but more myself. Interviewer: So you're disappointed in yourself? Participant: Well, yes. You could pay a bit more attention to that, I think. So that's the disappointment. [#5]
	Personal principles – 15 qts	Ah yes, especially that I find it a waste. That I find it... to throw it away. And initially, I find waste not so much about sustainability or sustainability, but more about, yes, someone could have just eaten it, that's a bit of a waste to throw away food. I think that's a bit from home indeed, from before, you know, you don't throw away food. [#7] Otherwise, I just find it something valuable that can still be eaten. Yes. I think. [#6] Yes, it's just good to eat. I don't know, it's just a principle or something. [#2]

	Recognizing the effort of food production – 6 qts	For my family, it probably didn't matter that much, but for me, it does make a difference. Then I was also more motivated to look at how can I still use that? Because then I know how much effort has gone into it. I know the garden it came from. I know that farmer, so then you know how much effort has gone into it. [#6] When other people have had to put energy into making it, then I think again, "Ah, what a pity, a lot of water, soil, everything has been used for it," [#3]
	Family in the slipstream – 21 qts	So I try to explain that, guys, ultimately this is also food is also scarce and also quite unfairly distributed over the world. Who has what and who does not. Well, whether they understand it right away, I don't know, but I try that occasionally, it just strikes me about those kids, that ease to ask all day and leave one bite. [#8] Yes, I think so. I think so. I don't intentionally think, well, away with it, or something. And that I've also gotten a bit, [husband] is more like that, I've also gotten to the point where, if he once cleans up the kitchen and clears the table, then he knows by now that I want him to save it, so to speak. [#6] Once is also enough. So, well, that awareness and, well, my family kind of follows along in the slipstream. They are all much less fanatic than me. Haha. But at the same time, they are also a bit involved in it at least. [#4] So all those things, eh, so talking about it and at least teaching my children, well, they are quite brainwashed whether they like it or not hahaha. But, so, to also pass on that it, that you don't get less quality of life if you waste less. [#4]
Saving food routines Saving food routines describes that people develop habits of saving and eating their leftover foods, often driven by the experience that they did or did not use it in the past.	Keeping leftovers habits – 10 qts	Well, with keeping, for example, definitely if it's a meal, I would definitely keep it. Even if it's just a little bit, a few bites. Then I think, well those few bites I'll eat right now or if it's more than a few bites, then I keep it in the Tupperware. [#9] Yes, I think so. Yes, he also always puts everything in a, in a, in a container. [#7]
	Leftovers day – 9 qts	Yes, if we have a lot of leftovers, then I sometimes make it leftovers day. But it's not like I use it to make another meal the next day or something. We're just too many for that. [#7]

		Yes, definitely. No, I think at my home, nothing was thrown away. No, we indeed had leftovers day every week. [#7] So it's more often used for lunch. I think we eat some kind of leftover for lunch three times a week. And then once every three, four weeks a meal from the leftovers. [#4]
	Past experience of use – 6 qts	Once in a while, you clean out the freezer and then you think, oh, there are all these opened bags. And more and more often, then just throw it away immediately, because it's going to go anyway. [#8] Cheese usually lasts a long time. Yes, we eat pasta quite often. So we do know, well, that will be used again. We'll make pasta again at some point. Yes. It will be used again at some point. So I don't necessarily make a new meal out of it. But then I know, in the time that it's still good, I will use it again at some point. [#3]
Concern of impact on the environment Concern of impact on the environment describes that people think they themselves should not waste food, because of all of the effort and resources that have gone into the production of the food.	Conscious of one's own responsibility to reduce impact – 13 qts	Then I wonder if I'm doing it frugally enough, so to speak, or if I can't make it more functional, so that you waste even less. Because I actually think that I contribute to that, I don't know, a part of it. [#6] Well, because I believe that sustainability is about not using more than you need. And then sometimes there are, you know, there are of course products that, I don't know, pineapples, that come from halfway around the world, so that has a huge footprint. [#4] I just think they just didn't really know what the impact was back then. Then they thought, "Well, something new is planned for tomorrow. It's fine." While they've also just changed in that regard, I think. It's just seeing how important it is to also adjust those small minor details in your own behavior. [#3]
	Waste of resources – 10 qts	Because a lot of energy is needed to produce that food. [#5] Because we produce all sorts of things that cost a lot of energy in all sorts of different fronts that then evaporates or is not needed or could be used differently. [#6] When other people have had to put energy into making it, then I think again, "Ah, what a pity, a lot of water, soil, everything has been used for it," [#3] Well, yeah, if you don't eat it now, a lot of water will disappear anyway, the water that was in the product. [#2]

