Deliverable 2.3

EMPIRICAL EVIDENCE SENSEMAKING

CHORIZO PROJECT

D2.3

Empirical evidence sensemaking

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Author(s)	Ixone Alonso Miquélez, Concha Ávila, Gabriela Alcat, Isabeau Coopmans, Capwell Forbang Echo, Anna Twarogowska, Bart Van Droogenbroeck, Bent Egberg Mikkelsen, Mukti Ram Chapagain, Balázs Cseh, Katalin Katus, Sasa Straus, Tamara Kozic, Robert Grah, Roman Wolf, Elisa Iori, Matteo Vittuari, Caterina Rettore, Filippo Pini, Sigve Eliassen, Patrycja Antosz, Markus Grendstad Rousseau, Ivan Puga-Gonzalez, Charilaos Latinopoulos, Paulina Szwed, Chantal den Broeder
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Contributors

Name	Organization
Ixone Alonso Miquélez	CTIC - CITA
Concha Ávila	FIAB
Gabriela Alcat	FIAB
Isabeau Coopmans	ILVO
Capwell Forbang Echo	ILVO
Anna Twarogowska	ILVO
Bart Van Droogenbroeck	ILVO
Bent Egberg Mikkelsen	UCPH
Mukti Ram Chapagain	UCPH
Balazs Cseh	HFBA
Katalin Katus	HFBA
Sasa Straus	ITC
Tamara Kozic	ITC
Roman Wolf	PCCI
Robert Grah	PCCI
Elisa Iori	UNIBO
Matteo Vittuari	UNIBO
Caterina Rettore	UNIBO
Filippo Pini	UNIBO
Sigve Eliassen	STRAWBERRY
Patrycja Antosz	NORCE
Ivan Puga-Gonzalez	NORCE
Markus Grendstad Rousseau	NORCE
Charilaos Latinopoulos	VLTN
Paulina Szwed	VLTN
Chantal den Broeder	VLTN

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Executive summary

The core objective of the CHORIZO project is to deepen our comprehension about how social norms (socially enforced rules and expectations) influence behaviours related to food waste generation. The project includes 6 real-life case studies to obtain primary data about how social norms shape behaviour at various stages along the food supply chain. The case studies were selected to represent not only these varying stages, but to also represent a diverse range of regional contexts and socio-economic conditions. An overview of the current contexts relevant to each case study is given to provide the necessary background.

This deliverable focuses on the results of the case studies. Integrating survey, in-depth interviews, and focus group interview data into analysis, patterns and correlations between social norms and food waste related behaviour were explored. Analysis across the case studies focused primarily on 4 food-related social norms: Good Provider Identity, Portion Size and Food Affluence, Suboptimal Food/Undesirable Food Quality, and Associations Between Food Waste Behaviour and Socio-EconomicStatus. The most prevalent of these social norms proved to be Suboptimal Food/Undesirable Food Quality and Good Provider Identity.

The deliverable extends the discussion by utilizing the empirical evidence generated by the case studies to delve into what possibilities there are to promote new learning strategies and communication packages about how to address food waste. The aim being to provide vital information to help all actors along the food supply chain to better address what drives food waste related behaviour. While each case study is unique, there emerged similarities among the case studies when it came to communication and learning strategies to mitigate food waste generation, primarily: the need to focus on providing a better understanding about date-marking, training needed in the procurement, storage, meal planning, and usage of leftovers, and enhanced abilities and venues to facilitate communication and collaboration among actors along the supply chain.

Ultimately, the results presented in this deliverable will be used within the project as input for work package 4 when determining how to best generate communication and learning packages and create capacity-building activities. External to the project, the results are envisioned to contribute to future research and policy to address social norms and behaviour in the pursuit of achieving near zero food loss and waste.

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Horizon
Europe

Glossary of terms and acronyms used

Acronym/Term	Description
FLW	Food Loss and Food Waste
FW	Food Waste
CS	Case Study
SN	Social Norm
MOA	Motivation, Opportunity, Ability
WP	Work Package
IDI	In-Depth Interview
FGI	Focus Group Interview
GDPR	General Data Protection Regulation
EC	European Commission
HORECA	Hotel, Restaurant, Café/Catering
NGO	Non-Government Organization
FIFO	First-In First-Out
SDGs	Sustainable Development Goals

1 INTRODUCTION

The **CHORIZO** Project, "**C**hanging Practices and **H**abits through **O**pen, **R**esponsible, and Social **I**nnovation towards **Z**er**O** Food Waste," stands as a groundbreaking research initiative funded by Horizon Europe, the European Union's flagship program. At its core, this project is a crucial endeavour aiming to deepen our comprehension of how social norms—those socially enforced rules and expectations—significantly influence behaviours related to the creation of food waste. The project commences with a dual-fold mission. First and foremost, it strives to harness the acquired knowledge to elevate decision-making and engagement across diverse stakeholders within the food chain. The ultimate objective is to address social norms and behaviour so that they help propel us towards the ambitious target of near zero waste. Secondly, the research findings are poised to be integrated into innovative products designed to spark, where possible and needed, transformative shifts in social norms regarding food waste. Behavioural insight is not just a component but the very essence of this project.

The project outcomes are meticulously built upon the foundations laid by the European Commission, notably through initiatives like the Farm to Fork Strategy within the European Green Deal. This strategic alignment underscores the project's commitment to promoting sustainability and combatting food waste. Furthermore, it seamlessly integrates with ongoing efforts of pivotal platforms such as the European Consumer Food Waste Forum (ECFWF) and the EU Platform on Food Loss and Food Waste (FLW), contributing substantively to the pursuit of the United Nations' Sustainable Development Goals (SDGs). The project, notably, aims to contribute to the critical target of SDG 12.3, aspiring to cut global food waste per capita by half at the retail and consumer level, and simultaneously reduce food loss throughout the production and supply chain by 2030.

Commencing with a comprehensive evidence-based analysis, the CHORIZO project scrutinizes past and present interventions aimed at preventing food loss and waste across EU member states. This thorough examination spans the levels of food loss and waste prevention, delving into the broader social, economic, and environmental impacts of these interventions. To enrich this empirical foundation, the project strategically integrates six real-life case studies. These studies yield firsthand, primary data illuminating how social norms intricately shape behaviour at various stages along the food supply chain. Here, the primary objective is to unearth pivotal correlations between social norms and behaviours concerning food loss and waste, providing invaluable insights to food waste phenomena. The case studies were selected to represent various stages across the supply chain, but to also represent a diverse range of EU geographical contexts and socio-economic conditions. Specifically, the case studies examine households, food services (including hospitality, restaurants, and schools), redistribution channels (such as food banks), and retail/distribution sectors (with a focus on date marking and smart packaging). A more detailed description about each case study is provided in chapter 2.

1.1 Understanding Deliverable 2.3 (D2.3) within the scope of WP 2

Gaining a comprehensive understanding of the objectives outlined in D2.3 (Task 2.4) is essential within the overarching framework of Work Package 2 (WP2). Within the framework of the work package a series of interconnected tasks have been meticulously designed to advance our understanding of food waste (FW) and to lay the groundwork for effective intervention strategies. Each task within WP2 is integral to the overarching objectives of the project. These objectives encapsulate critical elements necessary for the effective fulfilment of the ultimate task (2.4), thereby laying the groundwork for its successful execution.

- **Perform Initial Analysis and Develop Strategic Plans (Task 2.1):** The primary objective of Task 2.1 was to conduct an initial analysis aimed at comprehensively understanding the landscape of FW

within the project scope across the case studies. This task also involved formulating strategic plans and research goals per case study to provide a clear direction for the subsequent research activities, ensuring coherence and purposeful progression throughout the project.

- **Develop and Validate the FLW Datahub (Task 2.2):** Central to Task 2.2 was the creation and validation of the FW Datahub—a centralized repository designed to streamline data management and facilitate collaboration among project stakeholders. This initiative aimed to enhance data sharing and accessibility, thus optimizing the utilization of project outputs.
- **Collect and Pre-process Case Study Data (Task 2.3):** Focused on the meticulous gathering and pre-processing of data from designated case studies. This critical step was essential for ensuring the validity and usability of the case study data, laying the foundation for rigorous analysis and interpretation in subsequent phases of the project.
- **Perform Empirical and Sensemaking Analysis (Task 2.4):** Leveraging the datasets collected from the case studies, Task 2.4 focused on empirical and sensemaking analysis. This involved analysing data to uncover correlations, causality, and underlying patterns related to social norms which are influencing FW within each project case study. Its primary objective was to learn about pivotal correlations between social norms and behaviours concerning food loss and waste, providing invaluable insights to food waste phenomena, which are reported in chapters 4, 5, and 6 of this document. Case study partners - EV-ILVO, NORCE, CTIC-CITA, ITC, FIAB, UCPH, UNIBO, HFBA, and STRAWBERRY – provided vital and invaluable contributions to the drafting of this deliverable. Collaborative efforts from these entities ensured the successful execution of Task 2.4, laying the groundwork for a better understanding of what drives behaviour related to food waste generation.

1.2   Objectives of D2.3

The analysis of case study data plays a pivotal role within the scope of deliverable D2.3. Here below is a more detailed elaboration of the key objectives of this deliverable.

- **Explore Correlations:** This facet involves delving into the relationships between social norms, specific consumer FW behaviours, and FLW. Through this exploration, the analysis uncovers correlations and patterns, providing deeper insights into the underlying drivers of FW and the effectiveness of intervention strategies aimed at its reduction.
- **Compare with Previous Analysis:** By juxtaposing the current findings with evidence-based analyses of prior projects, this analysis contextualizes the results within the broader landscape of FW prevention and reduction efforts. This comparative approach offers a nuanced understanding of intervention effectiveness across different temporal and contextual dimensions.
- **Identify Influences of Gender and Intersectional Differences:** The analysis probes into the impact of gender and intersectional factors such as ethnicity, age, socioeconomic status, and geographical location on FW. By considering these influences, it sheds light on disparities and unique challenges faced by diverse demographic groups, thus guiding the development of more tailored and inclusive intervention strategies.
- **Provide Insights for Communication and Education:** Lastly, the analysis synthesizes findings into actionable insights to inform the design of communication and educational initiatives. By distilling key takeaways, this aspect of the analysis facilitates the creation of targeted strategies and materials aimed at raising awareness about FW and fostering behavioural change among stakeholders.

In sum, the data analysis serves as a crucial step in synthesizing case study findings and extracting actionable insights. These insights not only inform future research endeavours but also guide practical interventions aimed at tackling FW within the studied contexts, thus advancing the goals of the CHORIZO project.

1.3   Scope of the deliverable and report structure

Addressing the overarching question surrounding what drives behaviours related to food waste, our analysis delves into various dimensions to derive comprehensive insights. Firstly, we assess the initial conclusions regarding the impacts of FW prevention/reduction actions, distinguishing between those undertaken previously by case study members and those unrelated to the current case studies, but identified and analysed in WP 1 of the project. Secondly, we explore correlations among social norms across the case studies, particularly examining their implications for consumer behaviour and FW generation. Next, we compare these findings to the conclusions drawn from evidence-based analyses of previous projects within Work Package 1 (WP1), enabling a comprehensive understanding of the effectiveness of interventions over time and across different contexts. Moreover, we investigate the role of gender and intersectional differences in shaping behaviours related to FW, recognizing the nuanced influences of age, socio-economic status, and geographical location. Finally, this deliverable aims to contribute insights into the design of communication and learning/educational packages that effectively target FW behaviour, identifying gaps and opportunities within different sectors. Through this multifaceted approach, we seek to develop strategies that address FW at its root causes while promoting sustainable practices and behaviours across diverse settings.

The structure of the deliverable begins with an Executive Summary, highlighting key findings and recommendations. It is followed by the subsequent chapters:

- Introduction: Lays out the objectives of T2.4, emphasizing its relevance to Project CHORIZO, while also defining the scope of the deliverable.
- Case Studies Overview: Provides insight into the selection criteria and descriptions of each case study.
- Comparative analysis between previous projects of case study partners and prevention/reduction actions (T1.2): Assesses the initial conclusions regarding the impacts (economic, social, and environmental) of FW prevention/reduction actions, distinguishing between those undertaken previously by case study members and those unrelated to the current case studies, but identified and analysed in WP 1.
- Empirical Data Correlation and Sensemaking Analysis: Focuses on data pre-processing, FW measurement, qualitative and quantitative analysis of social norms and respective consumer FW-related behaviours, as well as discussion about gender and intersectional differences.
- The Econometric Assessment and Synthetic Analysis: Delves into relationships between social norms, FW behaviours, and FW, by conducting regression and cluster analysis, factor analysis, and structural equation modelling.
- Correlations between Social Norms, Evident Behaviour Towards FW, and FW Levels: Comparisons of the emerging patterns regarding social norms and food waste related behaviour across the case studies.
- Insights for Communication and Learning: Addresses how to promote more effective communication strategies and learning packages designed to address FW-related behaviour.
- Conclusions: Summarizes key findings, highlighting implications for future research and policy, and acknowledging study limitations. The appendices provide supplementary materials.
- The appendices provide supplementary materials.

2 CASE STUDIES OVERVIEW

2.1 Selection criteria

CHORIZO implemented six case studies (CSs). The case studies were deliberately selected to encompass a diverse geographical spread across Europe, ensuring the inclusion of a wide range of regions and socio-economic conditions, thereby providing representative information on various contexts in which different social norms may drive FLW behaviours.

Figure 1 Location of the case studies in the CHORIZO project
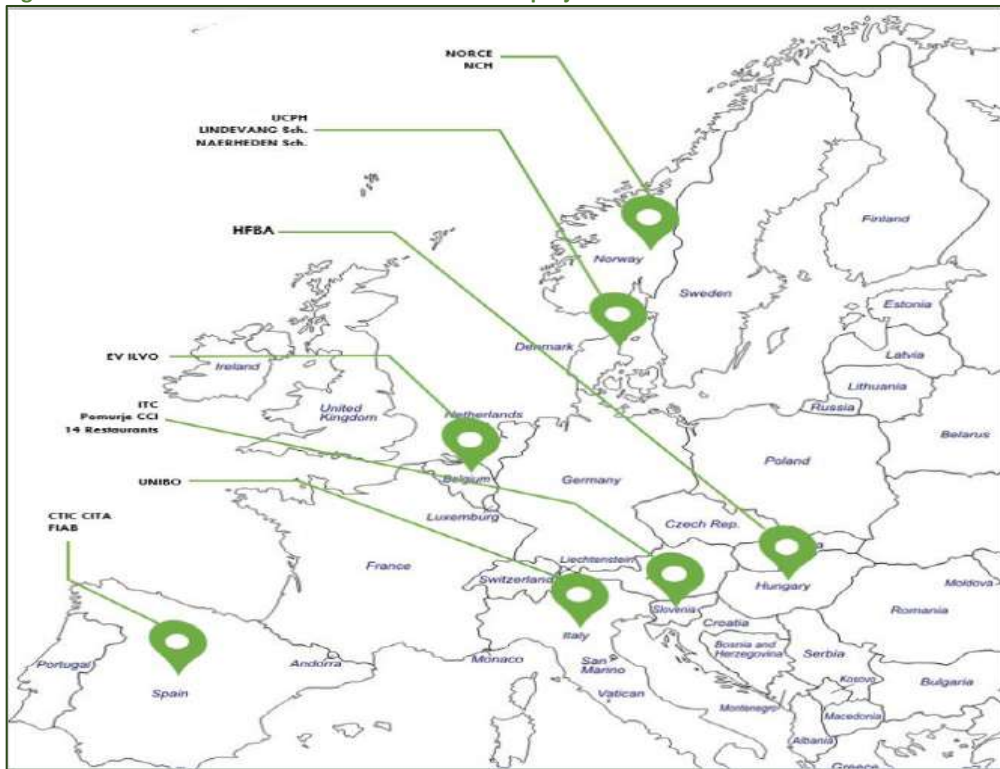
Source: Case Studies' Strategic Plan (D2.1) of the CHORIZO project

Case Study 1: Households in Flanders, Belgium and Spain in and off crisis period

Selection of this CS was driven by a strategic focus on addressing Food Waste (FW) at the household level, where more than 50% of FW in the EU is identified (United Nations Environment Programme, 2021). Recognizing households as a pivotal intervention point, the study aimed to go beyond the prevalent individual-centric approach **and delve into the collective dynamics of households**. Moreover, in light of the compelling evidence **linking the COVID-19 pandemic to a multifaceted behavioural shift within households**—attributed to factors like reduced income, disrupted supply chains, lifestyle changes, and restrictive measures—this case study presents an opportunity to explore the medium-term impact on social norms and FW behaviours. The intention was to unravel the intricate processes and dynamics leading to these shifts, offering valuable insights almost two years post the COVID outbreak when the project commenced. Household behaviours are expected to be highly culturally dependent, hence two subsamples will be generated in this case study: one in Flanders representing Central-West Europe culture and one in Spain to represent Sourthern/Mediterrean Europe food culture.

Case Study 2: Hospitality Sector in Norway – hotels

The selection of this case study is grounded in the recognition of FW challenges within the **hospitality (hotel) sector**, where wastage occurs across various stages, **from storage to meal preparation, serving, and consumption**. Past evidence underscores the substantial potential for FW reduction in this sector, leading to noteworthy economic savings, particularly in the context of **buffet leftovers and food overproduction**. While the hedonic and 'serve and eat endless' behaviour of hotel guests has been acknowledged as a significant driver of FW, there exists a critical gap in understanding the intricate interactions between guest behaviour, hotel business practices, and employee behaviours. This case study aims to bridge this gap by delving into the **unexplored dynamics between guest practices and the broader operational and personnel aspects of hotel staff**, providing a comprehensive exploration of FW within Strawberry hotels.

Case Study 3: Food Services Sector in Slovenia – restaurants

The selection of this case study stems from the significant **impact of FW in restaurants**, where approximately 65% is deemed avoidable.[1] The prevailing reasons include issues such as over-preparation, excessive buffet servings, incorrect portioning, lack of consumer practice in taking home leftovers, residues from preparation, and challenges related to over-ordering, overstocking, and inadequate storage facilities. A crucial aspect that this case study addresses is the prevailing **norm of consumers not accustomed to pre-ordering food**, coupled with **restaurants not offering this option**. The study, situated in the Pomurje region, Slovenia, strategically builds upon past and existing initiatives aimed at FW reduction in restaurants. By examining processes and behaviours across three key layers—retail and short food supply chains, restaurant operations, and consumer interactions—the case study aims to comprehensively investigate and understand the dynamics involved in minimizing FW, offering insights into the entire food ecosystem **from ingredient delivery to consumer behaviour**.

Case Study 4: Schools in Denmark – food waste, obesity and malnutrition

The selection of exploring **children's behaviour towards food waste** within schools is driven by the pivotal role schools play in **shaping future consumers**. Given that children represent the consumers of the future, understanding their behavioural drivers towards food waste is crucial. Schools can serve as influential spaces for **nudging behavioural change**. Food waste, obesity, and malnutrition are all considered as examples of behavioural change challenges, especially with regards to young people food consumption, which it can be assumed is partly due to the abundance of food choices that exists for young people. As such the challenge can be assumed to be how to make sure that children have access to enough quality food, but do not consume excessive amounts than they actually need. It is imperative to grasp the factors influencing school children's attitudes towards food waste and to uncover potential trade-offs between food waste and dietary quality, considering **the long-lasting impact of habits** formed at a young age. For instance, low plate waste might be linked to overconsumption and obesity, while increased food waste might result from a high-quality diet emphasizing fruits and vegetables. Recognizing the social context in which children's behaviour develops, including **interactions with families, peers, and the school learning environment**, is essential for understanding food waste and dietary decisions. This understanding can inform the development of **targeted educational interventions** that enhance **food waste literacy,** in particular since at school there is an openness to Sustainable Development Goals (SDG)-related teaching using the ESD approach (Education for Sustainable Development). Additionally, to foster lasting behavioural changes across generations, there is a need to broaden the scope of food waste literacy

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[1] Environmental Protection Agency:
https://www.epa.ie/publications/circular-economy/resources/nature-and-extent-update-15th-June.pdf

training beyond traditional settings like school canteens and home economics classes. Integration across the curriculum, especially in **science classes** and **teachings related to SDGs**, particularly SDG 12.3 focused on food waste, can contribute to a holistic and impactful approach. In particular, interventions that bridge the school family interface could be a promising approach.

Case Study 5: Food Banks' Mediated Supply Chain in Hungary

The selection of this case study is justified by the **pivotal role that food banks play as intermediaries** between corporate actors, other non-governmental organizations (NGOs), and consumers. The complexity of this role demands a good understanding of **food chain actors' motivations and behaviours** to ensure effective mediation. Additionally, the case study aims to investigate and navigate two inherent conflicts that food banks must balance. First, there is a growing pressure to **prevent surplus food upstream in the food chain** while simultaneously addressing **food insecurity** through the utilization of this surplus. Second, the challenge lies in addressing food insecurity without inadvertently contributing to malnutrition, requiring a **delicate balance in the distribution and allocation of resources**.

Case Study 6: Date marking and sustainable, smart food packaging – focus on Spain

The selection of this case study is driven by the critical impact of **date marking** on FW generation in the European Union. According to a European Commission (DG Health and Food Safety) report of 2018 (Market Study on Date Marking and Other Information Provided on Food Waste Labels and Food Waste Prevention) "up to 10% of the 88 million tonnes of food waste generated annually in the EU are linked to date marking. The main food categories contributing to food waste were fruit and vegetables, bakery products, meat including fish and poultry, and dairy products" (European Commission 2018, page iii). **Misinterpretations of data labels can lead to premature disposal of food items.** The case study aims to unravel the implications of consumers' perceptions of date marking, as well as obtaining a more holistic viewpoint on the issue by better understanding and incorporating industries viewpoints (distribution and retail) on date marking as well as innovative technologies like **sustainable and smart packaging** that can extend product shelf life. The case study also explores the role of date marking as a **business strategy element for distribution/retail actors**. Additionally, the study delves into the potential of smart packaging to mitigate FW by providing **clear directions and timelines for preserving products after opening**.

2.2 Objectives of the case studies

Case Study 1: Households in Flanders, Belgium and Spain in and off crisis period

The objectives of this case study that took place in Flanders-Belgium and Spain were the following:

- Identify which social norms impact FLW at the household level and how;
- Investigate the role of social network interactions and retail marketing practices on normative behaviours related to FLW practices;
- Explore behavioural changes in FW practices that occurred after the COVID 19 pandemic; and
- Create notion on the role of contextual factors on household FW behaviours by studying samples representative of the Spanish and the Flemish households populations.

Case Study 2: Hospitality Sector in Norway – hotels

This case study took place in Norway and had the following objectives:

- Understand how communication about food waste affects consumption level waste.

- Identify through in-depth interviews with staff how communication of food waste affects different groups of customers and waste in different food categories.
- Identify how the form of serving affects food waste.
- Understand how strategies of food production and procurement differ due to staff's formal education.

Case Study 3: Food Services Sector in Slovenia – restaurants

This case study took place in Slovenia and had the following objectives:

- Understand interactions in the food supply chain between retail, restaurants, and consumers, and the drivers (business, social) influencing food ordering, delivery, preparation, and consumption.
- Identify the social drivers and norms influencing the behaviour of retail and restaurant managers, and consumers, and the impact of those social drivers on FW.
- Understand behavioural drivers that are preventing all three actors (retail and restaurant managers, and consumers) from perceiving FW as a problem.

Case Study 4: Schools in Denmark – food waste, obesity and malnutrition

The objectives of this case study that took place in Denmark were the following:

- To understand the Awareness level of FW of young people (pupil).
- To understand the FW Actions, Amounts, and Motivation by young people.
- To understand the Abilities-skills & knowledge to tackle FW and maintain healthy consumption.
- To define the key factors [Strategies] to tackle FW, change social norms & school children's behaviour towards a balanced low-FW and high-nutrition behaviour.
- To explore the Policy approach to reduce school FW in school setting.

Case Study 5: Food Banks' Mediated Supply Chain in Hungary

The objectives of this case study that took place in Hungary were the following:

- Understand what social norms influence companies in choosing to donate food and what are the barriers that prevent them to donate.
- Understand the relationship and network between companies and NGOs and how these relate to FLW generation.

Case Study 6: Date marking and sustainable, smart food packaging – focus on Spain

The objectives of this case study that took place in Spain were the following (a combination of consumer and Industry elements):

- Understand the rationale behind marking by food industries (industry).
- Understand how date marking influences consumer behaviour to consumer or waste, and which are the social norms underpinning it.
- Understand the association between the length of shelf life and the perceived product quality by consumers.
- Understand economic actors' practices towards returning, disposing, or donating food past the 'best before' date and the underlying social norms (industry).
- Understand consumers and food industries' acceptance of sustainable and smart food packaging and the interaction with the perceived shelf life of products (industry).

2.3   Data Collection (interaction with T2.3)

In parallel to the above research objectives, the case studies generated data useful for analyses linked to other research outputs in the project. Hence, the data collection methods in the CSs had to be aligned with the partners responsible for these other research outputs. For this, multiple meetings with project partners were necessary to prepare the data collection methods in a way that they would yield data to be usable for all research and project objectives. To guide this complex and iterative process of data collection methodologies creation, the partners were assigned roles of data providers, data analysts, and data recipients. Their responsibilities are listed in Figure 2. This enabled across the CSs and WPs, appropriate designs of data collection techniques, appropriate data pre-processing practices, accessibility to all data and a smooth transition from data generation towards intelligence generation.