Theme 3 : ‘Ascribed value to leftover food’		
Abundant availability of alternatives Abundant availability of alternatives describes that people more easily throw away food, because there is always more and fresher food available at home or in the supermarket.	Limitless supply of products – 10 qts	I think it's a huge waste. I also think that when you deal with it like that, people no longer know where it actually comes from. It's just there, we all don't know that anymore. So I'm very much for conserving as much as possible. [#6] If I have a container full of chopped chives, but I have a plant outside with 5 cubic meters of chives, then I just chuck those chives because the chive snippets aren't needed anymore; they'll be all dry the next day. And because I know I have a plant from which I can clip chives. [#5]
Anxiety about food borne illness Anxiety about food borne illness describes that people throw away food when they are uncertain if it is still good to eat, due to fear of food poisoning. To determine the edibleness people use all kinds of personal strategies.	Doubts about edibleness – 37 qts	He's quicker to fear food poisoning or whatever. Whereas I think, well, let me taste it, it might be fine. [#8] The smell. Seems obvious. Or a fuzzy substance on top. So those are really the main reasons I don't use leftovers… or when you grab the leeks, and they're already all soggy. It's about taste, smell, and freshness of the ingredient. Then it's quickly over for me because I don't want food poisoning. [#5] Yes, lettuce is tricky because you always have it like… arugula stays okay but something like lamb's lettuce… then you think are you going to throw this away you think no yes….So then yes lettuce I don't know. [#1] But some things have also been lying there so long that you think hmm…I don't really think it's still good so I'm not going to cook based on that you know. [#1]
	Food decay – 9 qts	I do have an association with, uh, a bit of perishability or so. [#8] And it doesn't fit in the sauce basket, so it disappears somewhere out of sight. And then I always find it with a layer of little plants on it. Yes well that has to go then. So I stopped doing that. [#6] When I lived in a student house, it would sometimes mold because not everyone was paying attention. [#3]
	Expiration dates – 10 qts	First, I look at how much past its date it is. If it's really a month past its date, I do throw it away immediately. [#9] Really, because, because I have the perception with it of, uh, yuck, that, that, that's not going to be good anymore tomorrow. It makes no sense, huh. But, um, just give me the latest best-before date, so to speak. I then search for it at the back of that, uh, compartment. [#8] Yes, it's the ultimate sell-by date! [#6] You know, for me, it's also often with storing food, it's like there's always an expiration date on those products, but it's really also from a business perspective of okay, for us, it's safe to say that it should be thrown away because we certainly don't want anything to go wrong. So there's always a period after that when it's actually still edible, but just not beneficial for the company to write that down. Because yeah, what if someone gets sick from it and they get sued, yeah, they certainly don't want that. [#2]
Wasted value Wasted value describes that people feel negative emotions when wasting food, due to money loss or the perceived high quality of the food.	High quality products – 4 qts	Additionally, I know that when it's of high quality and maybe more expensive, then I definitely never throw anything away. [#9] And that it's just qualitatively very good food. And then, yes, I do have extra trouble throwing it away. [#4]
	Financial motives – 22 qts	Because I know what it costs. I do the groceries, so I'm also more aware of that, I think. [#6] Thriftiness is it. Yes. Yes. Thriftiness, because that was, well I don't know, my parents had a period when things weren't going so well financially. And then we did eat….then really every bite was saved and everything had to be eaten. [#4] Yes, mainly first, priority 1 is a bit from a financial perspective. [#2] Well yes, it saves money if you use things you already have. Just make a cheaper meal by eating what you still have at home. [#1]
Recognizing potential use Recognizing potential use describes that the chances of food leftovers to be re-used are driven by the ability of the person to think of how to use the leftover food. This includes on what type of meal to make but also if it is enough to feed people.	Too small portion size – 15 qts	Uh yes, that I do. Yes. Especially if I think, oh this is just too little for a whole meal. But so you need to add something, then I get or if I have, I add that. Even if it doesn't fit together for example. I don't care. [#9] Well, especially, look what [man] says, if you, for example, just to name something, you have a bag from which you take three-quarters and if there's one quarter left, then that's too little for the kids. So that means you have to buy a new bag anyway. You could use the bag with little in it, but then you have the other one again…[#8]

		The quantity. If it's too little to really be a meal, I throw it away. [#7]
	Experimenting with new dishes with leftovers – 10 qts	That's difficult. I do try something new sometimes, of course, because at some point you get tired of your own routine. [#7] Yeah, I always like to cook new things anyway, so yeah, that's the fun part if there are still things lying around... you often come up with something new because there's a limited range of products. It's sort of the syndrome of, you have so much choice in the supermarkets, so you just buy what you know or something, you know. While, now with that fridge, it's a bit limited. Then it's sort of a game of, okay, what am I going to do now, I have this, this and this, you know. Okay, well, that's quite a fun challenge, then I just look up those ingredients on the internet. Like, okay, what can I make with this? Oh, I can make this with it and then, oh, I've never made this before, okay, great, then I'll get that, see how it turns out. [#2]
	Lack of inspiration for cooking a meal – 26 qts	That I'm not so sure what to do with it. Yes, how would I put it? That's difficult. [#7] So I thought, that's too much hassle. There were too often things in it that I thought oh noooo. Because the deal was, we did a vegetable bag and my husband had said, yes, then you have to figure out what we're going to eat from it. [#4] No, then I would also go to the supermarket. No, I think it's just really only an extra thinking step. Something with those carrots. [#3] Also, what I kind of know, what I've eaten before. For example, I know a salad with some cherry tomatoes, a bit of onion through it, warming up the carrot a bit, that's tasty, I think, "Oh yes, I recognize this combination, I've seen it before, I could make that." I'm not creative enough to think I'm going to combine five different ingredients that I've never seen together and make something new. [#3]
	Combining food leftovers with fresh foods – 27 qts	Because I just find it really a waste to throw away. Or I do it in between. But if I really want to make a meal out of it, then I add something. So vegetables or a...I often eat such a separate veggie chicken schnitzel. [#9] My husband made a big pot of pasta on Sunday evening and then almost no one was hungry, so a lot was left over. And yesterday, I thought it's just not enough for three of us. So we eat this and I buy some

		fresh pasta and then I put some pesto and cheese on top. And then I make a salad with it. [#4] I'm not sure how to combine a dish that's already prepared with something that still needs to be cooked because it's fresh, so I prepare the new, not yet used dish separately. [#5] Yes, those are meal leftovers. Yes, usually they are leftovers from cooked meals. So a leftover soup and then some pasta. Then we make a salad with it or a piece of bread with it. [#4]
	Building up a meal – 18 qts	So for example, I see wraps lying there. Then I think, oh, that's a very good base. That makes me think, oh, that's enough for a meal for me, you know. Suppose those wraps weren't there. Then I'd think, ooh, that's going to be difficult for a meal. Because well, I have quite random things. I have fresh tuna salad, I have soy milk, I have veggie filet, I have an avocado... [#9] Well, I now have those carrots lying there, I also see cheese lying there, and I see lamb's lettuce. I also have pasta lying in that other cabinet. It's super easy to just cook pasta, make something with a red sauce, get some tomatoes. Then you have carrots, tomato sauce, cheese on top, lamb's lettuce on the side. And you basically have a normal meal with everything that's leftover. [#3] But kind of two ingredients that you initially think of well I don't know how that goes together. That I would then maybe also be less likely to think of well I'm going to combine that. But for example cheese and arugula, I already know okay that can probably go well together. [#1] Yes, I would just look, well okay, I have certain herbs here now, well that's not really filling, so. A can of lentils. So you can usually use rice with that or something. So well okay then, we have lentils now, we have cilantro, so we think of something Asian or something like a curry.[#2]
	Versatility of products – 7 qts	Yes, because it's too specific, you know. The product is too specific. With winter carrots, I have to make a tray bake or a mashed potato dish. And that's just too specific, you know. Lettuce, that's always fine. [#7] I found the organic vegetable bag really difficult last