Figure 2 Roadmap from raw data collection to exploitation of intelligence
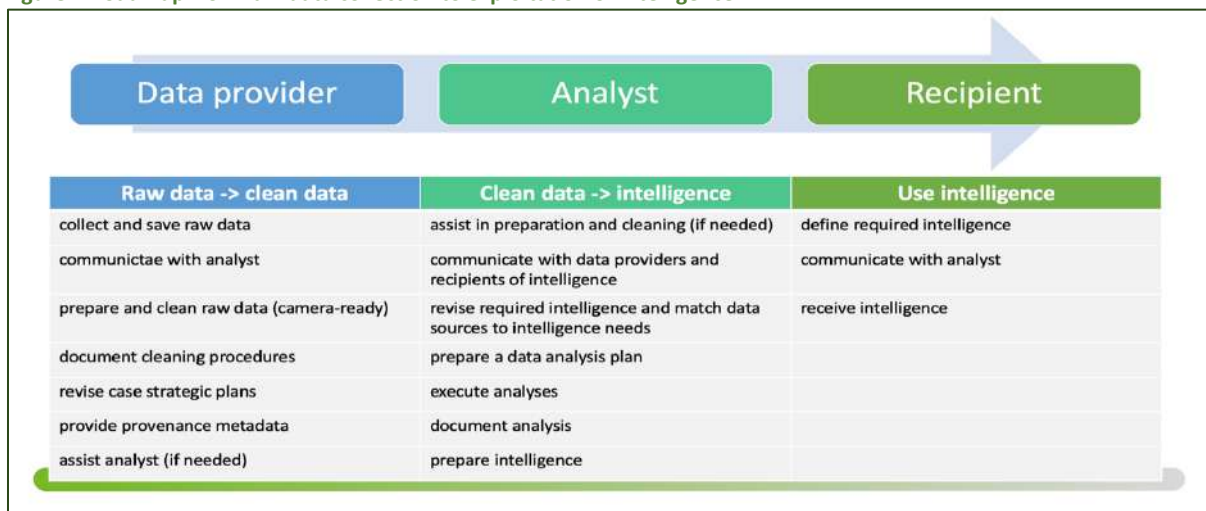
Following the data collection phase, it was necessary to meticulously develop and document cleaning and anonymization or pseudonymization procedures. These measures were crucial not only to ensure the integrity of the files uploaded to the datahub but also to provide comprehensive provenance metadata, thereby fortifying the reliability and traceability of the dataset, while abiding to the EU General Data Protection Regulation (GDPR). The guidelines for these procedures were used for quality assessment by the case study partners and are presented in Figure 3. For the remaining part of this section, specific details on the methodologies that were followed to collect data for each of the case studies are discussed.

Prior to delving into the individual case studies, it is important to highlight that during the conduct of in-depth interviews (IDIs), Focus Group Interviews (FGIs) and surveys, the responses were recorded and handled in a **confidential and anonymous** manner.

Figure 3 Guidelines for the guarantee of data integrity in quantitative and qualitative techniques

	Quantitative		Qualitative		
	Survey	Experiment	FGI	Workshop	IDI
1	Save raw data: adhere to the project's naming convention, add ".raw" at the end of the file name. Share internally cleaned, anonymized data.				
	file formats: .sav, .csv (for .csv save a file with numerical values and with textual value labels)		file formats: .txt, word.		
2	Format text: All text data is uniformly formatted. This includes standardizing capitalization, punctuation, and removing any unnecessary spaces or special characters.		Format text: All text data is uniformly formatted. This includes standardizing capitalization, punctuation, and removing any unnecessary spaces or special characters.		
3	Code categorical variables: For any categorical data, we need a clear and consistent coding scheme, as well as a codebook that describes what each code represents.		Anonymize the data: Remove all elements of the text that allow for identification of the respondent		
4	Perform sanity checks: Basic sanity checks to verify the integrity of the data. This would include checking for and reporting on any impossible values or inconsistent responses (e.g., a 25-y.o. who is retired).		Document all changes: It is important to document all changes between the raw dataset and the camera-ready, clean version used for analyses). For qualitative data in word, version control can be used to automate that process.		
5	Missing Data: Missing data can pose significant problems during analysis. Code missing data providing insight into why the data might be missing. Analyse missing data and flag variables with high fractions of missing data.		Prepare camera-ready provenance metadata: Provide final IDI protocols. Provide an external file with important metadata about the respondent (e.g., ID + respondent category).		
6	Weighting data: analyse socio-demographic data. Decide if data weighting is needed & compute analytical weights.		Agree on a camera-ready format(s): (a. depositing in a repository of choice, b. analysing data, c. any other needed by recipients)		
7	Data Correspondence: Making sure that columns that help join different datasets don't have inconsistent coding.				
8	Agree on a camera-ready format(s): (a. depositing in a repository of choice, b. analysing data, c. any other needed by recipients)				

Case Study 1: Households in Flanders, Belgium and Spain in and off crisis period

The data required for this case study was collected with three different techniques.

An online survey was conducted on the Flemish population by EV ILVO and on the Spanish population by CTIC-CITA through the MundoSabor platform. The sample size of the Flemish population was 800, while for the Spanish population 205 individuals took part in the survey, leading to a total of 1,005 participants.

EV ILVO also organized a **focus group interview session on the role of social norms in food waste household behaviours** with 13 representatives of consumer associations, food industry federations and innovation platforms, policy advisors, The Flemish agency of food marketing, academics, NGO's working on sustainable food systems, municipalities, the Flemish public waste agency, independent initiatives, city level initiatives and retailers' sustainability departments.

Finally, CTIC-CITA carried out **in-depth interviews** with 15 participants in three different locations in Spain, including vulnerable groups, to understand household trends and the impact of COVID-19.

Case Study 2: Hospitality Sector in Norway – hotels

The four data collection processes that were mentioned in the previous subsection, have different methodological approaches:

- The **hotel staff survey** adopted a **nested design**, encompassing three different hotel types with a total of eight hotels. The survey specifically targeted the staff members working within these hotels. The respondents were selected with **non-probability sampling** and the data was collected by following an **in-depth interview protocol.** The main variables of interest are the hotel type and the message type (i.e. no display, positive display, provocative display).
- For the **interviews with chefs**, 3 chefs with formal and 6 chefs without formal education were selected with **non-probability sampling** and an **in-depth interview protocol** was followed. The main variables of interest were food preparation routines, food planning and formal education.
- The **breakfast experiment** employed a **nested design**, encompassing three different hotel types totalling 8 hotels. The focus for each hotel was at the frequency of days per month during which each message was displayed. The total number of days that the experiment took place was calculated based on variation and power analysis and the weighting of food waste was achieved by Strawberry with the **eSmiley** measurement tool. The main variables of interest are grams of

waste per guest, hotel type, day type (working day vs weekend), number of guests and message type.

- For the **lunch experiment,** the sample consisted of days in a month, and it was limited to hotels with conference venues. The total number of days that the experiment took place was calculated based on variation and power analysis and the weighting of food waste was achieved by Strawberry with the **eSmiley** measurement tool. The main variables of interest are grams of waste per guest, hotel type, day type (working day vs weekend), number of guests and serving type (plated lunch vs buffet).

Case Study 3: Food Services Sector in Slovenia – restaurants

The data required for this case study was collected with two different techniques.

A **survey** (JotForm) was conducted on the Slovenian population by ITC and PCCI. The sampling process took into consideration the entire population in the Pomurje region and food service customers, with the voluntary response sample size being 802. The survey was distributed **online** and included the collection of demographic data such as gender, income, and education.

ITC and PCCI also carried out **in-depth interviews** with 5 restaurant suppliers and 14 restaurant managers. The suppliers were chosen based on the participating restaurants and the response rate was 100%. Gender and business size are among the main variables of interest.

Case Study 4: Schools in Denmark – food waste, obesity and malnutrition

The data required for this case study was collected with three different techniques.

UCPH carried out **total of 5 focus group interviews (FGIs)** with children from 4 different classes, total of 50 pupils at two school locations in Copenhagen, Denmark. The main focus of FGI was to identify FW actions and their motivation.

UCPH also carried out **in-depth interviews (IDI)** with three different stakeholders, i.e. 2 interviews with headmasters/school managers, 4 interviews with parents, and 3 interviews with teachers at the two locations. The focus of in-depth interview was to identify FW actions and motivation of pupils, including to explore behaviour change strategies.

Finally, UCPH organized a **workshop** (Future Foods Workshop) with total of 45 pupils from an additional 3 schools during the "Foods People Meeting" event. The data, knowledge, and inspiration gathered in the workshop were used as supplementary data to the FGIs and IDI data. Data collected from this workshop was in the form of researcher's observation notes, drawings, and an idea presentation from participant pupils. "Foods People Meeting" ("Madens Folkemøde" in Danish) is an annual 2-day event that aims to discuss topics of interest regarding the future of the food system. It works through exhibitions, workshops, and debates. It is a festival type of event with both indoor and outdoor activities. In the 2023 edition UCPH was invited to do a workshop on smart solutions for the future food system with a focus on some of the important themes that is central to WP4 in the CHORIZO Project, namely food waste mitigation, nutrition and health, and use of smart educational technology. The overall idea was to create new solutions on how food literacy training can be upgraded and to discuss how schools can contribute to this important task. The aim of the workshop was to bring pupils and event participants together to develop ideas or tools.

The methodological foundation developed through the other projects, SESAM (Sense Science & the Magic of Food) and Growing Green Communities, was utilized by UCPH to develop a workshop protocol that facilitated co-creation, which uses academic mentors combined with the active

participation of children and teachers to find solutions to food systems challenges, with a particular emphasis on the food environments found in elementary schools. Key features of the workshop are listed below:

- School kids from 3 different school (N = 45).
- Teachers acted as the primary supervisors (N = 4).
- Secondary supervision was provided from mentors from UCPH and its partners, and students were asked to present the outcomes at the end of the workshop.
- Kids were invited to participate as a part of their school class together with teachers.
- The overall workshop theme was "Future school food".
- The pupils were divided into 4 groups, with 4-6 pupils in each group working together to come up with some kind of a solution.
- The thematic headings for the 4 groups were:
  - *Reduction of Food Waste*
  - *Better Food Literacy*
  - *Promote Nutrition, Health & Sustainability*
  - *EdTech [Educational Technology]*

The participants were divided into groups according to their interests and ideas. They were seated in their groups around a table and were tasked with discussing a set of thematic ideas for the workshops and were facilitated by a moderator. The moderator's responsibility was to facilitate the process of the framework of the workshops. In other words, the moderator should assist on the methodological side but did not interfere with the content of the pupils' discussions. Finally, the pupils presented their idea in a group to a judge panel that was composed by mentors from UCPH and its partners.

Case Study 5: Food Banks' Mediated Supply Chain in Hungary

The data required for this case study was collected with **in-depth interviews**. The target population consisted of retailers, workers in the RECA (restaurants and cafes) sector, food processors, and charity organizations involved in the food bank network in Hungary. A **convenience sampling** approach was followed from the HFBA network, and the synthesis of the 30 interviewees was the following: 5 retailers, 5 RECA sector workers, 10 food processors, 10 charities. The data was collected through audio recordings and then transcribed. The interviewees asked questions around the drivers and social norms that influence companies' choices about food donations and the barriers that prevent companies from donating food. HFBA and UNIBO were responsible for the development of the questionnaire, the execution of interviews and transcriptions was done by HFBA, data analysis was performed by UNIBO and HFBA provided support in interpreting the results.

Case Study 6: Date marking and sustainable, smart food packaging – focus on Spain

The data required for this case study was collected with three different techniques. The case study was actually divided according to two main focuses – consumers and industry.

First, **survey interviews** were conducted on the Spanish population and on the population of 4 other EU countries (Estonia, Greece, Netherlands, and Hungary) by CTIC-CITA. The selection of these countries was based on the segmentation of Europe in 5 parts (north, south, east, west and centre) and taking into consideration the project's consortium of partners. The sample size for each for the different EU countries was the following:

- **Spain**: 237 participants
- **Estonia**: 246 participants
- **Greece**: 201 participants
- **Hungary**: 204 participants
- **Netherlands**: 282 participants
- **Total**: 1170 participants

The data was collected through the **MundoSabor platform** (Figure 4). During the online surveys the consumers were asked about the different aspects smart packaging, date-marking and habits related to food waste.

In the case of the surveys that were administered outside Spain, they were carried out with the **SurveyLab** tool, which allows the realization of surveys anywhere in the world, and from any type of electronic device.

Figure 4 Platforms used for online data collection

Figure 5 demonstrates the introduction pages on the MundoSabor website (left) where users had to log in to access the survey and on the SurveyLab tool (right).

Figure 5 Introductory sheets to CS 6 on-line consumer surveys
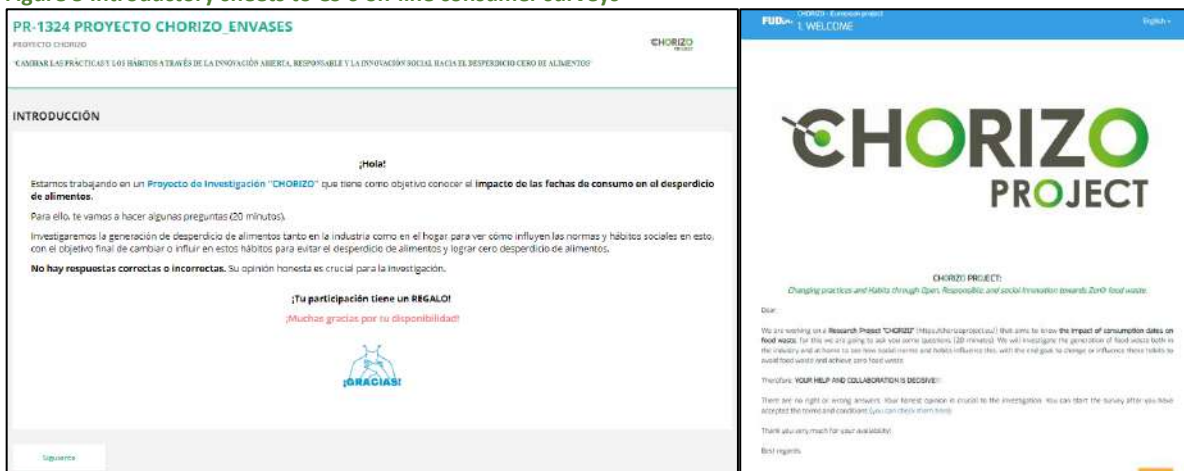
Apart from the large consumer survey, CTIC-CITA also conducted a smaller longitudinal survey of 13 **pilot homes**, with the objective to observe their behaviour towards leftovers and food waste across 5 weeks, and to understand how they correlate with their level of planning and organization for the week's meals. Data was also collected online through MundoSabor (screenshot from the survey in Figure 6).

Figure 6 Screenshot of 5-week survey completed by 13 pilot households in Spain

CTIC-CITA carried out **in-depth interviews** with 15 people, including those who are part of vulnerable groups (Plena Inclusion), to understand household trends. The interviews took place on a specific day and time, in three different locations in Spain.

The interviewer asked consumers several questions related to date marking and smart packaging, using the following questions as a reference:

- Does the consumer look at the marked date?
- Does the consumer understand the date marking?
- How does date marking affect food waste?
- Food waste causes which of the following impacts: social, environmental, economic or none?
- Does the consumer know the benefits of smart packaging?

In order to better understand the relationship between FW, date marking and sustainable, smart packaging, FIAB conducted interviews with 25 representatives of the **food industry** (4 start-ups, 12 SMEs, 9 multinational companies). The interviewees were asked a total of 30 questions that were divided into the following main sections:

- General questions about the food industry.
- Questions related to production.
- Questions related to storage/packing.
- Questions related to distribution.
- Questions related to social norms in all the stages.

In addition to the IDIs conducted with the industry sector representatives, a national workshop was held where food industry representatives were able to discuss face-to-face how their sector could influence FW prevention and reduction via company policy. Seventy percent (70%) of participants in the workshop represented companies from the food industry sector, while also policymakers, research institutes, as well as other organizations were in attendance to round out the discussions. The workshop was structured into 3 sessions:

1. Food Waste in the food industry (in general).
2. Food Waste in the food industry related to date-marking.

3. Food Waste in the food industry related to sustainable and smart packaging.

2.4   Data request procedures (T2.2)

In order to adhere to ethical research practices, and to abide by the EU GDPR, participants in every survey and in-depth interview were provided with a comprehensive consent form outlining various aspects of their involvement.[2] Each case study partner ensured that they abided by their organization's ethical research principles – especially when it came to interviewing vulnerable groups of society, such as children. The consent form consisted of distinct sections including, but not limited to, the following:

*   Explanation of the objective of the case study as part of the CHORIZO research project.
*   Brief outline of the participant's journey from taking the interview to the final storage and accessibility of their data.
*   Guarantee of data confidentiality and anonymity.
*   Reassurance of the voluntary nature of their participation.

To formalize their agreement, participants were required to affirm with signature that they had read and understood the information sheet, and that they had the opportunity to seek clarification on any aspect that was unclear to them.

With the consent form, participants permitted the use of their data for the specified study purposes, aligning with the details provided in the form. It was underscored that participation was entirely voluntary, with participants retaining the autonomy to withdraw from the study at any point without the need for justification. They were also reassured that withdrawing from the study would bear no negative consequences and would not impact any of their rights, thereby emphasizing the commitment to respect the autonomy and well-being of each participant throughout the research process.

2.5   Data storage and accessibility

In the context of data storage and accessibility, the CHORIZO project recognizes the crucial role of data in achieving its objectives. One of the project's strategic initiatives was to establish a FLW Datahub and an FLW "Insighter". Building on the open science policy of the European Commission (EC), this tool joins other existing research data management initiatives and international guidelines to ensure that research data is **F**indable, **A**ccessible, **I**nteroperable and **R**eusable (FAIR)[3].

As part of the FAIR principle, any article publications from the project case studies would be assigned a globally unique persistent identifier (PID) and described with appropriate metadata. The datasets are readable, and able to be processed with ordinary computer software. Moreover, they are reusable as they are findable, accessible and interoperable in the long term with sufficient

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[2] The European Commission's Ethics Self-Assessment Guidelines:
https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/common/guidance/how-to-complete-your-ethics-self-assessment_en.pdf

EU GDPR:
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02016R0679-20160504&qid=1532348683434

[3] European Commission (Research and Innovation):
https://open-research-europe.ec.europa.eu/for-authors/data-guidelines#fairdata

documentation that includes the CS strategic plans, and the cleaning procedures that were described earlier in section 2.3.

Important metadata that supplement the clean and anonymized datasets are:

- The information on how sample sizes were established in section 2.3.
- The codebook data with information on how fundamental indexes in the survey were calculated and other information about data transformation. The codebooks are available in the project shared Teams space, and where applicable, in the project's datahub to help external stakeholders and users of the datasets understand the coded variables.
- Syntaxes used for quantitative analysis are also available in the project shared space for project partners.
- Coding tree for qualitative analysis with a description of each code in the appendix.

Data collected from the 6 case studies belong to the second data layer of the Datahub, the first being previous and on-going actions to prevent/reduce FLW collected and assessed in terms of relevance. The data is accessible to CHORIZO project partners for the execution of other project tasks, especially for the modelling work in WP 3, and the efforts in WP 4 which will focus on communication and learning/education packages about food waste for external stakeholders, based on the project's results. For external stakeholders, the datasets in this layer will have visibility "private". This implies they can neither be pre-viewed (on site exploration of content) nor downloaded by users from the public with no administrative role. They can however be seen as existing datasets. These manipulations are possible for the data owners within the project with administrative roles assigned. Access to these "private" datasets can be requested by contacting the site administrator by using the "contact" tab attributed to the "private" dataset. The requester will then be redirected to their mail page to send an informative email who's auto-generated subject contains the "private" dataset name asking access to these datasets. The site administrator will then channel this request to the dataset owner. A stakeholder agreement or business model pertaining to the specific "private" dataset can then be made, and the requester granted access.

Figure 7 Requesting access to "private" datasets
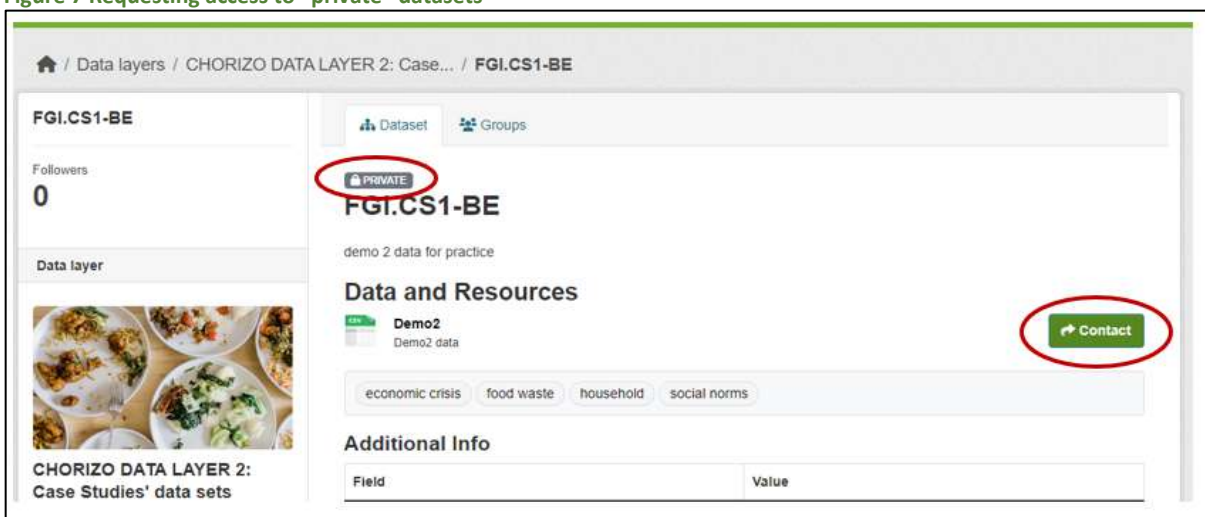
Source: FLW Insighter (D2.2) of the CHORIZO project

2.6   Data utilization in deliverable 2.3

In this section we provide a transparent and comprehensive overview of the data utilized throughout the analysis of the case studies. Since D2.3 intricately utilizes the diverse datasets presented in this chapter, we aim in Table 1 to clarify the use of data in this deliverable. Table 1 delineates the

datasets that were employed for each chapter and details the corresponding methods or processes applied.

Table 1 Overview of case studies' datasets and analytic methodology utilized in D2.3

Case Study	Dataset	Chapter	Methodology	Software/Application Utilized
CS1 Household Food Waste in and off crisis period	Survey Interviews Spain & Belgium	Chapter 4	1. Descriptive statistics and correlation analysis on food waste levels, consumers behaviours and attitudes and social norms. 2. Gender and intersectional differences.	- R Studio (version 2023.12.1+402) for survey descriptive and correlation analysis.
		Chapter 5	1. Regression analysis on food waste levels. 2. Clustering of consumers based on FW characteristics. 3. Factor analysis and Structural Equation Modelling employing the MOA hierarchy to reveal more intricate relationships and groups of social norms.	- Python for data processing and clustering - R programming language for regression analysis and SEM.
	Focus group Belgium	Chapter 4	Qualitative Analysis of FGI with a focus on evident social norms, the MOA framework, and behaviour.	- NVivo analytical software.
	In-depth interviews Spain	Chapter 4	Qualitative Analysis 1. Analysis of IDIs with a focus on social norms and the MOA Framework.	- Manual analysis utilizing Excel. - Supplemented with Quirkos analytical software.
CS2 Hospitality Food Waste	Hotel staff survey	Chapter 4	Descriptive statistics	- Google Forms
		Chapter 5	Relationships with results from breakfast experiment.	- Google Forms
	Interviews with chefs	Chapter 4	Qualitative Analysis 1. Analysis of IDIs with a focus on social norms and the MOA Framework.	- NVivo and Quirkos analytical software.
	Breakfast experiment	Chapter 4	Descriptive statistics on the number of guests, waste per guest and types of messages.	- R programming language.
		Chapter 5	Regression analysis on the effect of messages on food waste.	- R programming language.
	Lunch experiment	Chapter 4	Descriptive statistics on the number of guests, waste per guest and type of serving.	- R programming language.
		Chapter 5	Regression analysis on the effect of serving type on food waste.	- R programming language.
	Survey interviews	Chapter 4	1. Descriptive statistics and correlation analysis on food waste levels, consumers behaviours and attitudes and social norm.	- SPSS statistical software.

Case Study	Dataset	Chapter	Methodology	Software/Application Utilized
CS3 Food Services Food Waste			2. Gender and intersectional differences.	
		Chapter 5	1. Regression analysis on food waste levels. 2. Clustering of consumers based on FW characteristics.	- Python for data processing and clustering. - R for regression analysis.
	In-depth interviews	Chapter 4	Qualitative Analysis 1. Analysis of IDIs with a focus on social norms and the MOA Framework.	- Quirkos analytical software.
CS4 School food waste and relation with obesity and malnutrition	Focus group interviews with pupils	Chapters 4 & 6	Qualitative Analysis	- Quirkos analytical software.
	In-depth interviews with headmasters, parents, and teachers		Qualitative Analysis 1. Analysis of IDIs with a focus on social norms and the MOA Framework.	- Quirkos analytical software.
	Future Foods workshop		Qualitative Analysis	- Manual analysis – no analytical software.
CS5 Food waste in a food bank's mediated supply chain	In-depth interviews	Chapter 4	Qualitative Analysis 1. Analysis of IDIs with a focus on social norms and the MOA Framework.	- NVivo analytical software.
CS6 Food waste in relation to date marking and sustainable and smart	Survey interviews in 5 EU countries (Spain, Estonia, Greece, Netherlands, and Hungary)	Chapter 4	1. Descriptive statistics and correlation analysis on food waste levels, consumers behaviours and attitudes and social norms. 2. Gender and intersectional differences.	- XLSTAT
		Chapter 5	1. Regression analysis on food waste levels. 2. Clustering of consumers based on FW characteristics.	- Python for data processing and clustering. - R for regression analysis.

Case Study	Dataset	Chapter	Methodology	Software/Application Utilized
food packaging			3. Factor analysis and Structural Equation Modelling employing the MOA hierarchy to reveal more intricate relationships and groups of social norms.	
	Pilot home surveys in Spain	Chapter 4	1. Descriptive statistics and correlation analysis on food waste levels, consumers behaviours and attitudes and social norms. 2. Gender and intersectional differences	- XLSTAT
	In-depth interviews with consumers	Chapter 4	Qualitative Analysis 1. Analysis of IDIs with a focus on social norms and the MOA Framework.	- Manual analysis utilizing Excel. - Supplemented with Quirkos analytical software.
	In-depth interviews with industry	Chapter 4	Qualitative Analysis 1. Analysis of IDIs with a focus on social norms and the MOA Framework.	- Manual analysis utilizing Excel.
	National Workshop	Chapter 4	Qualitative Analysis 1. Summary report of the workshop with a focus discussions related to FW and its' relationship with date-marking and smart-packaging.	- Manual analysis – no analytical software.