		year, because then you get those things that you really think, yes, what should I do with this? So that was too much hassle for me. [#4] Yeah, yeah, yeah, a bit of potential or something. That's a good one. [#2]
Attractiveness of food Attractiveness of food describes that food leftovers do or do not get re-used based on if the food is appealing to the person. This includes taste and sensory experiences, but also the dissatisfaction of eating the same thing in a row.	Leftover meal seen as a treat – 8 qts	Because then it's usually a leftover from dinner and I love warm food. I'm not so fond of bread. So I'm always like yes it's just a win-win situation. Then you have your leftover which is just nice warm food and it's not bread. [#1] That I also thought that's ridiculous and that I learned more in my student house that you can really eat that just fine for a few more days, and it's really also tasty. [#3] No, from the day before yesterday, it was pasta I had cooked. It was a pasta with salmon and it was very tasty so I was really like I have to eat that leftover because it's a shame if I let it sit for a week and then haven't eaten it. [#1]
	Taste preferences – 19 qts	Only, the annoying part of that sometimes is the food is not always tasty. And then I don't do it. [#9] Well, especially my children are more motivated by some leftovers. Pastas, I mean, if [daughter] is going to hockey and there's pasta in the fridge, then she'll eat pasta before she goes hockey. [#7]
	Decrease in tastyness – 30 qts	Yes, just because I find it more delicious to just cook fresh and that it's just made right away and not that you've put it in the freezer. I find it less tasty myself, but well, that's just me. [#8] No, not if it's already been made. Suppose we had to eat chicken two days in a row. And we could prepare it freshly each time, then that's fine. But if it's the chicken I already made yesterday, but I just need to warm it up again, then it's less appealing. [#3] But yeah, there was something left over again, so it's there again. It becomes slightly less tasty each time. [#4]
	Feeling of boredom – 8 qts	Because sometimes they just don't want to eat what was already there, what they've already eaten. [#6] Because he, he, yeah, I just think he's a bit more of a conservative thinker who thinks, "Yeah, well, no, I ate that yesterday, I'll eat something new tomorrow." [#3] Well yes to eat the same thing again with that product. [#1]

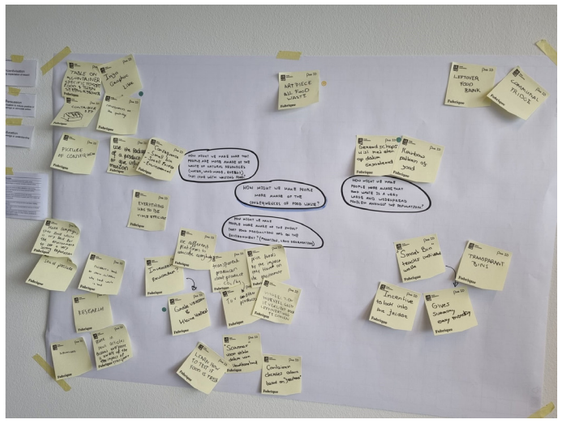
Appendix E: Questionnaire measures and sources

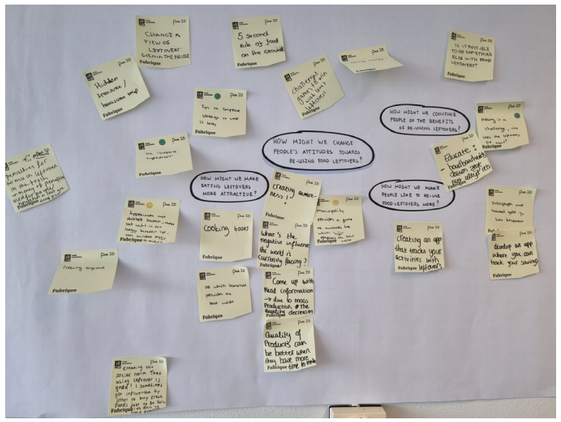
Latent variable	Measurement Items	Source
Intention to re-use food leftovers.	INT1: I always intend not to waste any leftovers. INT2: I always intend to re-use leftovers. INT3: My goal is to always re-use leftovers. INT4: I always intend to re-use leftovers by reheating them or transforming them into a different meal by adding some ingredients.	Adapted from Stancu et al., 2016; Visschers et al., 2016.
Attitude towards the re-use of food leftovers.	ATT1: In my opinion, re-using leftover meals/ingredients is good. ATT2: In my opinion, re-using leftover meals/ingredients is pleasant. ATT3: In my opinion, re-using leftover meals/ingredients is favourable. ATT4: In my opinion, re-using leftover meals/ingredients is desirable. ATT5: I like re-using leftover meals/ingredients.	Constructed according to Ajzen, 1991; adapted from Han, 2014.
Personal norm	PN1: Wasting leftover meals/ingredients would make me feel guilty towards people that don't have enough food. PN2: Wasting leftover meals/ingredients would make me feel guilty towards the environment. PN3: It is contrary to my principles to waste leftover meals/ingredients. PN4: I have been raised to believe that leftover meals/ingredients should not be wasted and I still live according to this principle. PN5: I feel obliged to not waste leftover meals/ingredients.	Adapted from Stancu et al, 2016; Visschers et al., 2016.
Skills in processing food leftovers.	SKL1: I find it difficult to prepare a new meal with leftover meals/ingredients. SKL2: I find it difficult to cook anything other than the recipes I know. SKL3: I find it difficult to tell if leftover meals/ingredients are still good to eat based on the appearance, smell, and/or the taste. SKL4: I find it difficult to store leftover meals/ingredients in appropriate conditions so they will last longer.	Adapted from Scalvedi & Rossi, 2021; Stancu et al., 2016; Visschers et al., 2016.

Perceived health risks.	PHR1: I believe that the risk of becoming ill as a result of eating food past its best-before date is high. PHR2: I am worried that eating leftover meals/ingredients results in health risk. PHR3: I think that consuming leftover meals/ingredients is harmless.* PHR4: I think that one can perfectly eat food products whose best-before dates expired a few days ago without risking their health.* PHR5: I think it is better to throw away leftover meals/ingredients than to risk eating unsafe food because it is no longer fresh.	Adapted from Principato et al., 2015; Visschers et al., 2016.
Awareness of consequences of food waste.	AC1: Food thrown away is **not** an issue as it is natural and biodegradable.* AC2: The packaging of the food thrown in the trash is a bigger environmental problem than food waste.* AC3: I think that the phenomenon of food waste is common. AC4: I consider household food waste reduction to be a major way to reduce pollution. AC5: I consider household food waste reduction to be a major way to conserve natural resources.	Adapted from Principato et al., 2015; Attiq et al., 2021.
Moderating variables	**Measurement Items**	**Source**
Environmental concern.	EVC1: If things continue on their present course, we will soon experience a major ecological catastrophe. EVC2: Humans are severely abusing the environment. EVC3: When humans interfere with nature it often produces disastrous consequences. EVC4: The earth is like a spaceship with very limited room and resources.	Adapted from Dunlap et al., 2000.
Financial attitudes	FNA1: I am conscious with the money I spend. FNA2: I follow a careful financial budget. FNA3: I am much more a saver than a spender. FNA4: Money is important for me.	Adapted from Franzen & Mader, 2022; Lay & Furnham, 2018; Rousseau & Venter, 1999.
Note. *Item was reverse coded. All items were assessed on 7-point Likert scales; higher values correspond to stronger agreement with the statement.		