3   COMPARATIVE ANALYSIS BETWEEN PREVIOUS PROJECTS OF CASE STUDY PARTNERS AND PREVENTION/REDUCTION ACTIONS (T1.2)

The overall aim of this chapter is to provide the context – as broadly as possible - for which the case studies within the CHORIZO project are conducting their work. To achieve this, three main elements have been taken into account. First, where applicable, an overview is provided of interventions (research, studies, projects, etc.) on food waste prevention and reduction interventions which case study partners have been involved in prior to CHORIZO, and which complement their current case studies within the CHORIZO project. Secondly, in cases where case study partners were not engaged in previous interventions on food waste prevention and reduction, a literature review of interventions that are complementary to each case study's topic and geographic location is provided. Finally, an overview is given of the interventions identified and analysed across the EU member states within WP 1 of CHORIZO. The final section of this chapter ties these three elements together to provide a cohesive outlook of the current contexts relevant for the case studies, particularly when it comes to interventions' impacts (environmental, socio-economic), effect on FW levels, and the evident social norms in relation to food waste behaviour.

3.1   Previous FLW prevention/reduction actions of case study partners and literature review

3.1.1   Household FW in and off economic crisis period in Spain and Belgium

Spain

The primary study devoted to FW in Spain is the longitudinal Spanish Household Food Waste Panel, established in 2014 as part of the Spanish Strategy "More Food, Less Waste," which measures and monitors household food waste in Spain[4]. It aligns with the European Parliament's resolution of 2012[5]. The aims and achievements of the strategy are as follows:

1. **Generation of Knowledge:**
   o Established the Spanish Household Food Waste Panel as a reliable measurement method.
   o Conducted pilot studies in primary production to demonstrate the viability of a periodic measuring system.

2. **Dissemination and Promotion of Best Practices:**
   o Conducted numerous awareness-raising activities, including "food waste reduction weeks."
   o Participated in national and international forums related to food waste.
   o Created practical guides, audit tools, and codes of best practice to assist companies in fighting waste.

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[4] More Food Less Waste: Strategy 2017-2020:
https://food.ec.europa.eu/system/files/2021-05/fw_lib_fwp-strat_national-strategy_estrategia_2017-2020_en.pdf

[5] European Parliament resolution of 19 January 2012 on how to avoid food wastage: strategies for a more efficient food chain in the EU:
https://www.europarl.europa.eu/doceo/document/TA-7-2012-0014_EN.html

3. **Analysis and Review of Regulatory Aspects:**
   o Engaged in reviewing standards affecting waste in Spain, particularly food donation-related ones. Actively participated in international forums and collaborations with organizations like the EU Platform on Food Losses and Food Waste and the FAO.

4. **Collaboration with Other Stakeholders:**
   o Supported private initiatives and collaborated with food banks and NGOs to promote the redistribution of excess food.
   o Provided information and resources through its website and a monthly bulletin.

5. **Fostering Design and Development of New Technologies:**
   o A life cycle study was conducted indicating the accuracy of date markings established by the industry.
   o Addressed consumer confusion regarding "expiry date" and "best before date" concepts, aimed at reducing food waste.

6. **Reduction of Food Waste:**
   o The Spanish Household Food Waste Panel revealed a gradual reduction in food waste in Spanish homes.
   o All stakeholders' efforts are bearing fruit, contributing to achieving Sustainable Development Goal (SDG) 12.3.
   o Weekly food waste in Spanish homes decreased by 1.5 million tonnes from Autumn-Winter 2015 to Spring-Summer 2016.

Overall, efforts have resulted in **increased awareness** and a **reduction in food waste** in Spanish homes, demonstrating progress toward the goals of the "More Food, Less Waste" strategy document. The Spanish Household Food Waste Panel was implemented within the strategy in collaboration with the Ministry of Agriculture, Fisheries, Food and Environment (MAPAMA). The panel employs a comprehensive methodology utilizing purchase and usage panels. The Purchase Panel tracks daily food and drink purchases by Spanish households, while the Usage Panel records recipes cooked at home. Data on wasted products and recipes are collected through online questionnaires, providing valuable insights into household food waste. Covering 100% of household food waste destinations with moderate complexity, the panel involves 4,000 households and 8,000 questionnaires, furnishing detailed information crucial for intervention design. Additionally, it facilitates optimized resource utilization and swift completion by sample households. The resulting information offers detailed insights into wasted products and recipes, categorized by sociodemographic criteria such as region, age of the housewife, presence of children, socioeconomic level, and life cycles. Notably, it indicates a decrease in total food waste at the household level over time and **identifies specific food categories and recipes most prone to wastage.**

Figure 8 Decrease of food waste post-pandemic (Covid-19)
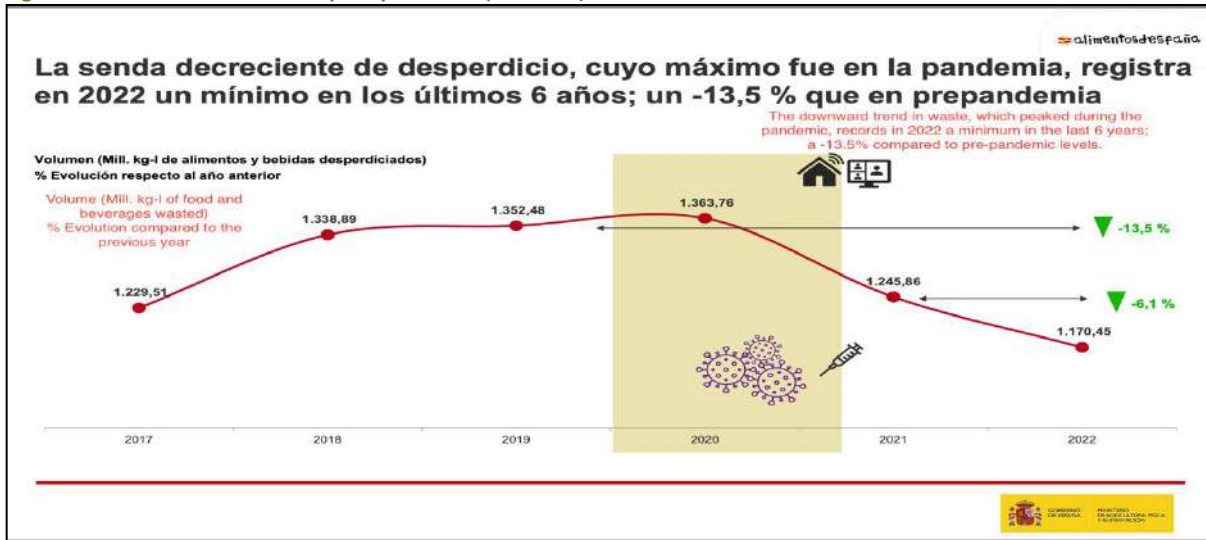
Source: Spanish Ministry of Agriculture, Fish and Food
https://www.mapa.gob.es/en/alimentacion/temas/desperdicio/informeanualdeldesperdicioalimentarioenloshogaresespanoles2022_v2_tcm38-659669.pdf

The conclusion from the last panel wave in 2022 shows that **waste levels decreased compared to the previous data-gathering period,** mainly due to fewer households disposing of food and improved handling of raw materials, **particularly perishables.** Decreased levels of food waste could further be explained by:

- Better time balance: flexi work; increased domestic consumption; more efficient and smaller meals at home.
- Increasing awareness of waste; a sense of responsibility for food waste; and better shopping and planning.

However, an **increase in the waste of prepared dishes**, notably meats, fish, and rice, has been observed. To further reduce waste, it is crucial to enhance the management of purchased quantities and carefully plan consumption at home and outside while also considering portion sizes. Items such as bananas, apples, fresh vegetables, deli meats, and sausages require better oversight, as well as monitoring of the quantity of cooked food in all dishes, given the overall rise in recipe waste. Targeted efforts should be directed toward older age groups (over 50), families with older children, and smaller households of 1 or 2 individuals.

Belgium

In a diary study described in the Food Waste Quantification Manual of the EU-funded FUSIONS project, a representative sample of 1,031 Flemish households was asked about the quantity, composition, and final destination of their discarded food per season, over the course of one year[6]. In addition, the study inquired about the reasons for throwing away the food. Each season, at least 250 respondents completed the diary in a standardized manner during one whole week. The four-step approach avoided potential seasonal effects, as well as effects related to end-of-year and holiday periods. On average, each household discarded approximately 1.7 kg of food and drink per week. In Flanders, this equates to an **average of 37 kg of food per year per inhabitant.** The top three categories of discarded food and drink are **coffee and tea, bread and pastries, and fruit**. Notably, a

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[6] FUSIONS project (2012-2016):
https://www.eu-fusions.org/index.php/about-fusions

significant portion of the discarded food, about 45%, is either given to animals or composted, typically using a container for vegetable, fruit, and garden waste or a compost heap. Interestingly, socio-economic characteristics such as age, urbanization level, gender, and social group did not significantly affect the quantity of food waste. However, **household size showed a notable impact**, with larger households experiencing higher average food waste. When questioned about the reasons for food waste, **incorrect portioning** (30%) and **product spoilage** (29%) emerged as the primary factors cited.

A survey conducted online and outlined in the "Causes and Determinants of Consumer Food Waste" within the EU-funded REFRESH project provides further insights into household food waste[7]. Drawing upon the insights of the Consumer Food Waste Model (Van Geffen, van Herpen, and van Trijp 2016), this study sought to explore the impact of various factors on food waste within households, including socio-demographic characteristics, household routines, motivation, skills, knowledge, and environmental factors. Actual food and beverage purchasing data were utilized in this investigation to overcome the challenge of respondents possibly inaccurately estimating their purchasing behaviour.

The study revealed that throwing away food is widely considered as **irresponsible** among Flemish households, with 82% expressing that notion. Additionally, 85% reported also feeling a **sense of guilt** associated with food waste. Other results obtained in the study presented the following:

- Various motivations were identified for reducing food loss and waste. The primary drivers included **respect for food** (47%), worldwide **food shortages** (40%), **money-saving** (55%), **environmental concerns** (33%), and simply disliking food wastage (63%).
- Not selling fruits and vegetables because they are **cosmetically imperfect** in terms of shape, colour, or measurements (60%).
- Leaving fruits and vegetables in the field (37%).
- Throwing away products past their best-before date without checking them first was widely considered as wasting food (37%).
- The most typical reasons for food waste among Flemish households was in regards to **preparing or serving too much food** (30%), followed by **spoiled or unappetizing products** (29%), don't feel like eating/drinking it anymore (11%), bought too much (7%), and the expiry date had passed (8%).
- Households reported receiving signals from their social environment regarding food waste. A significant portion (42%) stated that people in their **social circles expect them not to waste food.** Additionally, 45% regularly encountered reports about food loss in the media.

Regarding household practices, it was anticipated that planning would negatively correlate with food waste rates, a hypothesis that was validated. Enhanced **purchasing** and **meal planning strategies** were **linked to reduced food waste.** However, exploring various purchasing and preservation practices, as well as leftover management, yielded a more **complex picture**. Some purchasing habits, such as the frequency of shopping trips and impulse purchases, were positively correlated with food waste. Notably, purchasing smaller packs and portions showed no effect on food waste figures, which was unexpected. Additionally, **checking the expiry date was positively correlated with increased food waste**, indicating that households relying solely on expiry dates may discard more food. Interestingly, using sensory assessments to gauge product freshness did not show a similar correlation. Furthermore, households that reported **storing and reusing leftovers tended to waste less food** compared to those who did not adopt this practice. Effective skills and knowledge were found to play a crucial role in breaking habitual behaviour. Proficiency in cooking, portioning food

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[7] REFRESH project (2015-2019):
https://eu-refresh.org/about-refresh.html

properly, and estimating shelf life were positively correlated with reduced food waste. The **organization of time** and **meal regularity**, along with **household infrastructure**, were highlighted as important elements. Interestingly, irregular eating habits within the household were associated with greater food loss, while the possession of a cool storage room and freezer led to more food waste.

The **impact of motivation** was explored through hypotheses concerning attitude, awareness, and social norms. As predicted, households expressing disapproval of discarding edible food tended to waste less. However, **the perception of specific actions as food waste varied** among households. For instance, households viewing unsold imperfect produce as food waste tended to waste less. However, the perception of giving leftovers to pets as waste did not correlate with actual food waste figures. Notably, the social norm, encompassing factors such as parental behaviour, media reports, and societal expectations, showed no significant relation to the degree of food waste.

In a report on household food waste by Flanders Food, households generated approximately 468,000 tons of food waste in 2015, averaging 72.3 kg per person[8]. Despite this, the leading destination for food waste is composting, with 40% being composted, followed by 28% being used as animal feed and 24% being incinerated with energy recovery[9]. Despite efforts to reduce food waste, a considerable amount of edible food remains discarded, highlighting the need for continued intervention and awareness campaigns. Another challenge was to estimate food waste accurately due to various disposal channels. While efforts have been made to **refine estimation methods, including surveys and analysis of residual waste**, the need for further improvement and data validation has been acknowledged. Ongoing research and initiatives are essential to understand food waste dynamics comprehensively and develop targeted strategies for waste reduction and resource recovery. By engaging households, policymakers, and stakeholders, Flanders can continue to lead in sustainable food waste management practices, setting an example for regions worldwide.

3.1.2   Hospitality FW in Norway

The EAT SMART study conducted by Strawberry (formerly named Nordic Choice Hotels), aimed to influence guests' food choices, encouraging them to opt for healthier and more sustainable options such as salads and fish over meat (Mobekk et al. 2018). The study utilized principles from the Slim by Design approach and the GreeNudge toolbox to implement nudges effectively. The study was done in nine Nordic Choice Hotels in Sweden and Norway from April to June 2015. "Eat smart" signs were tested on warm fish dishes and four salad buffets. Three changes were made to the warm buffets: meat first, fish first with no sign, and fish first with an Eat Smart sign. Eat Smart signs were placed on four dishes in the cold salad buffets, and observers recorded the number of guests taking fish and meat dishes and the amount taken. Additionally, guests were allowed to add meat to their salad, or have it served separately, and the amounts taken were measured.

Placing "Eat Smart" labelled fish first on the buffet resulted in a 9% increase in guests choosing fish and a 7% decrease in guests choosing meat. Additionally, fish portions increased by 9%. The **effectiveness of the Eat Smart signs was particularly noted early in the week**, with Mondays seeing a 20% increase in fish selection and a 22% decrease in meat selection. In comparison, Tuesdays saw a 9% increase in fish selection and an 11% decrease in meat selection. When fish was placed before meat, there was a 2% increase in fish selection and a 7% decrease in meat selection. Interestingly, it

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was observed that the **portions of meat became larger when fish was prioritized first,** suggesting a potential area for further investigation in future studies.

Implementation of "Eat Smart" signs led to a **25% increase in portion sizes of marked salads.** However, the number of guests trying these salads remained the same. The effectiveness of "Eat Smart" **varied depending on the type of salad**. There was a slight decrease in guests opting for beans and root vegetables and a slight increase in those choosing salmon, with no change observed for mixed salad. The **portion sizes** significantly increased for beans and root vegetables but decreased for salmon. However, the portion sizes of warm vegetables and fish increased notably. Additionally, "Eat Smart" signs coincided with increased guests selecting healthy, warm vegetables.

Research also demonstrates that adding meat to salads decreased the salad's popularity by 4%. However, guests who opted for a salad with meat on top consumed 40% larger portions and took less other meat options from the buffet. When given the choice to add meat to their salad, guests took 40% more salad and 28% less meat from the warm buffet. Moving forward**, food providers can influence customers to make healthier choices by nudging them towards salads and fish over meat.** Implementing tools like Slim-by-Design and GreeNudge in more hotels can promote sustainable and profitable food solutions across Nordic countries.

The KuttMatsvinn2020 project was formally established in January 2017[10]. Norges Gruppen and ASKO Servering (both grocery wholesalers) initiated the project after identifying sustainability challenges in the hospitality industry. With support from other entities like Unilever, BAMA Storkjøkken, Nordic Choice Hotels, and Matvett, a preliminary project was launched in the fall of 2016. Matvett assumed the project leadership role from Norges Gruppen in January 2017. The initiative gained traction with many stakeholders beyond the initial founders. Initially planned for three years, the project was extended to four years due to the interest of participating businesses. It involved various sectors such as hotels, restaurants, canteens, retail, bakeries, and the public sector. Its main aim was to assess and reduce food waste among participating businesses. Suppliers from the food industry, wholesalers, and purchasing groups were also involved due to their close ties to the hospitality sector regarding product range, supply, and procurement.

Various deliverables were achieved throughout the project, including but not limited to establishing common measurements for food waste, running awareness campaigns, showcasing best practices, and engaging in international partnerships. Research conducted by NORSUS was instrumental in the detailed mapping of food waste, providing a methodology for measurement and reporting from food service establishments. The participants collectively achieved a 15% reduction in food waste, amounting to 390 tons between 2017 and 2019, equivalent to savings of 24 million kroner and 1400 tons of CO_2 emissions. Results from studies conducted in the project demonstrated that in hotels, **bread, fruits, and vegetables**, **mixed dishes, and fish/meat** are the product categories which have the highest food waste levels at the hotels. Buffets and plate waste accounted for the majority of food waste in the (studied) hotels while meal preparation accounted for 23% of FW.

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[10] KuttMatsvinn2020:
https://www.matvett.no/uploads/documents/CutFoodWaste2020-in-Norway-food-waste-in-the-food-service-industry-2017-2020.pdf

Figure 9 Composition of food waste in studied hotels
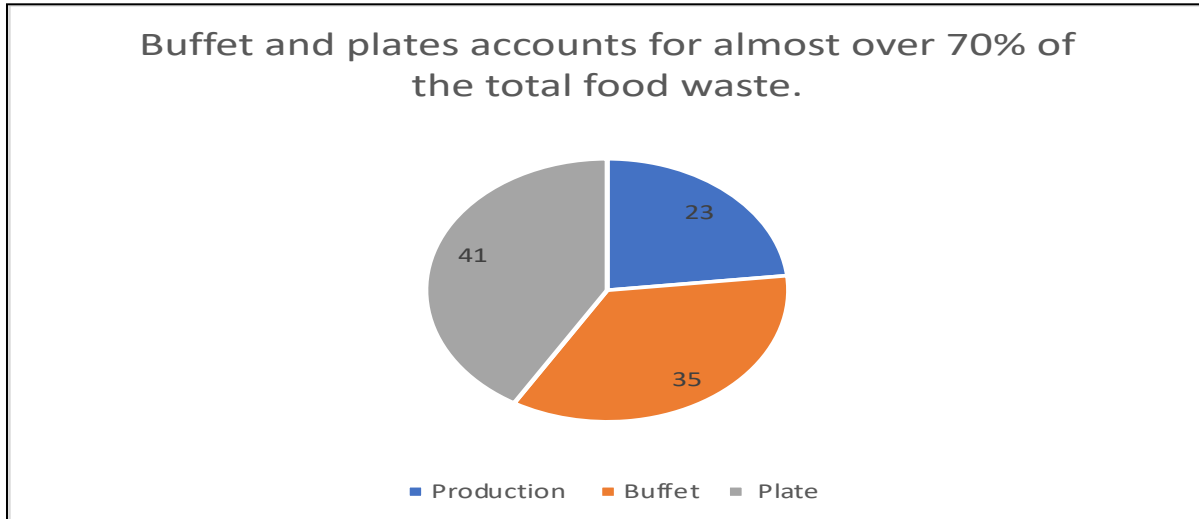
Source: Authors' illustration based on KuttMatsvinn2020 project.

When discussing waste, the most common challenges identified to avoid FW in the hospitality sector were:

• Lack of knowledge and training for staff, thus affecting items in stock expiring, or producing excessive quantities for the buffet.
• It is challenging to predict the number of guests who will eat.
• Due to safety measures, food must be discarded because it has been on the buffet display for too long.
• There are few opportunities to sell or give away food that is not consumed.
• The serving trays in the buffet are too large.
• Guests serve themselves more than they can eat.
• Too many dishes/options on the menu lead to increased purchases and more products in stock.
• Raw materials are packaged in too large units and unused.
• Raw materials have a short shelf life and must be discarded.

Partners of the project have contributed many good examples of measures implemented to address FW, which have been showcased on Matvett's website:

1. **Adjustment of portion sizes:**
   Communicating effectively with guests while ordering accompaniments and adjusting the number of side dishes like fries, sauce, or dips.

2. **Measurement for necessary insight:**
   Measuring food waste is crucial for understanding the amount of food discarded at the establishment, increasing awareness among staff, and allowing businesses to track trends over time.

3. **Selling instead of discarding:**
   Utilizing new technology like the "Too Good To Go" app, which connects consumers with surplus food establishments, has significantly reduced food waste. Food that would have been discarded can now be purchased by consumers at a reduced price.

4. **Training and competence for increased knowledge and confidence:**
Involving employees, enhancing their skills, and establishing routines are vital for reducing food waste. Various food waste courses have been conducted for food managers, kitchen managers, etc., either through KIT Academy or internally at participating businesses.

5. **Utilization of raw materials:**
Efficient use of raw materials is crucial for reducing kitchen waste. This involves proper filleting, peeling/prepping of ingredients to maximize their use, and using leftover parts for other purposes.

6. **Modernization of the buffet:**
Buffets have been identified as major contributors to food waste. Several establishments have successfully reduced buffet waste by reducing the number of items, focusing on quality over quantity, using smaller serving dishes, and introducing smaller plate sizes.

7. **Goodie bags for guests' leftovers:**
To reduce waste from guests' plates, establishments offer leftover food in goodie bags for late-night snacks or the next day's lunch. Implementing this practice automatically could make it a common courtesy for guests.

8. **Employee involvement:**
Employees are crucial in reducing food waste. They need to be involved early, take ownership of the effort, and be encouraged to highlight challenges and propose solutions.

9. **Creative reuse:**
Utilizing leftovers creatively involves making croutons from surplus bread, omelettes with cheese and vegetable scraps, or stews with various leftover ingredients. A "Daily Special" composed of surplus ingredients can enrich the menu.

10. **Guest involvement:**
Much food waste occurs during service (e.g., buffet) or with guests. Campaigns and information encouraging guests to take only what they can eat and fostering an understanding that excess is unnecessary can significantly reduce waste.

These measures demonstrate effective strategies for reducing food waste in the hospitality industry, emphasizing the importance of collaboration, innovation, and proactive management.

Results from the mapping of food waste in the Horeca Network Project between Sodexo, Nordic Choice Hotels, and BAMA in April 2016, show that most food waste occurs in meal production (44%), followed by plate waste (28%), buffet (24%), and storage (4%)[11]. In terms of food commodities, the majority were vegetables (397 kg), followed by miscellaneous items (295 kg), fruit (143 kg), and meat (139 kg) in total for the entire period and all hotels[12]. The most crucial recommendations from this study were:

- Reduce buffet container sizes.
- Smart production planning and increased use of cooking in small batches.

[11] Kartlegging av matavfall i Horeca-nettverk: Sodexo, Nordic Choice Hotels og BAMA: https://norsus.no/wp-content/uploads/or1816-kartlegging-av-matsvinn-horeca-nettverk.pdf

[12] Kartlegging av matavfall i Horeca-nettverk: Sodexo, Nordic Choice Hotels og BAMA: https://norsus.no/wp-content/uploads/or1816-kartlegging-av-matsvinn-horeca-nettverk.pdf

- Greater employee engagement by setting weekly reduction goals for food waste.
- Actively monitor what is being discarded.
- Check specifications for quantity during preparation. Prepare and cook smaller quantities to match demand.
- Carefully trim meat, fruit, and vegetables (e.g., reduce cutting the tops of carrots).
- Portion meal elements where possible.
- Maximize the use of prepared and unserved food in "dish of the day" offerings (e.g., soups and stews).
- Offer "small bite" versions of main courses.
- Ask customers if there are items they do not want included in a meal.
- Reduce side dishes and plate/bowl sizes but allow refills.

3.1.3   Food Services FW in Slovenia

The "Food Is Not Waste" project investigated the factors impacting the motivation of consumers, households, and organizations to minimize food waste[13]. The study encompassed surveys for consumers and organizations, including the HORECA sector. Most of the inquiries prompted respondents to indicate their level of agreement with specific statements using a 7-point Likert scale. The data reveals trends in food waste generation in the catering and food service sector from 2013 to 2019. Despite fluctuations, there was an overall increase in food waste during this period. **Inadequate portion sizes**, **planning issues** (e.g. fluctuations in guest numbers), and **strict hygiene standards** are cited as common causes of food waste in the catering and food service sectors. According to the republic of Slovenia statistical office, the magnitude of FW in the food services sector has indeed increased over the past few years.