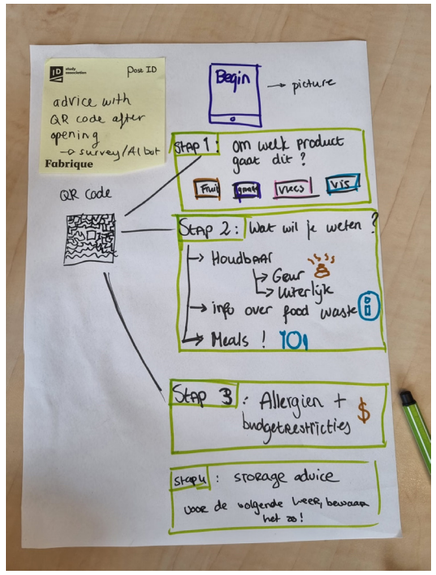
Appendix F: Example results from session

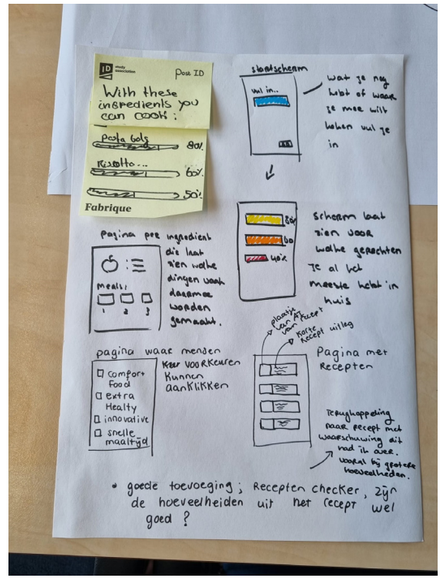
Example results from idea finding diamond





Example results from solution finding diamond





Appendix G: Signed project brief

TU Delft

DESIGN FOR our future

IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME
Complete all fields and indicate which master(s) you are in

Family name		7011	IDE master(s) IPD ☐ DfI ☐ SPD ✔
Initials			2nd non-IDE master
Given name			Individual programme *(date of approval)*
Student number			Medisign ☐
			HPM ☐

SUPERVISORY TEAM
Fill in he required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair	L.B.M Magnier	dept./section	RMCB
mentor	S.N. Nikou	dept./section	RMCB
2nd mentor			
client:			
city:		country:	
optional comments	This combination of Chair and Mentor are applicable, because they vary in backgrounds and expertise. While Lise has more experience with consumer behaviour, Shahrokh has more expertise on the marketing and organizational side. Their research is separate enough.		

! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.

! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.

! 2nd mentor only applies when a client is involved.

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in **by the Chair** of the supervisory team

Sign for approval (Chair)

Lise Magnier — Digitally signed by Lise Magnier Date: 2024.02.14 11:26:32 +01'00'

Name LISE MAGNIER Date 14 Feb 2024 Signature

CHECK ON STUDY PROGRESS
To be filled in **by SSC E&SA** (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total ____ EC

Of which, taking conditional requirements into account, can be part of the exam programme ____ EC

★	YES	all 1st year master courses passed
☐	NO	missing 1st year courses

Comments:

Sign for approval (SSC E&SA)

Robin den Braber — Digitaal ondertekend door Robin den Braber Datum: 2024.02.20 09:18:02 +01'00'

Name Robin den Braber Date 20 feb 2024 Signature

APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team comply with regulations?

YES	★	Supervisory Team approved
NO	☐	Supervisory Team not approved

Comments:

Based on study progress, students is ...

★	**ALLOWED** to start the graduation project
☐	**NOT** allowed to start the graduation project

Comments:

Sign for approval (BoEx)

Monique von Morgen — Digitally signed by Monique von Morgen Date: 2024.02.21 11:39:22 +01'00'

Name Monique von Morgen Date 21 Feb 2024 Signature

Personal Project Brief – IDE Master Graduation Project

Name student Heleen Sinnige **Student number** 4,674,715

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title Enoughness in Food Consumption: Design Strategies for Achieving Sufficiency.

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

In 2020, the human ecological footprint was more than 1.5 the amount that the planet can regenerate (WWF et al., 2020). We have exceeded the limits for a safe operating space in multiple planetary boundaries, resulting in significant changes in the environment. Especially in the more affluent parts of the world, people have a large negative impact on the environment in the categories mobility, housing and food consumption (EC, 2023). Data has shown that in the search for reducing the environmental impact of human activities, efforts for making consumption more efficient, up till now, have not succeeded (Sandberg, 2021). This resulted in the rise of a new approach for more sustainable consumption, 'sufficiency', which entails that people change their consumption patterns and reduce their consumption levels.