Figure 10 Increase in FW in the food services sector in percentages (2016-2022)

Source: Authors' illustration based on Slovenia Statistical Office.
https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/2780705S.px/table/tableViewLayout2/

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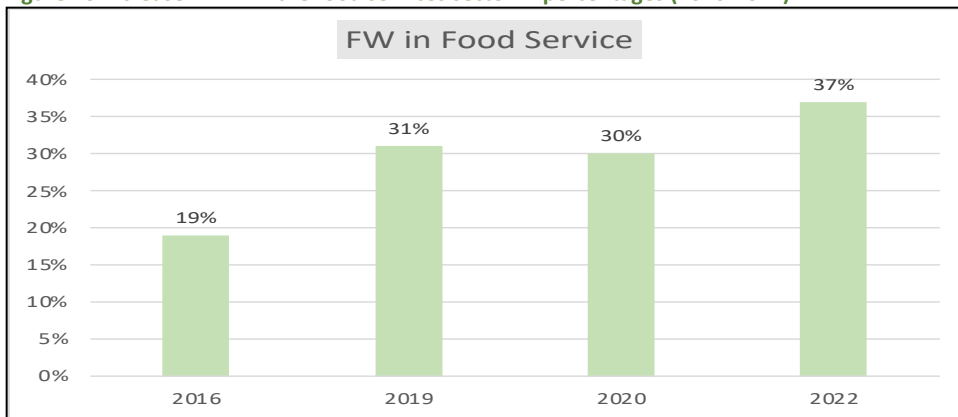
[13] Food is Not Waste research project:
https://ec.europa.eu/newsroom/sante/items/710577/en

Figure 11 Increase in FW in the food services sector in tonne weight (2013-2022)

Source: Authors illustration based on Slovenia Statistical Office.
https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/2780705S.px/table/tableViewLayout2/
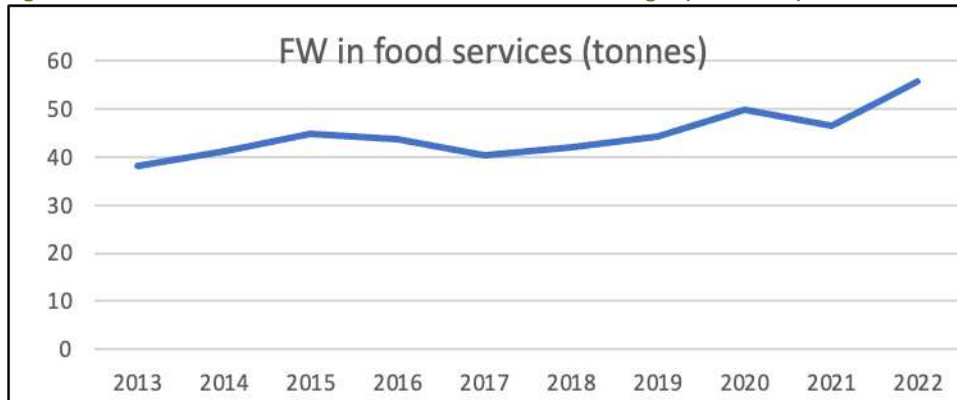
While organizations recognize food waste as a social problem, they often believe their current practices are adequate and are hesitant to implement further changes due to perceived costs and time constraints. In the catering and food service sector, unserved food is commonly discarded, although efforts are made to repurpose it in other dishes. However, a significant percentage of food is being wasted, with various factors contributing to this, including **portion sizes and guest preferences.** Respondents suggest several preventive measures to reduce food waste, including **raising standards for raw materials, employee education**, and **menu adjustments** based on market trends. Donating excess food was also considered, although it is less commonly practiced.

Another interesting result is that the findings from the telephone survey portion of the study revealed significant **gaps in the knowledge by food handlers** (from managers and chefs to assistant chefs and kitchen assistants) particularly in the realm of **food safety**. Expressly, deficiencies were noted in understanding **refrigeration and cooking temperatures** and in knowledge of pathogenic microorganisms and food temperature measurement during cooking. Among the three indexes developed for the study, the Temperature Knowledge Index exhibited the most significant knowledge gaps, with a rate of 37.8%, compared to 85.8% for the Personal Hygiene Index and 79.1% for the General Knowledge Index. **Formal food-related education and on-the-job training** were found to have the most positive impact. Addressing these findings by evaluating and potentially restructuring current food safety training methodologies in Slovenia is crucial. Food handlers in food establishments need proper education and training in food safety, as mandated by EU regulations. In conclusion, implementing periodic training sessions led by qualified food safety professionals and tailored training materials for various types of food establishments is crucial.

In another study 31 semi-structured interviews were conducted with organizations representing different phases of the food supply chain, with each interview involving 20-25 participants (Jevšnik et al. 2023). Notably, interviews were often undertaken simultaneously with multiple individuals from the same organization. Across all phases of the food supply chain, including HORECA, FW was found to be primarily influenced by **food business management decisions** and **guest preferences**. As in previous studies, **insufficient staff training** was identified as contributing to poor kitchen practices, leading to significant FW. Factors such as ordering practices, stock planning, and cooking methods were highlighted as crucial determinants of FW generation. Moreover, seasonal variations were observed to impact FW levels, with more significant quantities generated during off-peak periods. Portion sizes and service methods were also identified as factors influencing FW generation, with flexible portion sizes and self-service cafeterias demonstrating the potential for reducing FW compared to fixed portions. In the HORECA and food service sector specifically, key challenges revolved around: effectively **organizing stock, cooking, understanding guest preferences, and providing adequate staff training and educating guests**.

3.1.4   School FW and relation with obesity and malnutrition in Denmark

The importance of nutrition in schools is emphasized due to the significant time children spend there and its impact on their ability to learn. Interventions in schools have shown promise in positively influencing children's nutritional habits. The OPUS School Meal Intervention compared packed lunches with meals based on the New Nordic Diet (NND), emphasizing palatability, environmental sustainability, and local Nordic ingredients[14]. The study aimed to compare food intake and plate waste between packed lunches and NND meals and assess children's preferences. The study utilized a cluster-randomized crossover design, with measurements taken before and after interventions. Food intake and plate waste were measured by weighing lunches, with children rating meal likability. Statistical analyses revealed differences in waste and intake between packed lunches and NND meals. The median lunch intake during the New Nordic Diet (NND) period was 230 grams, while during the control period (packed lunch), it was 198 grams. The mean portion size for NND lunches was 318 grams compared to 241 grams for packed lunches. Children's ratings of the lunch were associated with increased food intake, with significantly higher intake on NND days compared to packed lunch days when ratings were considered. Edible plate waste was higher during the NND period, with 29% waste compared to 16% for packed lunches. The percentage of plate waste varied according to the menu, with the highest waste on soup and vegetarian days. Plate waste was inversely associated with lunch ratings. The study suggested **that the portion sizes and energy density of the food served influenced plate waste,** with more significant portions and lower energy density contributing to higher waste. **School** and **grade level** also influenced **plate waste**, with differences between schools and between 3rd and 4th graders. Strategies to reduce plate waste included **adjusting portion sizes, tailoring interventions to specific schools**, and **improving the palatability of school meals**. The study highlighted the importance of considering children's preferences and environmental factors in designing school meal programs to reduce plate waste and promote nutritious eating habits. However, it also noted limitations such as differences in eating environments between NND and packed lunches and the need for further research on the cost-effectiveness of such interventions.

To promote healthy dietary habits among Danish children, with a focus on transitioning to a more plant-based diet for both health and environmental reasons, FOODcamp[15] was introduced in 2014. It is a 5-day educational program aimed at enhancing children's cooking skills and understanding of healthy food choices, based on Danish dietary recommendations. Notably, FOODcamp incorporates sustainability principles, including addressing food waste. A whole day of the program is dedicated to utilizing food leftovers, underscoring the importance of minimizing waste in food systems. This aligns with **broader efforts to promote environmental consciousness** and **responsible consumption** among children.

The study evaluates the effectiveness of FOODcamp in improving dietary habits among 6th and 7th graders through a quasi-experimental controlled intervention (Outzen et al. 2023). It involves dietary assessments before and after the program to measure changes in food intake, including fruits, vegetables, meat, fish, snacks, and sugar-sweetened beverages. Additionally, the study identifies misreports of dietary intake using established criteria, ensuring the accuracy of data analysis. Overall, the research aims to determine whether interventions like FOODcamp lead to behavioural changes

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[14] OPUS School Meal Intervention:
https://www.jstor.org/stable/45150620

[15] Arla Fonden – FOODcamp:
https://arlafonden.dk/en/foodcamp/
https://arlafonden.dk/aktiviteter/madlejr/

and healthier food choices among schoolchildren, with a comprehensive approach to addressing both health and environmental concerns.

A summary of the key findings is provided here:

1. **Study Design and Participants**: The study involved 589 children from 16 control and 16 intervention classes in Danish primary schools. Dietary intake data with complete records were collected from 242 children.
2. **Intervention**: FOODcamp is an educational program focusing on healthy dietary habits and hands-on cooking activities. It targets 6th and 7th graders.
3. **Data Collection**: Dietary intake data was collected over 3-5 days at baseline and follow-up. Data analysis involved logistic regression models for binary outcomes (intake vs. no intake) and mixed models for continuous outcomes (positive intake).
4. **Results**:
   - No statistically significant effects of FOODcamp were found on the average intake of vegetables, fruit, vegetables/fruit/juice combined, or meat.
   - Among children consuming fish, discretionary foods, and sugar-sweetened beverages, no significant differences were observed in reported intakes between the intervention and control groups.
   - A tendency towards lower odds of consuming sugar-sweetened beverages was seen among children in the intervention group, but the results were not statistically significant.
5. **Discussion:**
   - The study did not find significant changes in dietary habits following participation in FOODcamp.
   - Dietary intake of the participating children was lower than recommended by Danish dietary guidelines.
   - The study suggests that dietary behaviour change may require longer intervention periods and parental involvement.
   - Challenges in dietary data collection included recall problems and underreporting, common in studies involving children.

The study concluded that FOODcamp did not significantly impact the dietary intake of selected food groups among 6th and 7th graders. While the **frequency of sugar-sweetened beverage consumption tended to decrease among FOODcamp participants**, the results were not statistically significant. It remains a possibility that the intervention duration was insufficient, particularly considering that children aged 11–13 years typically have limited responsibility for meal choices at home. Hence, it would be valuable to **incorporate family-oriented activities** and conduct subsequent dietary assessments to monitor any prolonged alterations in dietary behaviour. Successful school-based intervention studies often emphasize parental engagement and employ diverse strategies to ensure sustained behavioural changes over the long term.

Food waste in schools can have complex relationships with obesity and malnutrition. On the one hand, the prevalence of FW may contribute to an environment where food is abundant and easily accessible, potentially leading to overconsumption and the risk of obesity among students. Excess food availability and unhealthy food choices can promote unhealthy eating habits and contribute to weight gain over time. On the other hand, FW can also exacerbate issues of malnutrition, mainly if students from food-insecure households rely on school meals as a primary source of nutrition. When nutritious food is wasted, it deprives students of the essential nutrients they need for growth, development, and overall health. In this context, FW can perpetuate disparities in access to healthy food and exacerbate nutritional deficiencies among vulnerable populations.

Addressing FW in schools requires a multifaceted approach that considers the **complex interplay** between **food waste**, **obesity**, and **malnutrition** to promote a healthy and sustainable food environment for all students. The awareness-raising Campaign (ARC) of the EU MSCA NIGHT SESAM project, focusing on the SESAM21 event, aspired to influence all of the above. The campaign aimed to raise awareness about FW and attract visitors to the SESAM NIGHT events, involving six schools, 28 teachers, approximately 300 young people, MSCA researchers, and mentors from academia and businesses. The campaign spanned spring and summer 2021 with final events in Copenhagen and Tønder in September of that same year.

The campaign utilized various communication channels, including websites, social media platforms (LinkedIn, Facebook, Instagram), and press coverage to reach a wider audience. Efforts were made to engage schools as critical partners, leveraging their role as respected institutions within local communities. The involvement of graduate and undergraduate students as mentors and interns contributed to the campaign's success. The campaign focused on food, agriculture, nature, and climate themes, aiming to highlight the importance of research and innovation in addressing current food system challenges. The involvement of schools in planning and customizing these activities ensured their relevance to local contexts and educational goals. Overall, the SESAM21 campaign successfully raised awareness about the **role of science in society**, the **importance of food systems,** attracted participants to the events, and encouraged interest in research careers among young people. Main lessons learned:

1. **Awareness Raising:** Planning for communication and awareness should start early. Contingencies such as school dropouts and venue availability need to be addressed proactively.
2. **Engagement with Schools:** Early engagement and mentorship from researchers enhance the success of school-based activities. It's crucial to align the NIGHT program with school curricula and annual planning cycles.
3. **Media Strategy:** Focusing on local media and social media engagement, especially with young people, is effective in raising awareness. Video communication can be particularly impactful.
4. **Whole School Approach:** Involving the entire school community, including students, teachers, and families, maximizes engagement and supports the integration of science communication into the school environment.
5. **Early Planning and Documentation:** Providing a detailed playbook for schools facilitates planning and execution. Maintaining close contact with schools throughout the process ensures smooth coordination and addresses logistical challenges.
6. **Stakeholder Management**: Keeping diverse stakeholders informed early on is essential. This includes venue hosts, school staff, scholars, journalists, and partners. Managing administrative burdens is also important, leading to the recommendation of a mono-beneficiary approach.
7. **Governance Structure**: Establishing a simple and effective governance structure is crucial. This involves day-to-day management, a steering committee, and an advisory board. Early planning and clear communication with teachers are vital components.
8. **Respecting School Diversity**: Recognizing differences in school autonomy and organizational cultures is essential. Providing detailed handbooks and protocols, early kick-off meetings, and individualized relationship management are effective strategies.
9. **Digital Infrastructure**: Creating a streamlined digital infrastructure is necessary for managing data and communication effectively. Minimizing email usage and utilizing shared folders integrated with video conferencing tools can enhance efficiency.
10. **Involving Young People**: While involving young people in project management is desirable, practical challenges such as conflicts with school hours and meeting formats may hinder direct participation. Exploring alternative options like involving youth organizations or creating a separate board for student representatives could be beneficial.

3.1.5   FW in a food banks' mediated supply chain in Hungary

Food waste in Hungary has only recently gained attention, with efforts coordinated by the Ministry of Agriculture and Rural Development starting in 2013. While no specific national plan is dedicated to addressing food waste, it is integrated into the National Waste Management Plan (2014-2020) issued in 2013[16]. This plan outlines the Hungarian Government's approach to waste management, emphasizing priorities such as waste prevention, reuse of by-products, and various recycling methods. Specific to food, Hungary offers corporate tax benefits to encourage food donations, where 20% of the value of donated food can be deducted from the corporate tax base. Additionally, food donations are exempt from VAT, relieving both donating companies and recipients of Value Added Tax (VAT) payments.

The Media Union Foundation launched a campaign (2020-2021) which had the primary objective of altering social perceptions regarding food wastage and reducing food waste in Hungary[17]. The initiative operated on two primary fronts: a robust online campaign and a comprehensive effort encompassing TV, radio, press, and PR initiatives - all aimed at enhancing public awareness regarding the scale and significance of discarded food. Communication materials produced as part of the campaign offered practical tips on repurposing leftovers effectively (like donations to food banks). The campaign received support from the Hungarian Ministry of Agriculture and the National Food Chain Safety Office of Hungary (Nebih).

The "Broadening the Bridge" pilot initiative within the EU-funded REFRESH project, was directed at enhancing food surplus redistribution by expanding channel capacities through local public-private-NGO collaboration and securing additional funding.[18] Co-managed by the Hungarian Food Bank Association (HFBA) and the Hungarian Ministry of Human Capacities (HMHC), the project addressed the growing concern about food waste on the political agenda across the EU. Key findings revealed that food banks' capacities are constrained by available human and financial resources. Being labour-intensive and reliant on volunteers, food surplus redistribution faces challenges in consistent funding and human resources, leading to delays and inefficiencies. To address these issues, the project analysed the redistribution supply chain and identified "white spots" where food surplus existed but lacked organizations for redistribution. Collaborative efforts were established, such as in Paks, where local municipalities, social care organizations, and NGOs joined forces to initiate redistribution activities, successfully saving food and aiding hundreds of people. Additionally, the project led to the establishment of the first food bank outside Budapest in Debrecen, covering redistribution activities for the whole of Hajdú-Bihar County. Workshops and interviews collected best practices to enhance cooperation among stakeholders, and a cost model showed a high cost-benefit ratio, demonstrating the feasibility of using EU FEAD funding. As a result, redistribution activities increased by 144% in Hungary, with plans for further expansion. The project's success underscored the importance of **effective collaboration between public, private, and NGO sectors** in tackling food waste and ensuring food availability for those in need.

The European Federation of Food Banks unites 388 food banks across 24 countries, providing daily deliveries of over 4.1 million tons of food to 44,700 charitable organizations, benefiting nearly 8.1

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[16] National Waste Management Plan (2014-2020):
http://www.szelektivinfo.hu/hirek/414-megjelent-az-orszagos-hulladekgazdalkodasi-terv-2014-2020

[17] Media Union Foundation:
https://mediaunio.hu

[18] Broadening the Bridge pilot project:
https://corporate.tesco.hu

million people in need[19]. After an 8-month temporary membership, the Hungarian Food Bank Association attained full-fledged membership in May 2006. As a member of the European Federation of Food Banks (FEBA) since 2006, The Hungarian Food Bank Association, a non-profit organization established in September 2005, aims to bridge the gap between surplus food and those in need, thereby combating poverty, hunger, and malnutrition. In addition to aiding people in need, the food bank plays a crucial role in preventing food waste, contributing to social and environmental benefits. In 2023 alone, the entity delivered food donations to over 250,000 people, including contributions from their Spring and Christmas Food Collections[20].

Figure 12 Amount of food donations by weight (kg) from 2005-2023
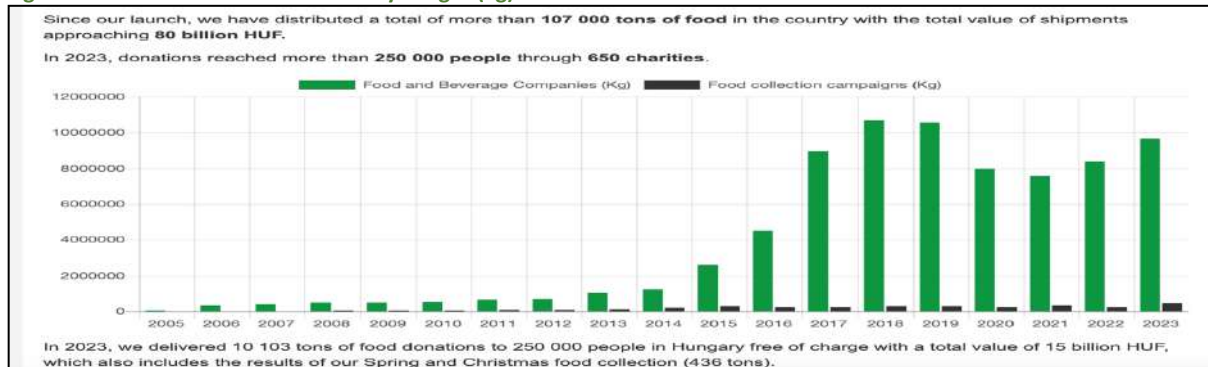
Source: Hungarian Food Bank Association
https://www.elelmiszerbank.hu/en/our_achievements.html

The Food Bank Aid Foundation Budapest, established in 2022 aims to address food insecurity while promoting sustainability in the food system. With a mission to provide food assistance to those in financial need and reduce food waste, the foundation operates with integrity, transparency, and compassion. As a key partner, the foundation receives funding from IOM (International Organization for Migration) Hungary since September 2022 to distribute food, non-food items, and organize social inclusion activities for displaced Ukrainians in Hungary. The Food Bank Aid Foundation has made a significant impact, assisting over 300 families since its inception and relying on the support of over 45 volunteers.

3.1.6   FW in relation to date marking and sustainable and smart food packaging in Spain

A study conducted by ICF in collaboration with research consultancies Anthesis and Brook Lyndhurst, as well as the Waste and Resources Action Programme (UK) was commissioned by the Directorate-General for Health and Food Safety (SANTE) of the European Commission (Lyndhurst 2018). Its primary objectives were to investigate the understanding and practices of food business operators (FBOs) and national competent authorities (NCAs) regarding the information provided on food labels, particularly date marking, and to assess the potential impact of these practices on food waste. The study aimed to support DG SANTE's efforts to prevent food waste through improved date-marking practices.

The study employed desk research, market research through a 'mystery shopping' survey, and semi-structured telephone interviews. Desk research focused on analysing EU food waste data to identify significant contributors to food waste and estimate food waste attributable to date-marking issues. The market research involved purchasing products from selected stores in eight EU member states,

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[19] European Federation of Food Banks:
https://www.eurofoodbank.org

[20] Hungarian Food Bank Association:
https://www.elelmiszerbank.hu/en/our_achievements.html

focusing on specific product types. Semi-structured interviews were also conducted with food business operators (FBOs), national competent authorities (NCAs), and EU-level organizations representing various sectors. **Fruit and vegetables, bakery products, meat, and dairy** were identified as significant contributors to EU food waste. Annual EU food waste attributable to date marking issues was estimated at 6.9 to 8.9 million tonnes, approximately 5% to 12% of total food waste. Challenges included the **legibility of date marks**, **inconsistent storage and open-life guidance**, and differing practices regarding food donation past the "best before" date. Recommendations were made to improve **technical guidance** for FBOs, **address illegible date marks**, empower consumers to make **informed choices, extend product life,** and address barriers to **safe food redistribution**.

The study recommendations were:

• Technical guidance and dialogue within the supply chain to promote best practices in date labelling.
• Encouragement for FBOs to address illegible date marks.
• Empowerment of consumers through coherent and consistent food information and education campaigns.
• Support efforts to extend product life through guidance and highlighting measures that increase product life.
• Addressing barriers to safe food redistribution, including clarifying legal positions and improving consistency of practice.

Overall, the study provided valuable insights and recommendations for stakeholders to mitigate food waste through improved date-marking practices and consumer education.

Spain has also introduced **New Environmental Signage Requirements** for **packaging**. The new regulations regarding packaging and waste management, are in alignment with the EU Packaging Waste Directive and the European Green Deal. The regulations, published in December 2022 in the Spanish Royal Decree 1055/2022, focus on achieving complete **recyclability or reusability of packaging by 2030.** The decree aims to reduce packaging waste generated in Spain, contributing to environmental protection and sustainable development. It introduces measures to increase transparency and producer accountability concerning product marketing and waste management. Key points within the regulations are:

1. **Extended Producer Responsibility (EPR) Scheme:** The decree includes targets to prevent, reuse, and recycle packaging, requiring producers to set up individual or collective EPR schemes and provide financial guarantees by June 30, 2023.
2. **Packaging Requirements:** Packaging must be at most 100 ppm regarding the total amount of certain substances (lead, cadmium, mercury, hexavalent chromium). Visible labelling on packaging items for waste sorting is mandatory, with no digital options mentioned.
3. **Environmental Labelling Requirements:** For business-to-consumer (B2C) packaging, separate waste collection bins must be shown for each component that can be separated by hand. Reusable packaging should indicate reusability conditions, and terms like "Environmentally friendly" are forbidden.
4. **Timeline:** While the provisions were published in December 2022, the labelling requirements will be practical from January 1, 2025.
5. **Green Dot Symbol:** The Green Dot symbol, previously mandatory, is no longer required under the new regulation. It becomes a licensed symbol, available for use upon license purchase.

In the realm of new technologies, a standout initiative is the "Study on the life cycle of food." (Strategy 2013). This study has yielded results indicating that for the products analysed, there are minimal discrepancies between the dates noted on food labels and the actual quality of the products

as determined by analytical testing. This suggests that **date labelling practices are generally accurate and reliable**. Furthermore, the study highlights the **significant impact of packaging types on food deterioration.** This finding underscores the crucial role of innovation in packaging technology in preventing or reducing food waste. By developing **innovative packaging solutions**, it becomes possible to **extend the shelf life** of food products and minimize spoilage. The emphasis on innovation in packaging technology underscores its critical importance in the broader effort to reduce food waste. By leveraging technological advancements and promoting collaborative initiatives, stakeholders can work together to develop sustainable packaging solutions that help minimize food waste and promote a more efficient and environmentally conscious agri-food system.

3.2   Prevention/reduction actions identified in T1.2

Work Package 1 of the CHORIZO project identified **395 food waste prevention/reduction actions** (i.e. interventions) that either took place or are still taking place in the EU-27 member states, the United Kingdom and Norway. They ranged in implementation at the municipal, regional, national, EU, and international level, with instances of overlap - such as certain municipal actions extending regionally, and various national actions extending EU-wide and even internationally. These actions pertained to different stages of the food supply chain, ranging from the initial primary production stage all the way to the consumer.

Of the 395 actions identified, **interviews took place on 46 of them** to find out more detailed information, including but not limited to: impacts (environmental, economic, social), food waste levels prevented, and any evident social norms and food waste-related behaviours. These 46 interventions covered the following stages of the supply chain: **primary production, processing and manufacturing (including valorisation), retail, redistribution, food services, households,** the **whole food supply chain**, as well as interventions that were considered "general awareness raising" initiatives focusing on increasing overall awareness about food loss and food waste in the form of campaigns, forums, or platforms for example, but not specific to a particular stage of the supply chain. The remainder of this section provides analysis of the environmental and socio-economic impacts, the amount of food waste prevented, and the social norms and food waste-related behaviour addressed in the interventions.

3.2.1   Environmental impacts

During the interviews conducted, data was obtained in regards to 5 of the 16 impact categories outlined in the European Commission's Environmental Footprint Method of 2013[21]. The fundamental principles of the method is based on the Life Cycle Assessment (LCA), which evaluates the release of emissions associated with all stages of a commodity, from production to end of life. The **5 impact categories** analysed in WP 1 were: **climate change, land use, water use, and eutrophication (freshwater and marine water)**[22]**.**

Of the 46 interventions for which interviews were conducted, in the case of 40 of them, it was noted by the interviewee that possible environmental impacts – predominantly the amount of **GHGs** prevented due to addressing food waste – were thought about during the development and implementation of the action. However, none of the interviews indicated activity towards actively taking into consideration as well other environmental indicators such as land and water use.

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[21] European Commission Recommendation (EU) of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations (2013/179/EU): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013H0179

[22] CHORIZO project deliverables 1.2 and 1.4 discuss in more detail the environmental impact. https://chorizoproject.eu/deliverables-repository/

Moreover, from the interviews conducted, there was a **data gap** when it came to indicating a keen interest in and being aware of possible environmental impacts, to actually putting into place a comprehensive, systematic monitoring and evaluation of the environmental effects of an intervention. For the interventions where environmental data was not available, there were various reasons cited why this was the case, such as being a one-time intervention (such as a cooking class on utilizing leftovers for example), but most often the reason noted was a lack of resources to systematically include environmental indicators. Consequently, for consistency, and to facilitate acquisition of data on the 5 impact categories, the calculations below are based on those interventions for which FW level data was possible to obtain during interviews, and then inputting that data into the European Commission (JRC) Food Waste Prevention Calculator.

Highlights include:

- The valorisation of biowaste for the production of biogas in Vaxjo, Sweden, addressed the most amount of GHGs (221 million kg CO2 equivalent) in comparison to the other interventions. However, the calculation is based on biowaste which is not only food waste, but can include any waste that is biodegradable.
- If adhering solely to food waste as part of the calculation, then the intervention with the highest impact for avoiding GHG emissions, is Direct Food Surplus in Hungary, with just over 28 million kg CO2 equivalent[23].
- Ranking the highest in terms of water conserved was the biowaste initiative in Vaxjo, followed by Direct Food Surplus, and the Food Mitigation Strategy in Denmark.
- The Food Waste Mitigation Strategy also came out on top when it came to eutrophication, by fending off high amounts of nitrogen and phosphorous from entering freshwater and marine water.

Table 2 Environmental impacts – Interventions for which interviews were conducted

Impact category	Climate Change (kg CO2 eq.)	Land Use (Pt)	Water Use (m^3 world eq. deprived)	Freshwater Eutrophication (kg P eq.)	Marine Eutrophication (kg N eq.)
Action					
Best of Waste	1.70E+05	6.78E+06	1.00E+06	2.93E+01	4.13E+02
Valorisation of biowaste for biogas production	2.21E+08	2.28E+10	3.86E+08	9.72E+08	1.23E+06
Budapest Bike Maffia	2.83E+04	2.61E+06	4.50E+04	5.37E+00	1.46E+02
Valorisation of chicory	4.00E+03	2.10E+05	2.52E+03	1.73E+00	1.54E+01
Direct Food Surplus Redistribution	2.83E+07	2.61E+09	4.50E+07	5.37E+03	1.46E+05
Etelmento	1.32E+04	1.30E+06	2.20E+04	2.67E+00	7.20E+01
Food Waste Mitigation Strategy	1.32E+07	1.24E+09	2.65E+07	3.55E+03	8.54E+04
Food Winners Brugge	1.84E+05	1.74E+07	3.71E+05	4.99E+01	1.19E+03
Foodello	3.37E+06	3.27E+08	5.63E+06	6.97E+02	1.78E+04

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[23] The interview with LIPOR actually provides data citing more GHG emissions prevention, however LIPOR data consolidates several of its interventions and not just one intervention.

Impact category	Climate Change (kg CO2 eq.)	Land Use (Pt)	Water Use (m^3 world eq. deprived)	Freshwater Eutrophication (kg P eq.)	Marine Eutrophication (kg N eq.)
Action					
Foodsavers Antwerp	3.37E+03	3.27E+05	5.63E+03	6.97E-01	1.78E+01
Foodsharing Tartu	1.67E+05	1.54E+07	2.64E+05	3.33E+01	8.52E+02
IKEA / United Against Food Waste	1.25E+06	1.22E+08	2.11E+06	2.57E+02	6.65E+03
Invendus pas Perdus	1.04E+06	1.01E+08	1.73E+06	2.15E+02	5.48E+03
JoteKonyha	4.74E+03	3.92E+05	8.33E+03	1.10E+00	2.83E+01
Krut	2.67E+03	1.55E+05	1.95E+03	1.16E+00	1.14E+01
Let's Save Food	6.47E+05	6.27E+07	1.08E+06	1.34E+02	3.41E+03
LIPOR[24]	7.05E+07	5.95E+09	1.26E+08	1.69E+04	4.25E+05
Hub di Quartiere contro lo Spreco Alimentare	1.02E+06	9.71E+07	1.67E+06	2.61E+02	5.29E+03
Sustainable Acquisition of Foodstuff (school canteens)	3.99E+05	3.76E+07	8.02E+05	1.08E+02	2.58E+03
Voedselhub Mechelen	1.29E+06	1.25E+08	2.16E+06	2.68E+02	6.83E+02
Vollcorner	3.65E+02	1.69E+04	2.10E+02	1.30E-01	1.30E+00
Waste Watch	1.46E+06	1.38E+08	2.94E+06	3.95E+02	9.46E+03
Yhteinen Poyta	1.77E+06	1.63E+08	2.81E+06	3.41E+02	9.12E+03
Foodie Save	2.49E+04	2.29E+06	3.93E+04	4.92E+00	1.27E+02

Source: Authors' calculation based on interview data inputted into the European Commission (JRC) Food Waste Prevention Calculator.
https://ec.europa.eu/food/safety/food_waste/eu-food-loss-waste-prevention-hub/resource/show/859

3.2.2 Socio-economic impacts

The food supply chain is a global, interconnected one with various actors working together to move a commodity through the supply chain. What occurs in one region of the world can affect the availability and price of the commodity in another part. Putting in place an intervention that complements and is part of an overall supply chain strategy to address food waste can **prevent monetary loss, in terms of production, storage, and distribution** of the product as it moves though the supply chain. In addition to this, common economic impacts highlighted across the interventions were **job creation** (particularly in the circular economy), increased **knowledge and skill sets**, and the ability to **innovate and sell new food products** (related to **valorisation**). The additional jobs created due to the interventions were mainly in the sustainability (circular economy) and logistics sectors, while the skills acquired depended on the intervention itself, but ranged from marketing, logistics, purchasing, storage, and proficiency in software technology. The creation of new jobs and skills increased awareness about food waste, including its repercussions and how to prevent it. This increased awareness gives rise to a number of positive social ramifications, including **strengthened relationships** among actors. One such example is Jótékonyha, a social enterprise of the Hungarian

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[24] LIPOR calculations are based on consolidated food waste prevented data for the following projects: Dose Certa, Horta a Porta, Terra a Terra, Fruta Feia, and Embrulha.

Foodbank, offering waste-free food catering services. Via the events, Jotekonyha's customers gain insights about food waste and learn about the Food Bank, with many applying thereafter to volunteer as helpers and / or donate money. Another positive socio-economic effect related to the household level with family realization of the benefits entailed for **household finances** by preventing food waste and not throwing it away. One such example was the Food Waste Fighters (Ireland) which aimed to help households eat more sustainably and economically, with a key piece of the program being a food waste app (No Waste) as well as family members keeping a diary to raise consciousness about how food was bought and being handled at the home. At the retail and food services level a different perspective about what could be sold to consumers was evident in interventions that addressed what might be considered **visually unappealing, but still healthy and safe to eat food.** Such food products not only provided economic viability in that they could still be incorporated into meals and /or sold in retail stores, but served as opportunities to showcase to consumers that despite aesthetic appearance, the product was still safe to be consumed. An example was the intervention supported by VollCorner (Germany) regarding the marketing and sale of optically imperfect carrots.

Another positive social impact was the ability to redistribute the food and thereby **help people in need** – it was a strong motivator for people, as evidenced by the responses in the interviews. These actions not only helped people, but also created a more cohesive community as it necessitated, especially in the redistribution stage, the ability to work with different stakeholders across the supply chain, including food services, retail, transport sectors, as well as charities and non-government organizations (NGOs). Supply chain actors had to communicate effectively and thereby were able to also learn from each other, understanding the challenges and opportunities within the redistribution system as a whole.

3.2.3   FW data

Of the 46 actions for which interviews were conducted, the majority of them **(30)** indicated that they were **able to prevent a certain amount of food waste** via their interventions. The interviews regarding actions in the **retail, food services, redistribution, processing and manufacturing** supply chain stages provided the **most robust food waste information**. Not all the interviews were able to obtain food waste prevention data. This was predominantly due to an initiative just getting underway (such as the Sprecometro app in Italy which started in 2023), or keeping in line with the overall objective of the Chorizo project of trying to better understand behaviour towards food waste – i.e. drivers, impediments, and opportunities to address it – some actions were not specifically geared towards measuring a reduction in food waste. Rather, they were geared towards raising awareness and knowledge about the issue and generate discussion as a starting point. One such example is Madvaerkstedet Madspild, a cooking course in Demark, for children (grades 6-8), where students learn about food waste, its environmental impact, and how to utilize leftovers. The **amount of FW prevented varies significantly** due to the **size** as well as the **timeframe** of the interventions. While no definite conclusions can be made due to the small dataset, it does appear that the higher amounts of FW prevented were more regularly evident in those interventions that took place at the **food services and redistribution stages** of the supply chain.

Table 3 Amount of food waste prevented – Interventions for which interviews were conducted

ACTION	FOOD WASTE PREVENTED	SUPPLY CHAIN STAGE
Best of Waste	160 tonnes (June-September 2022 / high season)	Processing & Manufacturing
Budapest Bike Maffia	8 tonnes (2022)	Redistribution
Direct Food Surplus	8,000 tonnes (2022)	Redistribution
Etelmento	3.5-4 tonnes (2023 projected)	Processing & Manufacturing

ACTION	FOOD WASTE PREVENTED	SUPPLY CHAIN STAGE
Foodello	1,000 tonnes (per year on average)	Retail
Foodsavers Antwerp	1.11 tonnes (2021)	Redistribution
Foodsharing Tartu	47 tonnes (2022)	Redistribution
Food Waste Fighters	225.69 grams per participant (August 7-29, 2021)	Households
Food Waste Mitigation Strategy	3,173 tonnes (2021)	Food Services
Food Winners Brugge	44.4 tonnes (2022)	Households
Foodie Save	7 tonnes (July 2022 – May 2023)	Retail
Hub di Quartiere contro lo Spreco Alimentare	297 tonnes (2022)	Redistribution
IKEA/United Against Food Waste	374 tonnes (April – December 2021)	Food Services
Invendus pas Perdus	308 tonnes (2018 – April 2023)	Redistribution
JoteKonyha	1 tonne (per year on average)	Food Services
Krut	6-12 tonnes (per year on average)	Processing & Manufacturing
Let's Save Food	192 tonnes (per year on average)	Redistribution
LIPOR[25]	15,177 tonnes (2022)	Food Services
SmartMat Hbg	37 grams per meal (comparing 2018 to 2020 figures)	Food Services
Sustainable Acquisition of Foodstuff (school canteens)	96 tonnes (2022)	Food Services
Valorisation of chicory	8 tonnes (November 2019-May 2023)	Processing & Manufacturing
Valorisation of Biowaste for Biogas Production	70,230 tonnes (2022)	Processing & Manufacturing
Voedselhub Mechelen	384 tonnes (per year on average)	Redistribution
VollCorner	0.6 tonnes (12 weeks – Q1 2021)	Retail
Waste Watch	352 tonnes (2022)	Food Services
Yhteinen Poyta	500 tonnes (2022)	Redistribution

Source: Interviews CHORIZO project partners had with implementers of the action.

3.2.4   Social norms and FW behaviours

Understanding what the drivers are (i.e. the motivation) behind FW-related behaviour, cannot be fully understood without examining the role of social norms. Per the work done in the CHORIZO project, and specifically outlined in Work Package 3 (deliverable 3.1), social norms are rules and expectations about behaviours that are socially enforced. In the literature, a common differentiation among social norms is to distinguish injunctive social norms from descriptive social norms. **Injunctive norms** refer to perceptions about normatively appropriate behaviour in a specific context (Cialdini et al. 1991; Gelfand et al. 2024). It relies on the perception that an individual has about what kind of behaviour is approved or disapproved of by the reference group[26]. Often there are reinforcing mechanisms (rewards or punishments) through which such approval or disapproval is expressed. **Descriptive norms** refer to an individual's perception about the likelihood that *others* engage in the

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[25] Data for LIPOR refers to consolidated data for the following projects: Horta a Porta, Terra a Terra, Dose Certa, Fruta Feia, and Embrulha.

[26] Reference group refers to a grouping of people or social network that an individual looks towards to help him or herself determine their own behaviour.

normative behaviour, and the individual follows such behaviour because it is deemed effective and appropriate (Cialdini et al. 1991). It is based largely on observation of what is prevalent or common behaviour and is particularly relevant for new contexts and novel situations.

Taking into account all 395 interventions identified in WP 1, these actions take place across the entire supply chain from primary production to consumption. Consequently, the ability to apply a social norm to all of these actions is limited, since not all of the actions were developed to try and change behaviour at an individual level. However, based on desktop research conducted on all the identified interventions and interviews on 46 of them, a classification of either injunctive or descriptive social norm was given to as many of the interventions as possible.

There were only **14 actions** deemed to be driven by **injunctive social norms**. These actions involved either voluntary agreements, legislation (such as the mandated bio-waste collection for energy production law in France), rewards (example of Froodly's mobile app in Finland rewarding consumers with credits towards free coffee for reporting still-fresh discounted products in their local stores), or punishments (being charged for any leftover food at buffet restaurants for example). By contrast, there were **66 actions** classified as driven by **descriptive social norms**. Most of these actions took place within a community context such as the "Community Fridges" implemented by Hubbub in the United Kingdom, providing a common space to bring people together to eat, connect, learn new skills and reduce food waste. Fridges are run by community groups in shared spaces such as schools and community centres. Broader socio-environmental movements were also a common theme in actions driven by descriptive social norms, such as circular economy initiatives.

The CHORIZO project also identified via literature review in Work Package 2, four social norms specific to food waste (ICF et al. 2018; Stangherlin et al. 2020; Graham-Rowe et al. 2014; Versluis and Papies, 2016; Zhao et al. 2019; and Middleton et al. 2018). These norms are: **sub-optimal food/undesirable food quality**, **good food provider identity**, **portion size and food affluence,** and **associations between food waste behaviour and socio-economic status**. These four social norms could be found in the list of actions identified in WP 1. There were 80 actions classified under "general awareness-raising" meaning that they are actions which focus on increasing overall, broad, general awareness about food loss and food waste - in the form of campaigns, forums, platforms, guides, and educational workshops. Consequently, they are actions which may address to a certain extent any of the four food waste-related social norms. A petition signed by more than 10,000 people, gave impetus to stores such as Penny Market and Tesco to sell "wonky" (i.e. not aesthetically pleasing but still safe to eat) fruits and vegetables. Or the action "Noi Con Mente" in Italy (Puglia region), where the focus is on the ethical value of food and promoting a culture of conscious consumption, thus falling into the "portion size" social norm.

However, there was one food-related social norm which appeared more frequently than the others and was most often found under the **retail stage** (33 actions out of the total 45) – **"suboptimal food/undesirable food quality".** Nevertheless, the norm could also be found within other categories (primary production, processing and manufacturing, food services, households, whole supply chain) and in particular the **redistribution sector**. The commercialization of suboptimal food is a key mechanism for tackling food waste, with the retail sector perhaps having the most influence in terms of being at the nexus of the relationship between the primary sector (production) and consumers (consumption), and thereby being able to influence – directly (advertising campaigns for example) or indirectly (such as reward programs for buying certain foods) – purchase choices (Hartmann 2021).

Overall, the interventions identified in WP 1 were more driven by descriptive social norms where the individual's perception of what is effective, appropriate and common behaviour is key, and particularly relevant if the situation or context is new. To this effect, with food waste being a relatively new topic at the individual level, it makes sense that interventions which help an individual

understand the impacts of food waste and concretely see what rather can be done with surplus food via communal activities, seems to drive more interventions than injunctive social norms.

3.3 Comparative analysis: Previous projects of case study partners, literature review, and prevention/reduction actions identified in T1.2

According to the statistical arm of the EU – Eurostat – and the most recent food waste figures in the European Union (2021), households generate 54% of total food waste, accounting for 70 kg per inhabitant[27]. The remaining food waste generated is spread across the other stages of the supply chain, namely primary production (9%), processing and manufacturing (21%), retail and distribution (7%), and food services (9%). The case studies in the CHORIZO project incorporate research done in all of these stages to some extent, with the only one not covered being primary production.

Based on the previous sections of this chapter - literature review and the summarization of current interventions, particular **socio-economic impacts** often emerge in the discussion. The Ministry of Agriculture, Fish and Food in Spain indicates that food waste levels in the country decreased post-pandemic. The **inflation effects of the pandemic** have evidently played a role, necessitating individuals and households to look at the economic consequences of food wastage. In effect, the raising prices of food has encouraged individuals to re-assess their planning, shopping, meal preparation, storage, and consumption practices. However, there are **nuances,** with the economically poorer households being affected disproportionately due to higher food prices, than more affluent households. The overall premise does stand though in that by preventing food waste and not simply discarding surplus food, families are in effect also not "throwing away" money. Several interventions in WP 1 at the household level were focused on raising awareness about the **economic value of food** in terms of what it means for **household finances**, and helping families more effectively plan for, prepare, consume, and store food. One such example was the 'Food Waste Fighters' project (2021) in Dublin Ireland, which aimed to help households eat more sustainably and economically, via usage of a food waste app (No Waste) and to keep a diary to raise consciousness about how food was bought and being handled in the home. Another example was the 'No Time To Waste' pilot program in the United Kingdom over the summer months of 2020, led by retailer Tesco. The program's objective was to help households make simple and accessible changes in regards to how food is managed at home, and to test whether that had an impact on food wasted and money spent on food[28].

But the economic impacts of food waste are not only felt at the household level. Businesses, such as retailers and those active in the food services industry, also experience economic repercussions. The food supply chain is highly interconnected relying on various actors within the supply chain. As a commodity moves through the chain from inception to ultimate consumption, economic investments are systematically incorporated into the product – be it initial investment costs for cultivation, or equipment needed for logistics, storage, and distribution for example. Putting in place interventions that complement and are part of an overall sustainable food supply chain strategy, in effect **prevents monetary loss, when it comes to the production, storage, and distribution** of the food commodity. Moreover, by incorporating a focus on preventing food waste, a specific set of skills are required, at different levels of the supply chain, thus facilitation another positive socio-economic impact – **job**

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[27] Eurostat 2021 figures on food waste in the European Union: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Food_waste_and_food_waste_prevention_-_estimates#Amounts_of_food_waste_at_EU_level

[28] No Time to Waste project (Tesco): https://www.tescofoodwastechallenge.co.uk

and skill creation. The interventions analysed in WP 1 show that the additional jobs created were mainly in the sustainability and circular economy domain. Such employment varied across the supply chain from primary production to the logistics, manufacture and processing, and distribution sectors, while the skills acquired were diverse, from marketing, to purchasing, storage, and proficiency in software technology, to name a few examples.

Positive socio-economic impacts were also evident in the redistribution sector (i.e. redistribution of surplus food fit for human consumption). Despite the logistical challenges involved in redistributing food, there was also the opportunity for the actors to closely collaborate and **learn from each other** to understand and address the challenges and opportunities within the redistribution system as a whole. The redistribution interventions identified in WP 1, as well as the literature review of what has been done in the redistribution sector in Hungary, showcase another overwhelmingly positive socio-economic impact– **providing food to those in need**. Such actions not only help people, but also create a more cohesive community as it necessitates, the ability to work with different stakeholders across the supply chain, including food services, retail, transport sectors, as well as charities and non-government organizations (NGOs). As noted in the literature review, in 2023 alone, the Hungarian Food Bank Association (HFBA) donations reached over 250,000 people[29].

The latest Eurostat statistics on food waste levels mentioned at the start of this section, demonstrates that the household sector in the EU is a key contributor to food waste. Therefore, understanding behaviours related to food waste within the household, as well as the challenges and opportunities to address these behaviours, is vital in the fight to curb food waste. From the literature review as well as the work accomplished in WP 1, among the key reasons for food waste in households emerged the factor of preparing too much food. This overlaps with the social norm of **"good provider".** In this social norm there is the desire to be a good parent, partner, spouse, host, cook, and therefore emphasis is placed on the amount of food provided, often exceeding what is needed (Graham-Rowe et al. 2014). This norm does not only come into play when providing food for family members such as children, but also when entertaining guests. In this respect, the literature review highlighted another closely aligned social norm which was also evident in WP 1 – **"portion size".** Portion size is taken to indicate how much is considered socially acceptable to eat, without being considered excessive, although it might be excessive in reality (Versluis and Papies, 2016; Zhao et al. 2019). Hosts want to ensure that their guests have sufficient to eat, rather than too little, which might be considered bad etiquette. It is a norm found within households, but rather more frequently in the literature review and the work conducted in WP 1, in the food services industry, such as restaurants, hotels, and school canteens. Interestingly, the EAT SMART project (2015) conducted by Strawberry, proved the effectiveness of 'nudging' (such as via labelling or changing the order of the presentation of food items) to affect not only customers' food choices but in turn also the portion size.

Another social norm evident in both the literature review and the work within WP 1, is that of **"suboptimal food/undesirable food quality"**. This norm refers to not buying or not utilizing food in meal preparations, or eating it due to "sensory deviations" - primarily unusual shape or colour (ICF et al. 2018, Stangherlin et al. 2020). The norm can be found within several stages across the supply chain - primary production, processing and manufacturing, food services, retail, households, and the redistribution sector. The commercialization of suboptimal food is a key mechanism for tackling food waste, with the redistribution, retail and food services sectors perhaps having the most influence in terms of being at the nexus of the relationship between production and consumption. In this context, there are various efforts under-way to increase the preferability of 'suboptimal' food. From social enterprises such as 'Kromkommer' in the Netherlands, which conducts awareness-raising and

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[29] Hungarian Food Bank Association:
https://www.elelmiszerbank.hu/en/our_achievements.html

educational campaigns for consumers about the use of fresh fruits and vegetables, even though they are not aesthetically pleasing, to German retailer VollCorner's initiative over several months in 2021 to conduct scientific tests on optically imperfect carrots. Data was obtained as to how unusual the carrots can look until they are not purchased anymore, while testing the effects of different communication strategies and price reduction[30].

While identifying the behaviours related to food waste generation and the social norms that drive them is vital in the overall fight against FW, what is evident from the literature review as well as the actions identified in WP 1, is the importance of somehow being able to address these behaviours. In this respect the discussion shifts to understanding what abilities and opportunities exist to potentially address those behaviours. The literature review of studies that have taken place on households in Belgium, such as those within the EU-funded FUSIONS and REFRESH projects, demonstrated various factors that influence the amount of FW generated at the household level, such as for example household size. However, these two projects, as well as the literature review in this chapter, demonstrate that what plays a determining role in addressing FW generation, are the **routines, skills, and knowledge** about **food purchase, preparation, consumption, and storage** in the home playing a determining role in addressing FW generation. Such factors – i.e. **abilities and opportunities** to utilize resources available - are key to affecting FW-related behaviour and was also witnessed in the interventions identified and analysed in WP 1. One such example is Carrefour's STOP Waste initiative, a largely awareness raising and education campaign for customers on how to plan, process, share, and sort food at home[31].

Another training pertinent for households (and consumers in general), as well as **industry,** pertains to the **date marking of products**. The literature review highlights a European Commission (DG Sante) commissioned study (2018) on date-marking.[32] It highlighted the importance of both industry and consumers to play their part so that food is not unnecessarily thrown out due to misinterpretation about expiry dates. Several factors come into play including food safety concerns and the level of understanding of what "best-by" and "use-by" mean. WP 1 identified several efforts (interventions) aimed at addressing date-marking. One such example is Arla's initiative 'Changing Consumers Mindset' (Denmark), which is working on changing the 'best before label' to 'also good after' to provide increased clarity for consumers[33]. The literature review also brings to the fore the important role of **packaging,** particularly when it comes to its role **in relation to food deterioration**. While research is being invested into new 'smart packaging' options, consumers need to be made aware of the options available to them.

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[30] Kromkommer:
https://www.kromkommer.com

VollCorner:
https://www.zugutfuerdietonne.de/fileadmin/zgfdt/sektorspezifische_Dialogforen/Gross-und_Einzelhandel/Dialogforum_Fallstudien-Sammlung.pdf

[31] STOP Waste project (Carrefour):
https://serwiskorporacyjny.carrefour.pl/en/sustainable-development/our-customers/stop-waste-or-how-to-reduce-food-waste

[32] European Commission – Directorate General (DG) Sante – "Market study on date marking and other information provided on food labels and food waste prevention":
https://food.ec.europa.eu/system/files/2018-07/fw_lib_srp_date-marking.pdf

[33] Arla:
https://www.arla.com/sustainability/

The **importance of training** not only pertains to the household sector however, but was also evident in the literature review and WP 1 when it came to the food services and redistribution sectors. The literature review on the food services industry covers the hospitality sector in Norway, the restaurant sector in Slovenia, and schools in Denmark.

- In relation to the hospitality sector in Norway and more specifically hotels in the country, one of the case study partners (Strawberry, formerly known as Nordic Choice Hotels) has been active in several interventions aimed at lowering food waste. Examples include EAT SMART (2015), KuttMatsvinn2020 (2017-2021), and the HORECA Network Project (2016). All projects were key in identifying levels of food waste generated in the hotel sector, with the latter two highlighting that a significant amount of the food waste within the hotels partaking in the studies occurs during **meal production**.[34] Consequently, similar to the household sector, one of the key areas to address in order to lower food waste amounts is the **training of kitchen staff** in terms of purchase, stockpiling, meal preparation, and creative reuse of leftover or surplus food. WP 1 bolsters these findings via identification and analysis of several interventions that focus on the importance of education for kitchen staff, including chefs, to help lower the amount of food waste. One such example is the on-going WASTED initiative (Ireland), a national peer-to-peer education programme for chefs and food service teams, headed by the non-profit social enterprise Grow It Yourself[35]. Via courses and workshops with food service teams proactively sharing food waste skills and knowledge, the program focuses on reducing food waste in the hospitality industry.
- The "Food is Not Waste" project in Slovenia noted gaps in knowledge of food handlers – all the way from restaurant managers to chefs and assistants in the kitchen. For this project, the gap in knowledge also extended to issues of food safety, with necessary refrigeration and cooking temperatures highlighted. What was recommended in the project was **formal food-related education** and **on the job training.** The literature review further revealed ordering practices, stock planning, and cooking methods as crucial. A good example identified in WP 1 is Dose Certa, an on-going initiative being implemented by LIPOR (Municipalities Association for Sustainable Waste Management of Greater Porto) in the Porto region of Portugal[36]. Dose Certa is a program aimed at restaurants and canteens to implement active measures (such as menu planning) to tackle food waste. Another example is the Food Waste Mitigation Strategy[37]. This food waste mitigation intervention in the city of Copenhagen, Denmark started in 2021, and is part of the municipality's urban food strategy outlining the ambition to cut food waste on the plate. It is targeted at the municipal food service sector (all institutional food service units in the city) and includes food waste mitigation counselling, awareness raising, and training for kitchen staff.
- In the school environment, FOODcamp, an educational program for children on understanding what are healthy food choices, stresses that within the school context, it is also important to address **meal planning** and that the **preparation process** ought to be improved to better match supply with the demand. There are several interventions identified in WP 1 which support the importance of training in meal planning and preparation and determining the **broader supply**

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[34] Literature review section (3.1) highlights meal production accounting for 44% of food waste (HORECA Network Project) and 23% in the KuttMatsvinn2020 project.