A sufficient consumption approach, also known as 'enoughness', strives for a maximum amount of consumption that is environmentally sustainable, but fulfills the needs of the individual (Gossen et al., 2019). But what does it mean for people to consume sufficiently? And what should be done in order to make people reduce their consumption levels to 'enough'. Already, there are ongoing sufficiency practices in the world. For example, sharing cars instead of everyone owning one or switching from a mainly carnivore diet to a plant based diet. However, the success is still marginal.

In the coming 6 months I will be conducting research about what it means to consume sufficiently in the domain of food consumption. When it comes to sufficient consumption, it can feel for people as if they are 'sacrificing' their daily habits and patterns. The opportunities of the research lie mostly in the question 'how can the feeling of sacrifice be reduced and a sufficient consumption practice be more perceived as 'attractive'?'. Subsequently boosting the adoption of a sufficient consumption pattern. The research will not cover the physical or health implications of a diet too deeply, it will mostly be focused on the motivations of people that shape their consumption behaviour. The study will be conducted in the Netherlands, which means that the insights of the research are not likely to be generalizable to other countries and cultures. Moreover, due to time and capacity limitations, it will not be likely that a fully representative sample group of the Dutch civilization will be found.

→ *space available for images / figures on next page*

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

As described in the context, there is a challenge in motivating people towards adopting a sufficient consumption pattern. Changing their behaviours feels like a sacrifice for people. Subsequently, opportunities lie in identifying what drivers and barriers shape the food consumption behaviour of people today and where interventions can be done to make a sufficient consumption pattern more attractive and a logical choice. The goal of the research is therefore to uncover effective design strategies based on underlying behaviour and motivations. To subsequently provide examples that bridge the gap between these strategies, and how that could look like in action.

As stated in the context description, the most harmful categories of consumption in the European Union, is the consumption related to food, housing and mobility (EC, 2023). In my research I will be focusing on the food consumption domain. Mobility and housing will stay open for further research. The starting point of the research is to find out what it entails to consume food sufficiently according to the four types of sufficient consumption by Sandberg (2021). From there on, a research gap will be found that I will focus on for the rest of the project.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Investigate the range of possible sufficient consumption activities in the food domain, select a specific domain for which systemic interventions are still needed, determine drivers and barriers of acceptance for the adoption of this activities and design interventions / strategies for behaviour change.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

The project starts with a literature review of studies that have been conducted in the domain of sufficient consumption. The aim is to first research all the existing sufficient consumption activities and apply it to the domain of food consumption. From there on, barriers and drivers towards sufficient consumption will be identified and mapped out. From this I will form a conceptual model that visually shows the factors and relations between factors towards consumption sufficiency.
The next step is to complement the conceptual model by conducting and analysing interviews.

To validate the conceptual model, I will conduct a quantitative analysis on the model by sending out a survey. From the analysis I will determine how the tested factors have an effect on the dependant variable.

From the results of the quantitative analysis, I will find the most promising design directions as a starting point to design trajectories and guidelines for moving people towards consumption sufficiency.

Project planning and key moments

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	14 Feb 2024
Mid-term evaluation	24 Apr 2024
Green light meeting	4 Jun 2024
Graduation ceremony	4 Jul 2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	
For how many project weeks	
Number of project days per week	

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

I wish to start this project for multiple reasons. First of all it is something that I personally feel passionate about. In the past I have done a project where I did research on how 'honesty' in products can motivate people towards repairing their products when they are broken, or better accept refurbished products. In this project I learned about a few activities that help people to consume more sufficiently. In a different project, I focused on researching how we can move people towards practicing gratitude more often. Here I learned more about making people more aware of how much they have in reach and how we take so much for granted. I enjoyed these projects very much and they made me feel motivated to work on trajectories that could improve our living patterns. Secondly, sufficient consumption is very topical and there is still a lot to uncover about it, which makes me very curious.

There are a few competencies that I would like to work on. I would like to learn more about consumer behaviour and consumer psychology in general, but also strategies on how to influence it. Next to that, I want to gain experience in interviewing and analysing interviews. Furthermore I would like to conduct a quantitative research analysis, by using a survey.

Lastly, I want to learn how to build and execute an extensive literature research, how to structure effective meetings and project planning.