[35] Grow It Yourself – WASTED program:
https://giy.ie/programmes/wasted/

[36] Dose Certa:
https://www.lipor.pt/pt/sensibilizar/100-desperdicio/desperdicio-alimentar/

[37] Food Waste Mitigation Strategy:
https://maaltider.kk.dk/sites/default/files/2022-06/The%20City%20of%20Copenhagen%20Food%20Strategy%202019.pdf

and demand by incorporating an understanding of what drives customer's food choices. One example is the FoodOp Digital Platform (Denmark), a digital platform that helps professional kitchens automatically measure food waste and guest choices, and use these insights to make better food for the environment and for food service guests[38]. The platform consists of a menu planning system that is synchronized with data from scales that are placed under all serving plates and garbage bins. The scales automatically collect data on how much is taken and wasted for each dish, which is used to optimize future menus based on composition, quantity and the guests' choices.

- A common challenge identified in WP 1 for the redistribution sector and also evident in section 3.1, is the overarching logistical framework of moving food in an effective, timely, and safe manner from one location to the next. There is a significant amount of coordination involved to ensure that food is not lost along the way. Moreover, fluctuations in the availability of surplus food can make it difficult to optimise redistribution. It is a sector that consistently needs to adapt to what can be at times abrupt changes in the food systems supply chain. The overarching logistical framework challenge is evident in the numerous redistribution interventions identified in WP 1, such as the currently active NGO 'Excellents Excedents' in France[39]. The entity works on the transport component of picking up surplus food from food services sector and delivering it to entities that sell at reduced price or to charities and food banks. Overcoming these challenges via **training in innovative, sustainable distribution and logistics mechanisms**, is key and further affects the downstream stages of a supply chain such as retail and food services.

The objective of this chapter has been to provide a comprehensive overview of the current contexts relevant for the project's case studies. The intrinsic economic value of food – whether at the household level or other stages of the supply chain – warrants attention. Globally, 14% of food valued at an estimated 400 billion is lost from harvest up to, but not including retail, while another 17% is wasted at the retail and consumer levels (FAO, 2019; UNEP 2021)[40]. By addressing food waste, there are also numerous socio-economic benefits such as job creation and the ability to provide food to those in need of it. Another intrinsic and de facto benefit of reducing food waste is environmental. Within the European Union (EU), it is estimated that food waste accounts for at least 6% of its total greenhouse gas emissions (Feedback EU 2022: 4). Efforts to prevent and reduce food waste thus play a critical role in the battle to mitigate the effects of climate change. And while it is important to isolate the social norms that drive food waste-related behaviour, what research and interventions to date have shown is that nothing can change if efforts are not also applied towards providing the abilities and opportunities to change those behaviours. The next chapters delve into the research conducted within the case studies, which add more detailed and robust data to the overall discussions about understanding and addressing food waste-related behaviour.

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[38] FoodOp Digital Platform:
https://foodop.dk/maal-og-reducer-madspild/

[39] Excellents Excedents:
https://www.excellents-excedents.fr

[40] Food and Agriculture Organization of the United Nations:
https://www.fao.org/policy-support/policy-themes/food-loss-food-waste/en/

4   EMPIRICAL DATA CORRELATION AND SENSEMAKING ANALYSIS

This chapter is divided per case study. For case studies 1, 2, 3, and 6, due to the quantitative and qualitative nature of their work, the discussion is divided into five sections. First, for each case study a detailed exploration of the dataset's **demographics**, accompanied by a brief overview of the **methodology** and the tools/software utilized for the analysis is provided. This is then followed by a quantitative analysis of **food waste measurements**. The third section shifts attention to an investigation of **behaviours, habits, and attitudes** surrounding food waste. Here, both quantitative and qualitative methods are employed. The fourth section looks into the **social norms** influencing the aforementioned behaviours and directly or indirectly affecting food waste, utilizing again a combination of quantitative and qualitative approaches. Finally, **gender and intersectional differences** underlying these social norms are explored. For case studies 4 and 5, due to the highly qualitative nature of their research, focus is given to solely the food waste related behaviours, delving into the varying motivations, including social norms, that drive them.

The quantitative data in this chapter, based on the surveys conducted in each case study, is presented largely via **descriptive statistics and correlation analysis**. It is in the next chapter (chapter 5) that the focus moves beyond descriptive and correlation analysis, delving deeper into an econometric assessment of the data utilizing regression analysis, clustering analysis, factor analysis, and structural equation modelling.

The qualitative analysis in this chapter is based on the in-depth interviews, focus group interviews, and workshops, and employs the Motivation, Opportunities, and Abilities (MOA) framework. This framework provides a structured approach to understanding the complex interplay of factors influencing individuals' behaviours and the social norms at play regarding food waste. In the CHORIZO project social norms are defined as the **rules or guides for actions perceived by individuals within the norm's target group as expected by others**, drawing upon the work of Bicchieri (2006). The project focuses on various norms related to food consumption and waste behaviour.

Sub-optimal food/undesirable food quality: This norm involves the acceptance or rejection of food based on its perceived quality, influencing decisions about consumption or disposal (ICF et al. 2018; Stangherlin et al. 2020). In many cultures, there is an implicit expectation that food should meet certain standards of freshness, appearance, taste, and texture to be considered desirable or acceptable for consumption. When food fails to meet these standards, individuals may feel inclined to reject it, either by refusing to consume it themselves or by disposing of it. This norm can have significant implications for food waste generation. When consumers adhere strictly to standards of food quality, perfectly edible food may be discarded unnecessarily, contributing to the overall volume of food waste.

Good provider identity: This norm may originate from historical contexts where food scarcity was more prevalent, and having an abundance of food symbolized wealth, generosity, and social standing (Graham-Rowe et al. 2014). Consequently, individuals may feel pressure to demonstrate their ability to fulfil this expectation, even in circumstances where food scarcity is not a concern. This societal pressure to exhibit abundance can lead to behaviours such as over-purchasing groceries, preparing excessive amounts of food, or offering larger portions than necessary during meals. As a result, individuals may inadvertently contribute to food waste by purchasing more food than they can consume or by preparing quantities that exceed actual dietary needs. Moreover, the desire to uphold a "good provider" identity may also influence perceptions of food quality and freshness. Individuals may feel compelled to prioritize quantity over quality, opting for larger quantities of less expensive or processed foods, which may have longer shelf lives but lower nutritional value.

Portion size and food affluence: This norm relates to perceptions and behaviours surrounding portion sizes and food abundance, potentially leading to overeating and subsequent food waste in societies with readily available and affordable food (Versluis and Papies 2016; Zhao et al. 2019). This norm is particularly salient in societies where food is abundant, affordable, and readily accessible. In such contexts, there is often a cultural inclination towards larger portion sizes and an expectation of abundance during meals. This expectation may stem from historical factors, economic prosperity, and cultural norms surrounding hospitality and generosity. As a result, individuals may habitually serve or consume larger portions of food than necessary, reflecting a perception that ample food signifies wealth, hospitality, and social status. The normalization of large portion sizes can contribute to overeating and/or to food waste. Additionally, the abundance of food resources may lead to a lack of appreciation for the value of food, resulting in a cavalier attitude towards food waste. As individuals become accustomed to larger portion sizes, their perceptions of what constitutes a "normal" serving may become skewed, leading them to continue overestimating their food needs and contributing to excess consumption and waste.

Associations between food waste behaviour and socio-economic status: These norms highlight the connection between socio-economic status and attitudes or behaviours towards food waste. (Middleton et al. 2018). It reflects the disparities that exist between different socio-economic groups in terms of their access to resources, their perceptions of food value, and their disposal practices. Socio-economic status encompasses various factors such as income level, education, employment status, and access to resources. These factors significantly influence an individual's purchasing power, dietary choices, and overall relationship with food. As a result, individuals from different socio-economic backgrounds may exhibit distinct attitudes and behaviours towards food waste. In societies with higher levels of income inequality, individuals from higher socio-economic backgrounds may be more likely to purchase excess food, indulge in luxury items, and discard food more readily due to a perceived abundance of resources and a higher expectation regarding food quality standards. On the other hand, individuals from lower socio-economic backgrounds may adopt more sober approaches to food consumption, prioritizing thriftiness, and resourcefulness to make the most of limited resources. Furthermore, socio-economic status can shape individuals' perceptions of food value and their willingness to discard food based on subjective factors such as freshness, appearance, and brand reputation. Those with higher socio-economic status may be more inclined to discard food based on minor imperfections or expiration dates, whereas individuals with lower socio-economic status may be more resourceful in finding ways to salvage and repurpose food items. Additionally, disparities in access to food resources and waste management infrastructure can exacerbate food waste disparities between socio-economic groups. Individuals with higher access to supermarkets, restaurants, and food delivery services can be more prone to higher levels of food waste due to over-purchasing and over-ordering. Conversely, individuals with lower socio-economic status may rely more on food assistance programs, discount stores, and community resources, which may result in more conservative consumption habits and lower levels of food waste.

Understanding and addressing these (and others if present) norms are essential for developing effective strategies to reduce food waste and promote sustainable consumption patterns. By recognizing their influence, interventions can be tailored to target specific attitudes, social norms and behaviours, ultimately contributing to minimizing food waste and creating a more equitable and sustainable food system.

4.1   Case Study 1: Households in Flanders, Belgium and Spain in and off crisis period

The following points offer a concise **summary of the main findings**:

- There exists a disparity between Belgium and Spain in their hospitality habits, notably in the practice of **offering leftovers to guests**, which is more prevalent in Belgium compared to Spain.

- Distinct variations in social norms surrounding **household roles** are observed, with Spanish respondents less likely to agree that a good head of household ensures all family members can eat what they desire, in contract to Belgian respondents.
- Similarly, Spanish respondents are less inclined to agree that **parents should finish their children's leftovers** compared to their Belgian counterparts.
- The majority of respondents in both countries acknowledge the **impact of economic crisis and rising food prices** on their food purchasing and preparation habits.
- Social norms related to **over-preparation and serving large portions** are deeply rooted in people's behaviour and contribute to FW.
- Given the entrenched nature of these behaviours, **efforts to address food waste** should prioritize strategies focused on leftovers management (e.g. recipes, cooking skills, preserving food etc.)

4.1.1 Overview of data demographics

To understand the profiles of the respondents, the analysis will begin by examining their role in household **food management.** The majority of the respondents (46%) in Belgium (BE) and Spain (ES) (57.6%) decide together with another household member on how food management is done at household (HH) levels. This was followed by a large proportion of the respondents in BE (45.1%) and ES (37.1%) who indicated that they solely decide on what and how much to buy as regards food in their households (HHs). Only 8.9% of respondents in BE and 5.4% in ES mentioned they never, or rarely, influence food management decisions in their HHs (**Figure 13**).

On the **role that the respondents play in cooking**, the majority in BE (49.1%) and ES (42.4%) revealed they are the "only cooks" in their households. Another large portion of the respondents (21.8% in Belgium sample and 30.7% in Spanish sample) indicate to usually cook together with another household member. Fewer respondents, that is 3.4% in BE and 4.4% in ES, indicated they were "primary cooks" and "never cooks" respectively **(Figure 14)**.

Moving to the demographics of the two samples, in Belgium and Spain, some basic descriptive statistics associated with the **composition of the households** are presented in **Table 4.** In addition to the above, the percentage of the respondents that are parents is 62.9% for BE and 54.1% for ES.

Figure 13 Distribution of roles in HH food purchase in Belgium (left) and Spain (right)
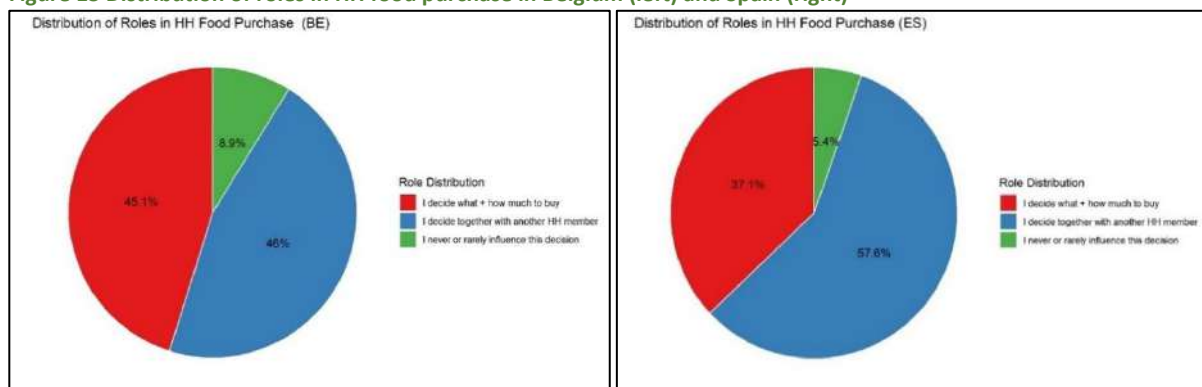
Figure 14 Cooking roles in the household in Belgium (left) and Spain (right)
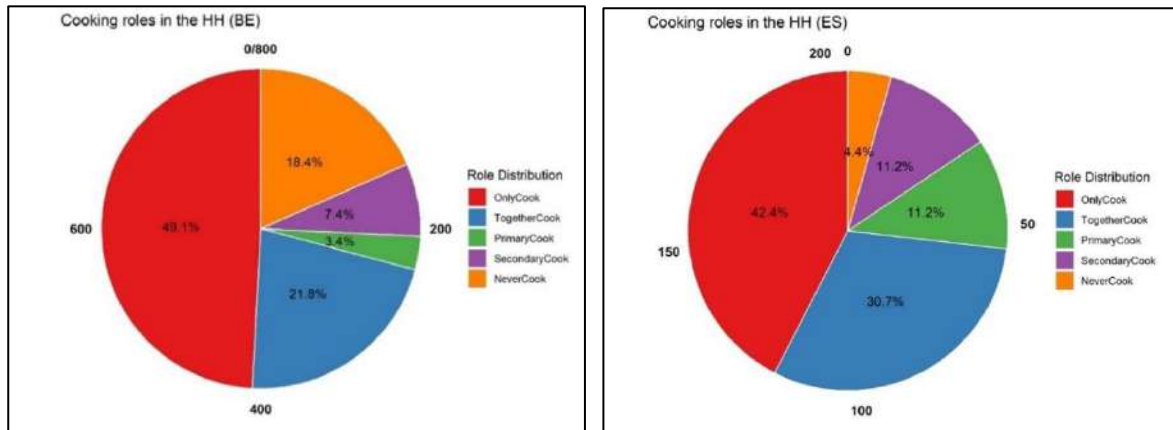
Table 4 Household composition descriptive statistics

Variable	Belgian subsample			Spanish subsample		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Household (HH) size	1	6	**2.5**	1	6	**3.0**
Children in the HH	0	6	**1.2**	1	5	**1.9**
Age of respondent	18	79	**49.9**	19	74	**43.4**

In both BE and ES, **most of the households are composed of couples and children** (32.4% and 46.3% respectively). The second largest HH group consists of couples without children (32.5% in BE and 26.8% in ES). The least common HH group in BE (5.8%) is that of "single person living with others" while in ES it is the "I live alone" group (7.3%) (**Figure 15**).

The respondent population was made up of more men in BE (56.1%) compared to more women in ES (68.3%). A slight majority of the respondents in Belgium were of the **age group 55+ years** (37.6%) while for the Spanish population, 58.5% were between 35-54 years old **(Figure 16)**.

Figure 15 Household composition in Belgium (left) and Spain (right)
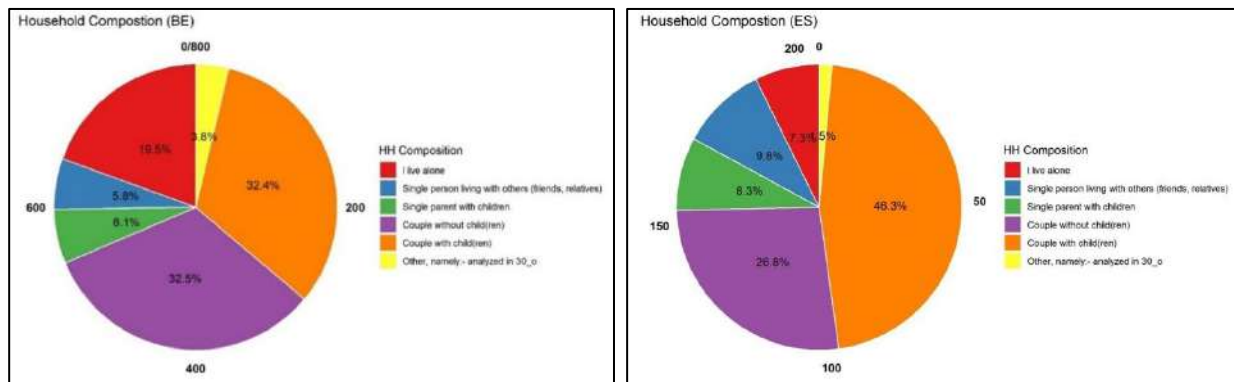
Figure 16 Respondents' age category in Belgium (left) and Spain (right)
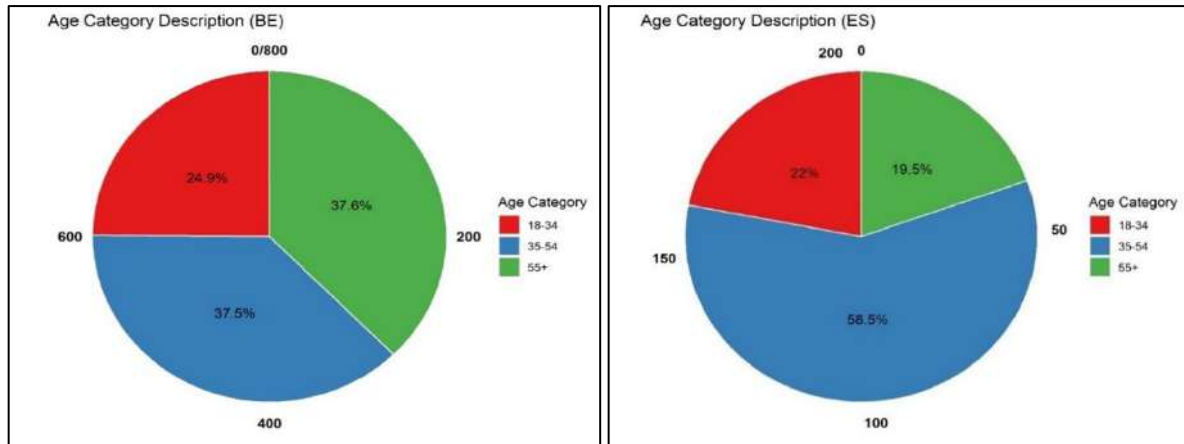
In Belgium 56.1% of respondents have attained at most upper secondary level of **education** while 43.9% have higher education. In Spain, the majority of respondents (69.7%) have reached higher education and above, while 30.3 % have at most upper secondary education.

Regarding the household **income level**, the pattern is similar in both BE and ES. The first three major categories indicated include the following responses **(Figure 17)**:

- *"We make ends meet on current income"* (45.4% in BE and 42.4% in ES)
- *"We live comfortably with current income"* (33.1% in BE and 42% in ES)
- *"We are struggling with the current income"* (13.5% in BE and 9.8% in ES)
- Less than 10% in both countries fall under the categories "*we are having a difficult time with our current income*", "I don't know", and "*I rather not say*".

For **employment status** in BE and ES, the first three major categories indicated include the following responses **(Figure 18):**

- *"Full-time work" (41.8% in BE and 74.6% in ES)*
- *"Retired" (31% in BE and 2.4% in ES)*
- *"Part-time work" (9.6% in BE and 10.7% in ES)*
- Less than 10% in both countries fall under the categories "unemployed", "student", and "stay-at-home father/mother".

Figure 17 Household income level description for Belgium (left) and Spain (right)
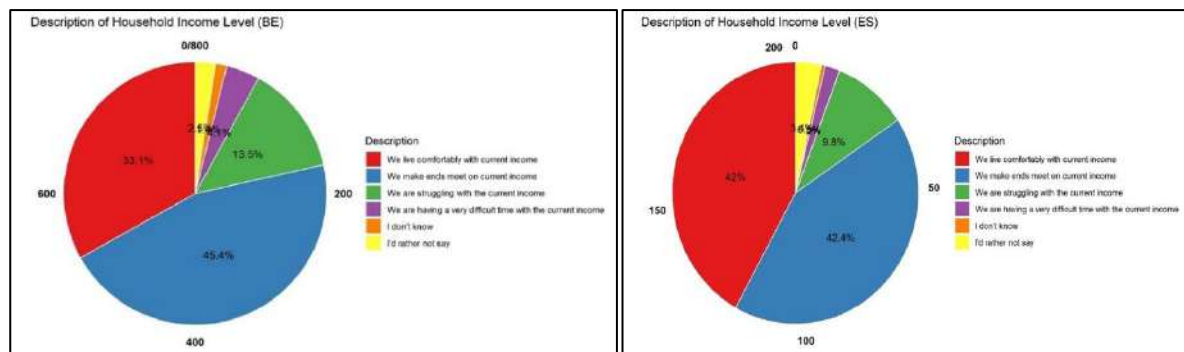
Figure 18 Respondents' employment status in Belgium (left) and Spain (right)
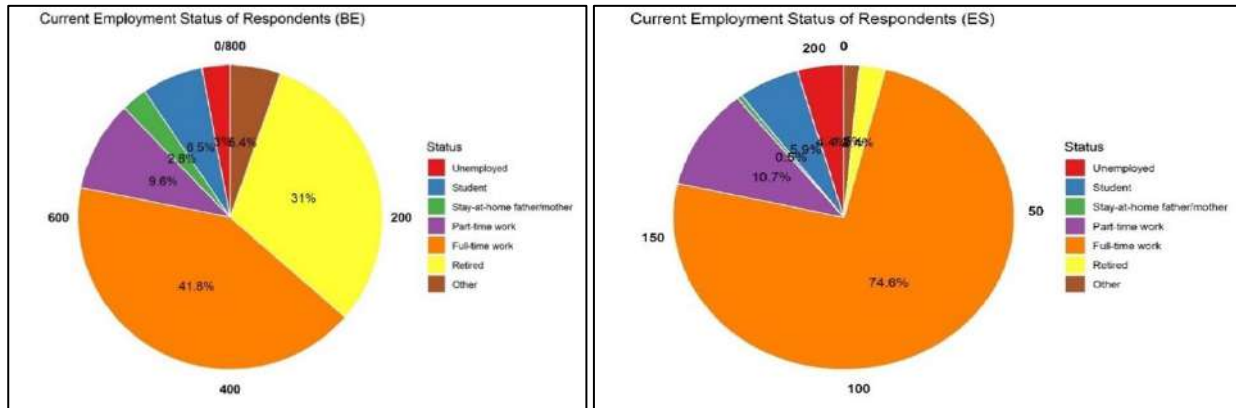
Majority of the respondents in Belgium (19.5%) live in the **rural areas** while the majority in Spain (32.2%) live in the very **urban areas**. On the other hand, the smallest proportion of respondents in BE (8.2%) live in the very rural area while that of ES (2.9%) live in the very rural area **(Figure 19).**

Figure 19 Description of hometown in Belgium (left) and Spain (right)
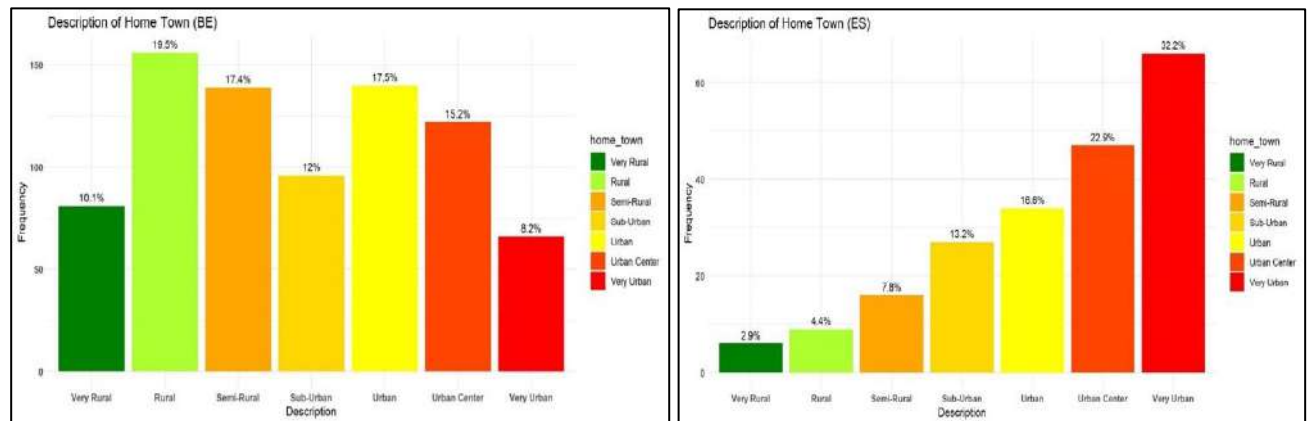
4.1.2   Food waste measurement

Descriptive Statistics and Correlation Analysis

There were four major ways that food waste was interrogated to the respondents in the questionnaire. In particular:

- The perceived food waste amount relative to a household average of 1.7kg.
- Estimated food waste amount relative to prepared meals amount.
- Perceived weekly food waste amounts per food type.
- Food waste frequencies broken down by food categories (perishable, non-perishable etc.).

The perceived food waste amount relative to a household average of 1.7kg

Compared to an average of 1.7 kg of food wasted per week in households, a greater proportion of respondents (73.8% in Belgium and 76.6% in Spain) reported that they waste less. This indicates a possibility of the respondents in both countries of under-estimating the quantity of food waste generated per week in their households. On the other hand, fewer respondents (11.4% in Belgium and 10.8% in Spain) acknowledged the fact that their households wasted more than 1.7 kg of food per week. The results for Belgium and Spain are represented in **Figure 20** below.

This tendency of underreporting food waste might stem from a **desire to perceive one's behaviours favourably**, aligning with the psychological phenomenon of **social desirability bias**. Individuals might consciously or subconsciously underreport their food waste, fostering a **perception of being more efficient in managing consumption than reality dictates**. Understanding and addressing this potential gap between perception and actual waste practices is pivotal in developing effective strategies to curb food waste.

Figure 20 View on quantity of food waste generated per week in Belgian (left) and Spanish (right) households compared to 1.7kg
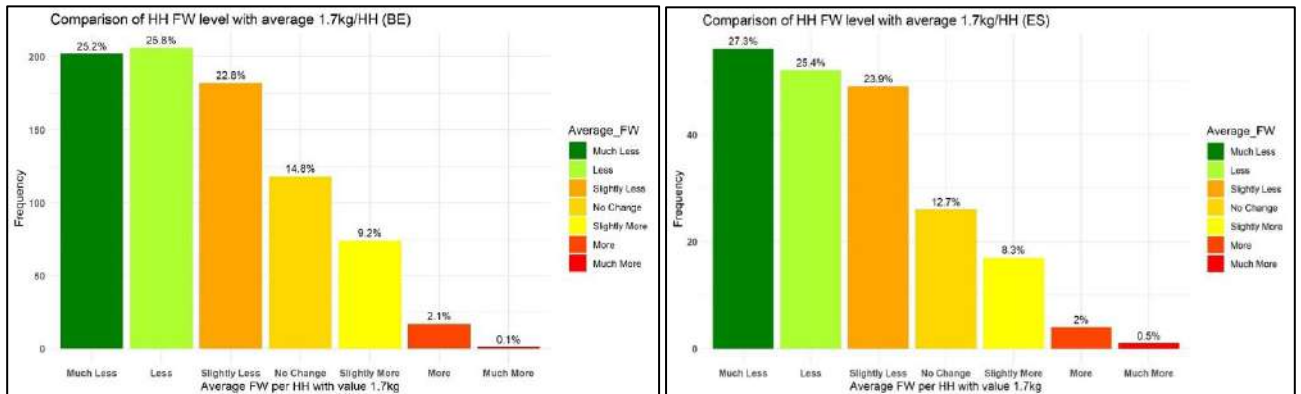
Estimated food waste amount relative to prepared meals amount

The greater proportion of respondents in both Belgium and Spain indicated that a **greater share of food prepared in the households was consumed after preparation**. This was on average 75% in Belgium and 65% in Spain **(Figure 21)**. The same trend of a higher proportion of **food finally consumed** in households was observed for both Belgian and Spanish populations **(Figure 22).**

Figure 21 Average share of food consumed immediately after preparing in Belgian (left) and Spanish (right) households
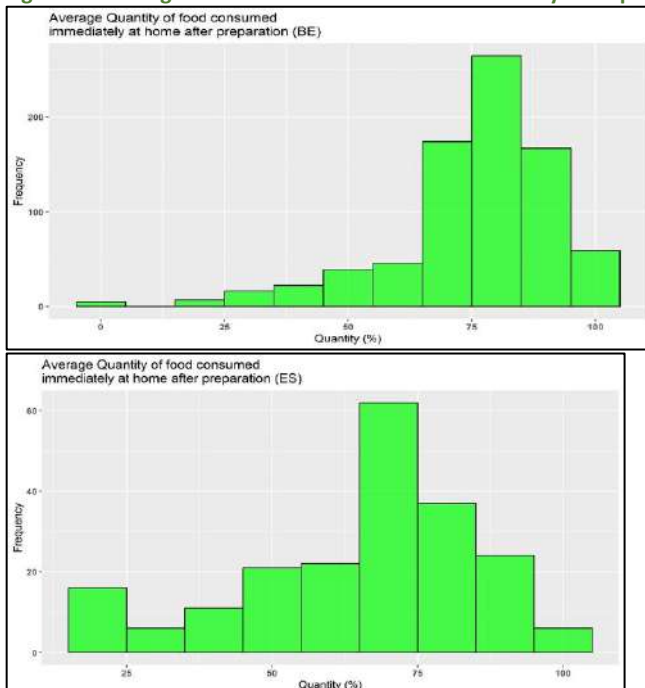
Figure 22 Average share of food finally consumed in Belgian (left) and Spanish (right) households
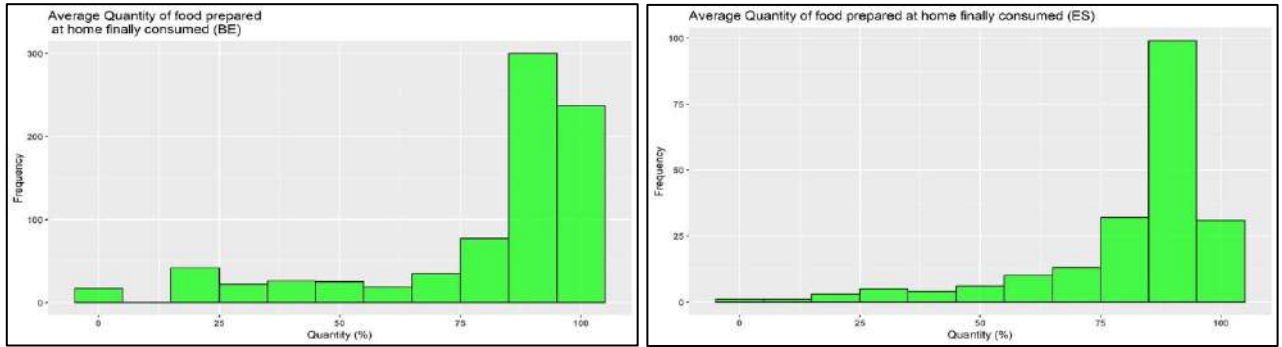
Perceived weekly food waste amounts per food type

A greater percentage of respondents indicated that they wasted less than one slice of **bread** per week in their households. This was 45.4% in BE and 60% in ES. Respondents who revealed their households wasted one slice or more were more in BE (44.2%) compared to ES (25.4%). However, Spanish households on average have a perceived higher amount of bread waste generated (3.9%) - greater than one loaf compared to Belgian households (1%). The results for Belgium and Spain are represented in **Figure 23.**

Figure 23 Perceived weekly bread waste generated in Belgium (left) and Spain (right)
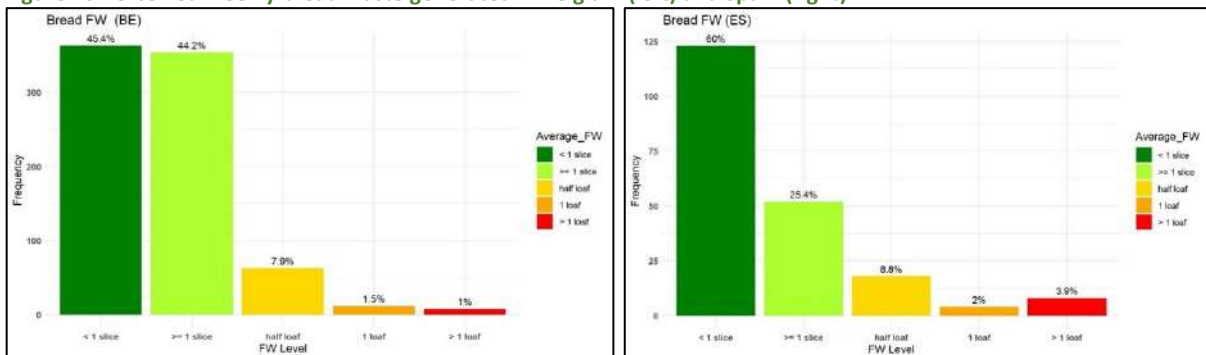
Figure 24 Perceived potato, vegetable, and grain products weekly waste in Belgium (up) and Spain (down)
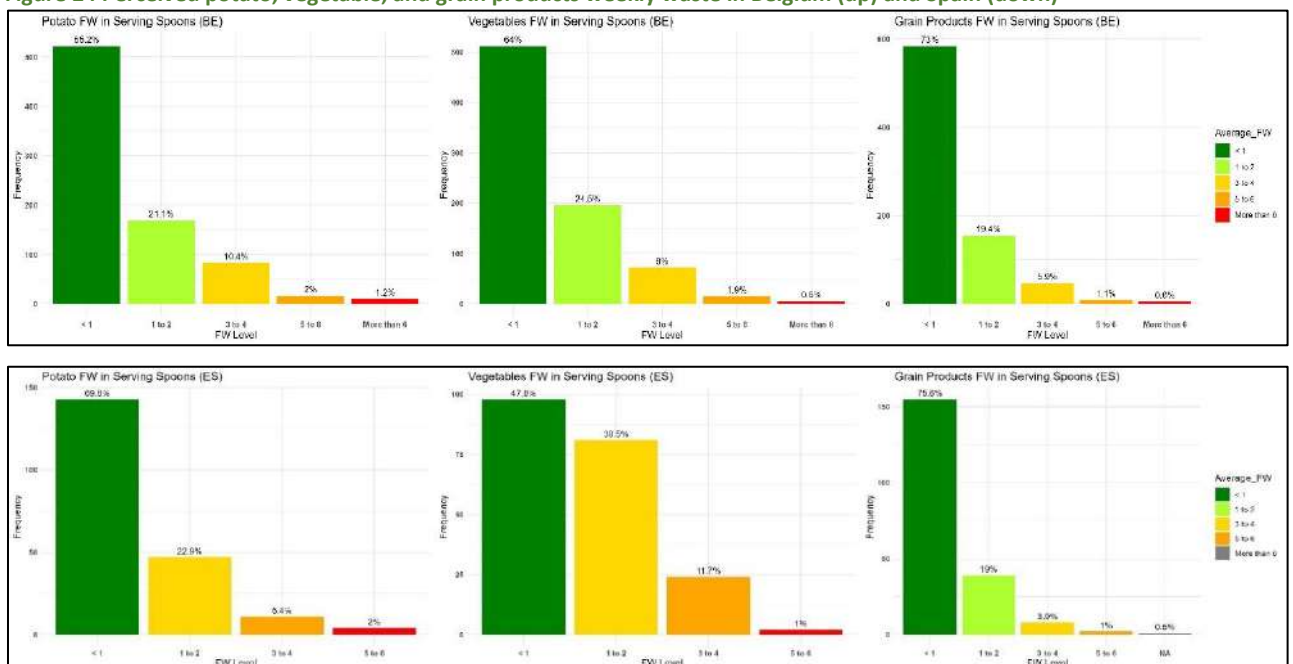
Figure 25 suggests a similar trend in the perceived weekly waste generated for **fruits** in Belgian and Spanish households. A greater proportion of respondents indicated that they waste less than a quarter piece of fruit (56.2% in BE and 41.5% in ES) per week in their households. In Belgium 19.6% indicated they waste on average one whole fruit per week compared to 26.6% in ES. A little less than 1% of the respondents in BE indicated they wasted more than 4 whole fruits per week compared to 1% in ES.

Figure 25 Average fruit waste generated per week in Belgium (left) and Spain (right)
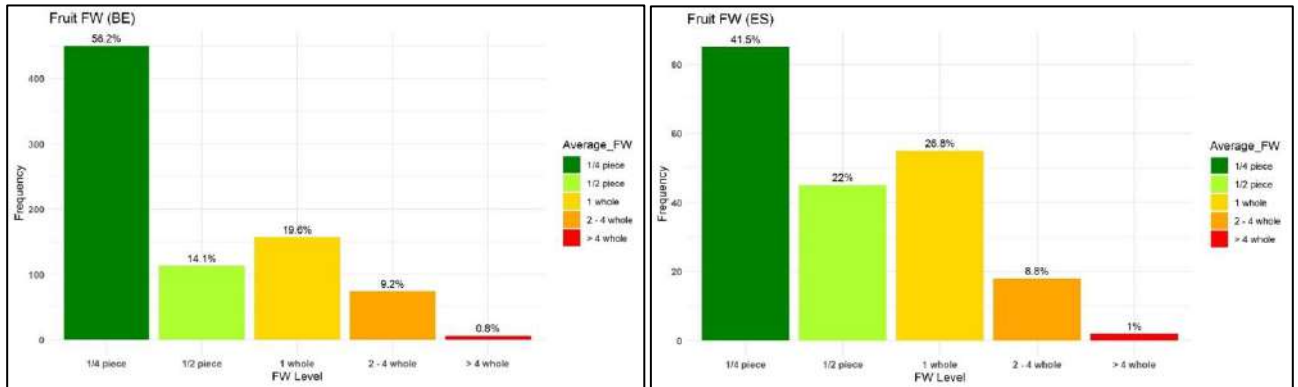
Perceived average weekly **meat, fish, and meat substitutes** waste generated showed a similar pattern in both BE and ES households. A majority of the respondents suggested they wasted less than half a portion of these foods (82.4% in BE and 78.5% in ES, **Figure 26**).

Figure 26 Meat, fish, and meat substitute perceived weekly waste generated in Belgium (left) and Spain (right)
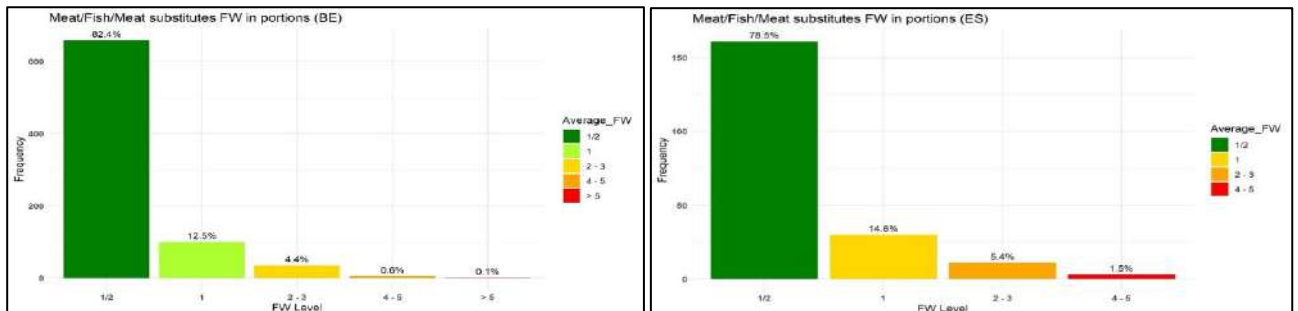
Perceived whole **egg** waste generated showed a similar trend in both BE and ES households. Most of the respondents suggested they wasted less than one whole egg (91.2% in both BE and ES; **Figure 27**).

Figure 27 Egg perceived weekly waste generated in Belgian (left) and Spanish (right) households
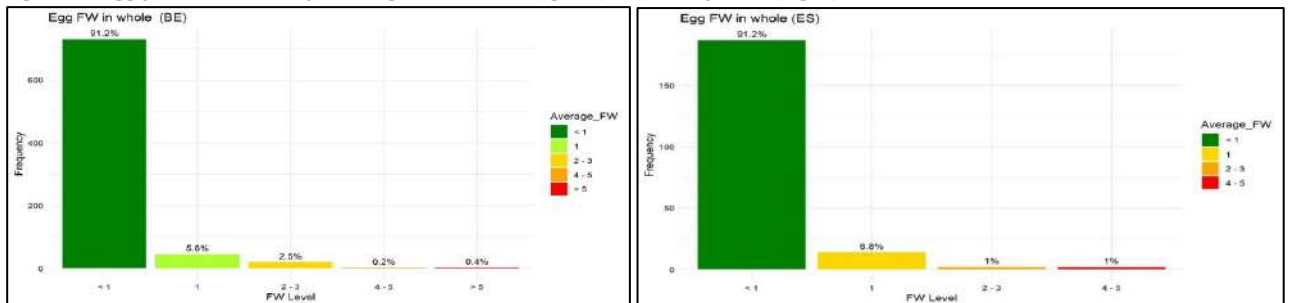
Figure 28 provides a consolidated view of Figures 23 to 27. Apart from the mean values, the variance is demonstrated with one standard deviation below and above the mean. **Potatoes, fruits, and bread emerged as the standout categories; however, it needs to be noted here that the units are**

different. Whether due to purchasing habits, storage practices, or meal planning, the differences above prompt **a closer examination of consumer behaviours surrounding specific food types**. For example, targeted educational campaigns or initiatives focused on optimizing utilization and storage of the higher-waste items could contribute significantly to reducing overall household food waste.

Figure 28 Spider graph of food waste levels by food type in Belgium (left) and Spain (right)
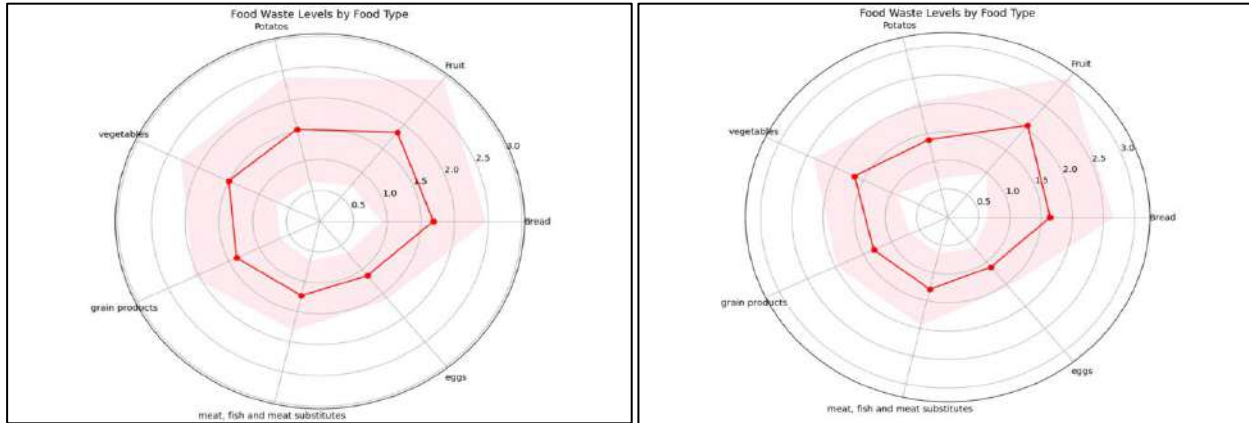
Food waste frequencies broken down by food categories (perishable, non-perishable etc.)

The bar plots (**Figure 29**), spanning a spectrum from "Never" to "Every day" across different waste categories, highlight meal leftovers on plates and meal leftovers after storage as the categories with the highest average **food waste frequency** both for Belgium and Spain. The examples that were given to the respondents for the various categories are the following:

- Leftover ingredients: half an onion or leak, the other half of which was processed.
- Partly used perishable: half a package of salad, half a brick of milk.
- Completely unused perishable: an entire package of pre-packaged lettuce, a brick of milk.
- Partly used long-shelf life: half a box of cookies.
- Completely unused long-shelf life: a box of cookies.

Long shelf life coupled with **completely used or partially used food** are factors that influence food waste generation. In Belgium 50% of respondents from households indicated that they "never" throw away completely unused food that has long shelf life as compared to 44.4% for Spanish households. About 33% indicated they throw away completely unused food with long shelf life, less than 4 times a year in BE and 37.1% in ES. Overall, the same trend is seen in both countries with a very small proportion of respondents (0.4% in BE and 1% in ES) reported to throw away completely unused food with long shelf life once a week.

When these foods with **long shelf life are partly used**, the chances of them being thrown away slightly increases. This is seen as the respondents in BE who indicated they "never" throw away completely unused food with long shelf life drops from 50% to 39% when these foods are partly used and a drop from 44.4% to 37.6% in ES. There is also an increase in the frequency of partially used food with long shelf life been thrown away less than four times a year from 33% when completely unused to 39.2% when partially used in BE and 37.1% to 42.4% in ES.

Figure 29 Food waste frequency by food category in Belgium (left) and Spain (right)
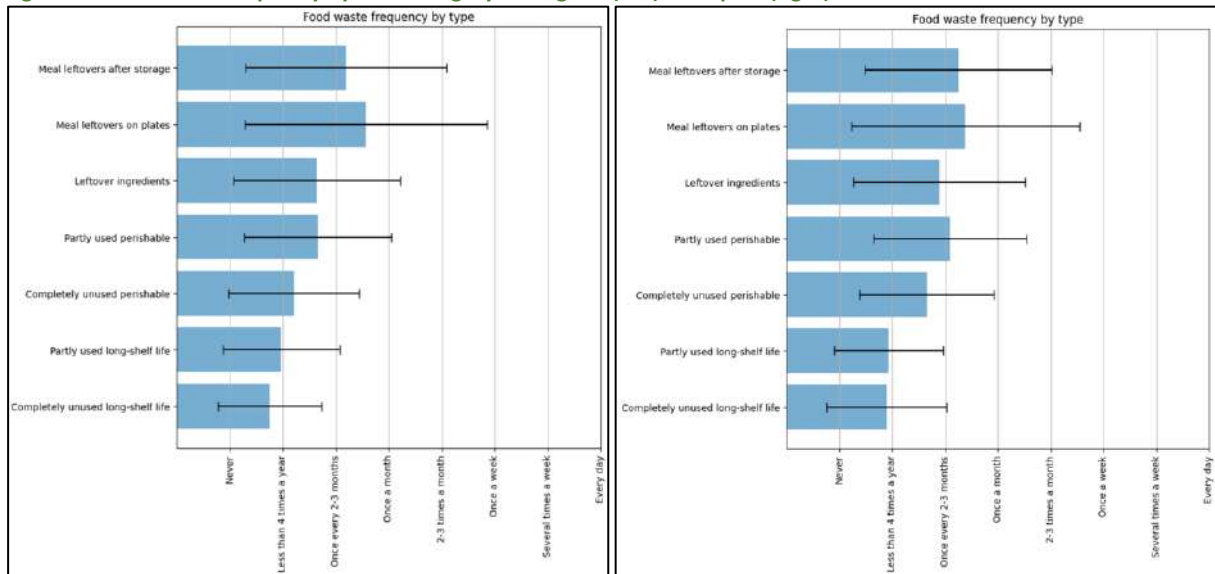
Note: After recoding the frequency categories to numerical values (0 for Never – 7 for Every Day), the bars indicate the mean value for each food type, while the error bars indicate their variability (one standard deviation below and above the mean value).

High perishability or low shelf life coupled with either completely unused or partially used food can also influence the frequency at which food is thrown away. A majority (37.5% in BE and 41.5% in ES) suggested that they throw away perishable but completely unused food less than 4 times a year. This number slightly increased in BE (38.6%) but dropped in ES (35.1%). Despite this drop in ES, the trend of responses in both countries were the same indicating a slight increase in frequency to throw food for partially used and perishable foods. This is even more evident as the category of respondents who indicated throwing away food several times a week increased from 0.2% for completely unused and perishable foods to 0.6% for those partially used and perishable in BE, and 1% to 1.5% in ES respectively.

Although 28.1% and 21.5% of respondents in BE and ES respectively indicated that the never throw away **leftover ingredients**, a majority of 30.1% and 29.8% suggested that the throw away leftover ingredients at most four times a year in BE and Es respectively. A smaller proportion of respondents (0.1% and 0.5% in BE and ES respectively) mentioned they throw away leftover ingredients every day.

For **leftover meal**, a similar trend is seen for frequency of waste generated. However, it was noticed that in BE, more meal leftovers are thrown away (3.8% compared to 2% in ES) every day.

When **leftover meals are stored**, it is expected that food waste will be prevented. However, it seems that sometimes the intention of consuming leftovers as a later occurrence is not translated into behaviour, potentially because the leftover was forgotten or got spoiled. In Belgium 38.4% of the respondents, and in Spain 38.6% of the respondents, indicated that this tends to happen once a month or more often.

Upon examining **Figure 29** and comparing the food categories, the higher level of plate leftovers may indicate a need for interventions aimed at optimizing portion sizes. However, it's important to consider that this reporting might be influenced by households with small children, where uneaten food on plates is common. While reducing portion sizes could be one approach, it's crucial to balance this with ensuring adequate calorie intake. Conversely, the lower waste frequencies observed in partly used long shelf-life and completely unused long shelf-life categories imply a more efficient

utilization pattern for items with extended shelf life. This points towards a better management of non-perishable goods.

4.1.3   FW-related behaviour

<u>Qualitative Analysis</u>

In case study 1, two qualitative data collection methods took place. In Spain, in-depth interviews with household members were conducted. The interviews focused on motivations and social norms, what drove FW related behaviour, as well as what type of food was being discarded. In Belgium a focus group interview session was held with representatives from various companies and initiatives. This discussion focused largely on which social norms influence household behaviours related to FW generation, and why this is the case. Consequently, this section on "FW-related behaviour" focuses on the in-depth interviews conducted in Spain, while the following section on social norms incorporates information and data from both the interviews in Spain and the focus group interview session in Belgium.

Spain:

CTIC-CITA carried out in-depth interviews on FLW with 15 participants across three different locations in Spain, including vulnerable groups, to understand household trends and the impact of COVID-19. Responses were recorded and treated anonymously. The 15 in-depth interviews (IDIs) were conducted in June and July 2023. The sample recruited, consisted of 10 representative consumers (selected from the database of the MundoSabor platform, and residents in Navarra, La Rioja, and Madrid to carry out the interviews in person) and 5 consumers from "vulnerable groups" (with the collaboration of the "Plena Inclusión" Foundation of La Rioja, which recruited consumers from the association with a grade 1 intellectual disability). Most respondents were females (the female-to-male ratio was 9 to 6), aged between 23 and 83 years old. The translated transcripts were manually coded and analysed utilizing Excel and Quirkos. To code the transcripts the MOA qualitative coding tree was used (see Appendix). Two coded were added withing the process:

- Food literacy - as a general category of abilities related to food. This code is only technical, used to group up the different kinds of food abilities (high level) in one category.
- Hunger anxiety - used to mark the situation in which respondents talk about the reasons for not wasting food by those who were food deprived in the past. Most commonly, it describes the roots of an injunctive norm in their families of origin, when their mothers' generation teaches them that 'you must eat everything put on the plate' because wasting food is immoral and forbidden.

While efforts were made to ensure that each interviewee possessed sufficient knowledge about household behaviour related to food, the study's main limitation is that some respondents might not have the most knowledgeable sources regarding food purchase, preparation, use, and storage in their household.

The majority of respondents considered that they threw away very little food, especially compared to others. 4 out 15 respondents admit that they threw away too much or were aware that they should throw away less. For instance, one interviewee mentions "the little we throw away is already more than it should be." When many adults lived together, they developed different food preferences and attitudes toward food; this heterogeneity increased FW within these households.

All interviewees considered that other people buy and throw away leftover food due to:

- Lack of organization/planning;
- Buying/cooking extra food because they think "there is no shortage of food"; and
- Buying and then not liking the product.

About the type of food thrown away in households, 9 of the interviewees said that the most commonly wasted items were expired fresh produce, especially fruit. Meanwhile, 5 of the interviews said that the most commonly wasted items at home were leftovers from prepared meals and the remaining interviewee was unaware of what was thrown away at home.

In terms of behaviours towards leftovers or food waste, respondents report that they try different methods to reduce food waste. Some adopt preventive measures such as planning their shopping and weekly meals to buy the right amount of food, using up almost all their food stocks before shopping, or organizing their stored food by keeping items with the closest expiry dates in sight. Others focused on reducing waste by ensuring eating all the food that had been cooked, freezing fresh produce or prepared food that would not be consumed soon, or reusing leftovers or food that was about to expire to make other recipes. Other reported actions included offering leftover food to pets or people close to them, such as a neighbour.

Motivation

The majority stated that they were not influenced by what others might think of them but did what they thought was right, or what they learned at home. Two interviewees, one of which belonged to the 'vulnerable group', reported that they listened to people in their immediate environment regarding the condition and suitability of food items because they felt that their opinion and advice were essential, and because they knew best what was good for one's health. Most interviewees are guided by what they have learned in their families, especially from their mothers and grandmothers. Among the actions they referred to were:

- Reusing leftovers to make other recipes;
- Eating everything on the plate;
- Eating food even if one does not like it;
- Keeping leftovers in the fridge for another time;
- Feeling bad about throwing food away because there are people who do not have any;
- Planning shopping and meals; and
- Buying only what is needed.

The most notable **generational difference** lies in the attitudes of older people who lived through the war and had been deprived of food. These individuals reported that they valued food more and were more accustomed to doing whatever it took to not throw food away, and they expressed a predisposition to never experience food deprivation again.

All the respondents declared that they were motivated to not waste food and to apply additional measures to reduce waste in the future (although the level of motivation varied across the respondents, it was still definitely present). Most of them noted the argument that wasting food is immoral because there are people in need; those who are suffering from hunger. All the respondents seemed aware of the consequences of FW, although most did not start to talk about it spontaneously; instead, when asked by the interviewer, they confirmed all types of social, ecological, and economic impacts.

Opportunities

It is easier to not waste food if one can buy more frequently (i.e. higher **nonmaterial resources** such as time) and in more local, neighbourhood stores (i.e. higher **material resources**). Some of the respondents, having that privilege, mentioned that in those circumstances, there was no need for them to plan their shopping. However, this lack of planning can lead to the same outcome (in terms of FW generation) as observed with respondents who do not have access to non-material and material resources, such as time and local food stores.

The sizing of portions in dinners or catering needs to be adequate for guest or customer expectations, which often translate to portions being deemed "too big" and thus increases food waste. At stores, cheaper food was often packed in enormous quantities, prompting two respondents to declare that they were forced to buy more than they needed at a given moment due to their limited economic resources (i.e. they buy bulk quantities because they are cheaper). However, these factors are *potentially leading to an* increase in FW. The abilities that moderate these factors (such as food literacy, knowledge about storage, how to use leftovers, etc.) are further discussed below.

Abilities

Having limited abilities in planning, purchasing, and/or cooking food affected the amount of declared food waste (i.e. increased the amount). Those with higher abilities declared that they stored/reused the additional food, while those with indicated lower abilities wasted the food (i.e. discarded it). For 4 respondents, whose food literacy was modest, we observed the highest declaration of FW in this study. Although all respondents were highly motivated to mitigate FW, those with poor organizational skills and limited cooking and storage knowledge, wasted more than other participants (see Table 5).

Table 5 Data at the individual level

R.	Gender	Age	Type of households	In charge of shopping and cooking?	Declarative food waste	Main reason(s) for FW magnitude
1	Female	43	Adults (2) + kids (2)	Yes	Low	High ability of planning the purchase of food
ˣ **2**	Female	57	Adults (3)	No	Low	High ability of planning the purchase of food
3	Female	23	Adult (1)	Yes	Low	High ability preparation skills (cooking)/reuses the leftover
4	Female	57	Adult (1) + kids (3)	Yes	Low	High food literacy
ˣ **5**	Male	51	Adults (2)	No	Low	High food literacy
6	Female	63	Adults (3)	No	Low	High ability of planning the purchase of food
7	Male	41	Adults (2)	Yes	Moderately	Low ability of planning the purchase of food
ˣ **8**	Male	30	Adults (8)	Yes	Low	High ability of planning the purchase of food
9	Female	54	Adult (1)	Yes	High	Low Food literacy
10	Female	60	Adult (1)	Yes	Low	High food literacy

R.	Gender	Age	Type of households	In charge of shopping and cooking?	Declarative food waste	Main reason(s) for FW magnitude
11	Male	50	Adults (2)	No	Low	Economical (no waste to save money)
12	Male	58	Adults (2)	Yes	Low	High food literacy, Economical (opportunity to buy small amounts in small shops)
13	Female	42	Adult (1)	Yes	Low	High Food Literacy
14	Male	60	Only adults (4)	No	High	Low ability of planning the purchase of food
15	Female	26	Only adults (2)	No	High	Low ability of planning the purchase of food

*If the given respondent was not in charge of planning, purchasing, and cooking, then abilities refer to the person in charge in their household.

**Participants marked with "x" eat, on weekdays, at a restaurant or food cooked by a caterer.

Main conclusions on food waste behaviour from the IDIs in Spain

- The respondents at the declarative level were motivated not to waste the food.
- The major factor increasing the FW in the respondent household was a lack of abilities in planning and purchasing food and/or cooking skills.
- The injunctive social norm shaping the FW behaviour is the norm-setting by the families of origin.
- Some respondents reduced the amount of food they bought and wasted during the crisis period because of increasing prices.
- Heterogeneity in food habits among adults living together contributes to increased food waste in households.
- Of the respondents, 13 out of 15 report not to be influenced by others' opinions regarding food waste; they rely on their own judgment or learned behaviours from home.
- Various methods to reduce food waste include planning purchases, consuming leftovers, freezing unused food, and repurposing expiring ingredients.
- Expired fresh produce, particularly fruit, is the most wasted food, followed by leftovers from prepared meals.

Descriptive Statistics and Correlation Analysis

In this subsection we discuss the various aspects of household FW behaviours and attitudes, focusing on the following key themes: eating out preferences and pre-ordering behaviour, portion size perceptions, motives for finishing or not finishing meals and leftover decisions, as revealed by data collected from the surveys conducted in Belgium and Spain.

The current section is organized around the following themes. Each theme sheds light on different factors regarding food consumption and waste in the household.

- Meal planning and grocery shopping behaviours
- Cooking and serving habits
- Portion Sizes
- Habits around hosting guests
- Treatment of expiration dates and leftovers
- Crisis impact on food waste behaviours

Meal planning and grocery shopping behaviours

In Belgium, most of the respondents go for **grocery shopping** several to at least one time per week (85.4%) while only about 3.5% of the respondents do grocery shopping every day. A similar pattern was seen for Spanish respondents as 79% suggested they do grocery shopping several to at least once a week and 6.3% every day **(Figure 30).** Overall, very similar trends were observed in Spain and Belgium. Most households (80% or more) tend to **shop on a weekly basis** (once or a couple of times a week).

Meal planning and shopping behaviours in the households could influence the amount of food waste generated. The following statements were examined at the household levels in Belgium and Spain and the aggregated results are presented in **Figure 31**:

- *"We buy products that have a longer shelf life, even if it means reaching for a package at the back of the shelf":* In BE, 82% of the respondents agreed (19% somewhat agree, 29% agree and 34% totally agree) that they buy products with longer shelf life as compared to about 6% of the respondents who did not agree to this statement, and the rest (11%) were neutral. A similar agreement pattern was observed in Spain with 72% of the respondents agreed (25% somewhat agree, 24% agree and 23% totally agree) to buying products with longer shelf life. However, about 10% of the ES respondents disagreed to this notion with over 20% were neutral.

- *"At the checkout it always turns out that we bought more products than planned":* A majority of respondents in BE, that is 62% (32% somewhat agree, 19% agree and 11% totally agree) indicated to commit impulse buying in shops sometimes too often. This is compared to 19% who disagreed to this statement and the rest (19%) being neutral. In ES, the bulk of the respondents, 67% (32% somewhat agree, 14% agree and 21% totally agree) agreed to impulse buying while 22% disagreed and 12% were neutral.

- *"Before we go to the store, we always make a shopping list":* Making a shopping list before going to the store is a practice essential for targeted buying and saves time. Of the respondents in Belgium, 79% agreed (16% somewhat agree, 20% agree and 43% totally agree) to always making a shopping list before going to the store as compared to 13% who disagreed and the rest (8%) were neutral. Of the respondents in Spain, 88% agreed (28% somewhat agree, 33% agree and 27% totally agree) to always making a grocery list before going to the shop while 8% disagreed and 5% were neutral.

- *"Before going to the store, we always check the food stock at home (e.g. in the refrigerator, pantry)":* In BE, 84 % of respondents agreed (20% somewhat agree, 34% agree and 30% totally agree) to always checking what they have as stock in their households before going to the store. However, 9% of the respondents disagreed to this, with 8% being neutral. For the ES respondents, 83% agreed (11% somewhat agree, 27% agree and 45% totally agree) to always check their stock before going to the shop, while about 10% disagreed and 7% were neutral. These results indicate that checking the food stock at home is already a common practice for many households.

- *"Before we go to the store, meals are always planned ahead for several days":* A majority of 59% of respondents in BE agreed (18% somewhat agree, 22% agree and 19% totally agree) to always planning meals for several days ahead before going to the store, while 26% disagreed and 16% were neutral. In ES, 53 % of the respondents agreed (22% somewhat agree, 15% agree and 16% totally agree) to always planning their meals for several days before going to the shop while 29% disagreed and 18% were neutral. These trends suggest that both populations are quite diverse in terms of whether households tend to plan meals for several days before going to the shop or not, but

the share of households tending to plan the meals seems higher than those who don't have this habit.

Figure 30 Frequency of grocery shopping in Belgium (left) and Spain (right)
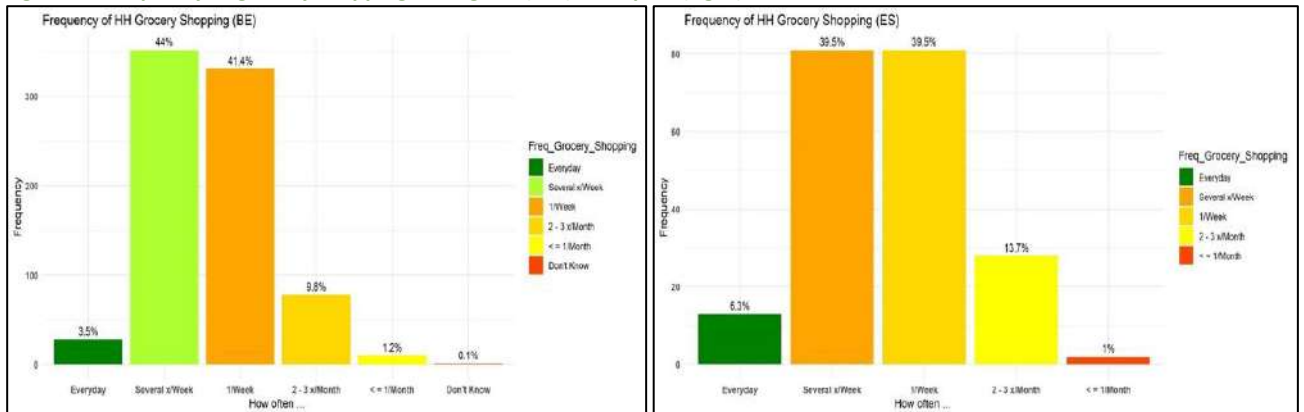
Cooking and serving habits

Moving on to **cooking and serving habits** in households, the observations vary in different countries probably because of different cultural practices. These differences can impact the potential of generating food waste. For the questions related to cooking and serving, a subsample of 653 respondents from 800 in BE and 196 from 205 in ES gave insights to the following scenarios. The aggregated results are presented in **Figure 32**.

- *"We regularly allow household members to scoop/determine their own portions":* Portion sizes play a crucial role in food waste management. A greater proportion of respondents (79%) in BE recorded an agreement (21% somewhat agree, 25% agree and 33% totally agree) to the fact that they allow household members to determine their portion sizes while 6% disagreed and 15% were neutral. In ES, a similar trend with lower magnitude in agreement was observed (63%, where 19% somewhat agree, 19% agree and 25% totally agree), while 20% disagreed and 17% were neutral. These results indicated that, there is more freedom in portion size determination in BE compared to ES.

- *"We always tend to serve larger portions than my family members are likely to eat during the meal":* How large a portion size is, is another central factor in food waste generation. In BE, respondents in their majority agreed that they serve large portion sizes than their family members are likely to eat during meal. This was 45% of the respondents (26% somewhat agree, 16% agree and 3% totally agree), while 35% of respondents disagreed to this statement and 20% were neutral. In ES, relatively more respondents disagreed to the serving of larger portion sizes than their family members are likely to eat during the meal to the magnitude of 51% (15% somewhat disagree, 14% disagree and 22% totally disagree), while 28% agreed and 21% were neutral.

- *"We never serve dishes that a member of the household doesn't like":* In BE, 54% of respondents agreed (16% somewhat agree, 18% agree and 20% totally agree) to never serving food or dishes that a member of the household does not like while 27% disagreed and 19% were neutral. In ES, a similar trend but of lower magnitude was observed where a majority (46%) of respondents agreed (15% somewhat agree, 14% agree and 17% totally agree) to never serving food that a member of the household does not like while 33% disagreed and 21% were neutral.

- *"We always make sure that leftover ingredients from a previous meal (e.g. previously cut vegetables, half a packet of minced meat) are still used for a later meal":* In BE, 86% of respondents

agreed (22% somewhat agree, 30% agree and 34% totally agree) to the re-use of leftover ingredients from previous meal in the next meals while 5% disagreed and 9% were neutral. In ES, a similar trend and slightly higher magnitude was observed where a majority (90%) of respondents agreed (18% somewhat agree, 26% agree and 46% totally agree) to the re-use of leftover ingredients from previous meals for the next while 4% disagreed and 6% were neutral. These results indicate high level of re-use of leftover ingredients in both BE and ES.

- *"We always make sure to first use the food that is in danger of expiring/about to expire":* In BE, 92% of respondents agreed (17% somewhat agree, 30% agree and 45% totally agree) to always using food stuff close to expiration while 5% disagreed and 9% were neutral. In ES, a similar trend and slightly higher magnitude was observed where a majority (90%) of respondents agreed (18% somewhat agree, 26% agree and 46% totally agree) to the re-use of leftover ingredients from previous meals for the next while 4% disagreed and 6% were neutral.

- *"We often use tools (e.g. scale, measuring cup) to prepare just the right amount/ portion size per person":* The use of tools such as scales, measuring cups is a factor in food waste management. In BE, a significant proportion of the respondents agreed that they use tools during cooking and serving food. This was 44% of the respondents (17% somewhat agree, 17% agree and 10% totally agree), while 38% of respondents disagreed to this statement and 17% were neutral. In ES, a significant proportion of the respondents disagreed to the use of tools during food preparation to a magnitude of 49% (8% somewhat disagree, 12% disagree and 29% totally disagree), while 36% agreed and 16% were neutral. The distribution of responses suggests that for some households, adopting the habit of using tools could aid in preparing the right amounts of food and potentially reduce unintentional overpreparation. Further examination of the characteristics distinguishing households that already employ tools from those that do not, could help determining a targeted approach for stimulating tool use at those households where it seems more necessary.

- *"We always think carefully about how much exactly we need to prepare so that everything gets eaten":* In BE, 80% of respondents agreed (21% somewhat agree, 33% agree and 26% totally agree) to always giving a careful thought on the quantity of food to be prepared to enable complete consumption while 11% disagreed and 9% were neutral. In ES, a similar trend but of slightly lower magnitude was observed where a majority (69%) of respondents agreed (18% somewhat agree, 30% agree and 21% totally agree) to thinking carefully on the amount of food to be prepared while 18% disagreed and 13% were neutral.

Figure 31 Reported practices and habits on meal planning and shopping behaviour in Belgium (up) and Spain (down)

Perspectives during preparation for grocery shopping (BE)

Perspectives during preparation for grocery shopping (ES)
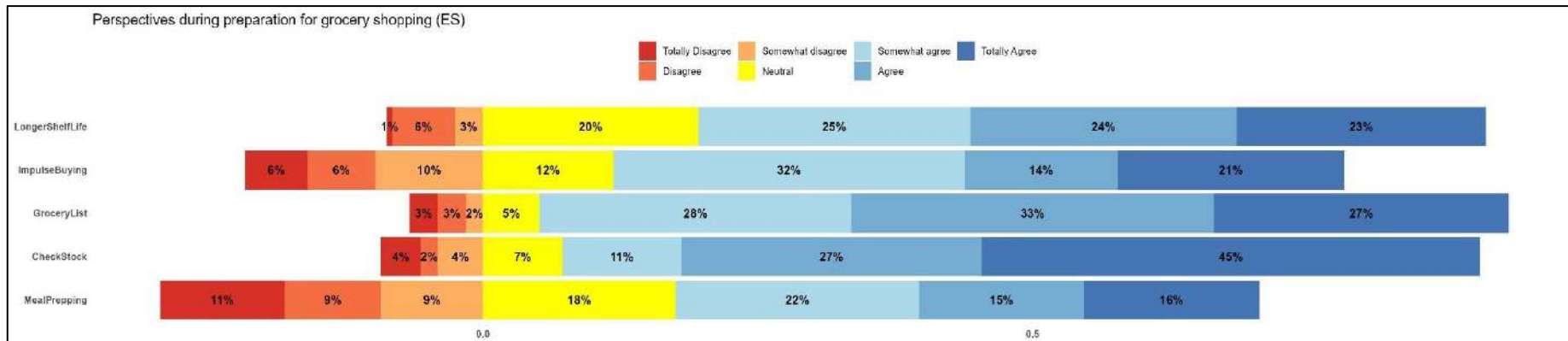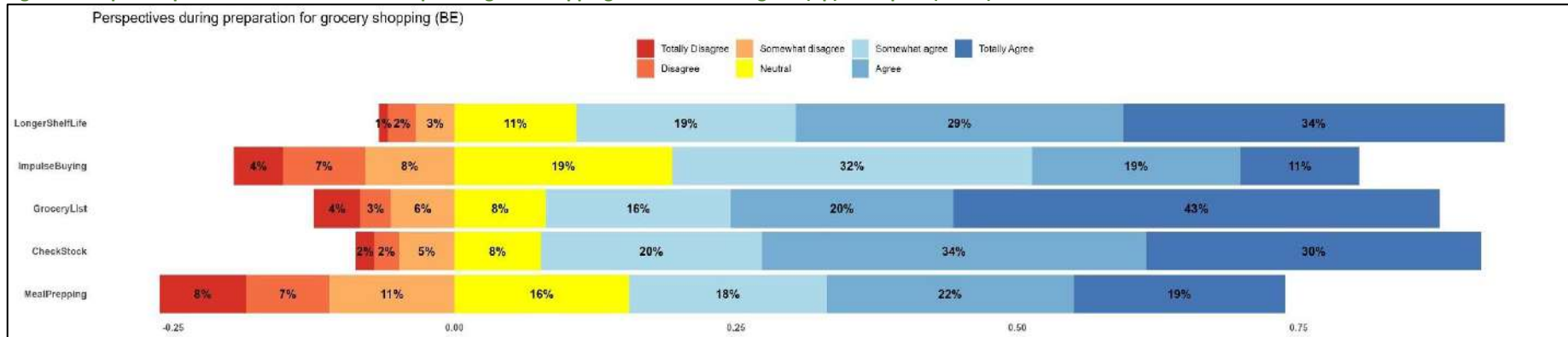
Figure 32 Reported practices and habits when cooking or serving a meal in Belgian (up) and Spanish (down) households
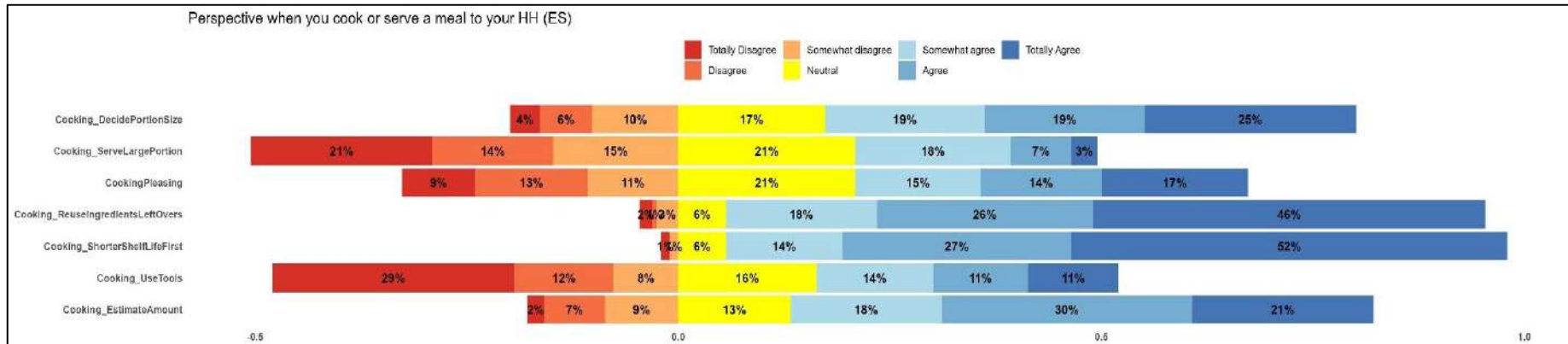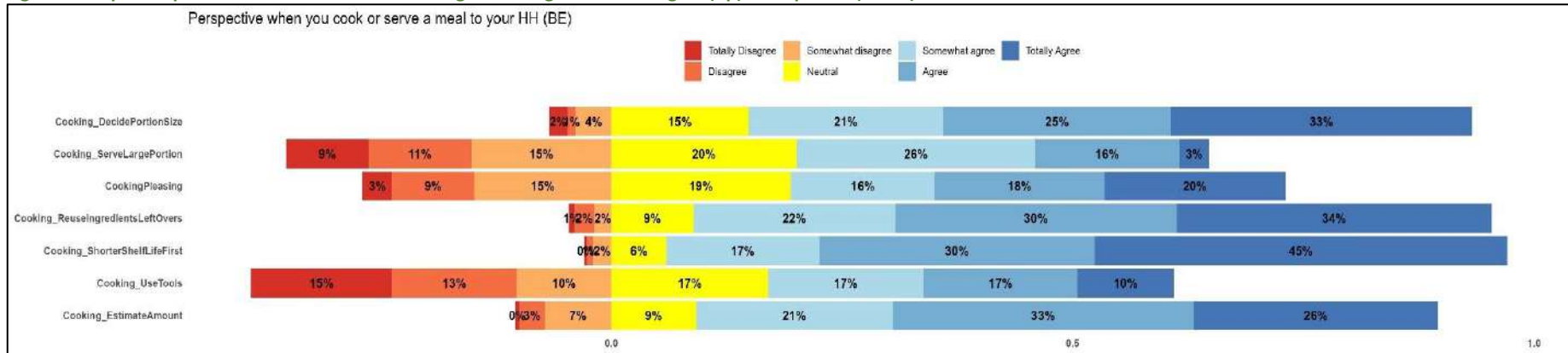
Portion Sizes

A greater proportion of respondents suggested that there is no difference in **portion sizes** from one household to another (47.8% in BE and 49.8% in ES) (**Figure 33**). However, 2.1% of the respondents in BE and 4.4% in ES think that their portion sizes could be much larger than those of other HHs. On the other hand, 1.5% of the respondents in BE and 2.4% in ES indicated that their portion sizes are much smaller than those of other HHs.

Figure 33 Comparing portion sizes with other households in Belgium (left) and Spain (right)
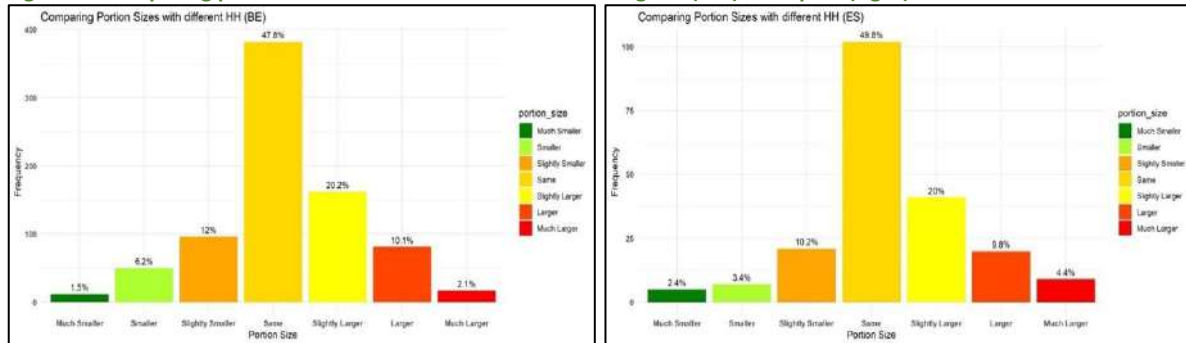
A greater proportion of respondents suggested that they frequently have the **feeling of having eaten too much** (34.8% in BE and 42% in ES). However, 1.4% of the respondents in BE and 3.9% in ES expressed having this feeling after every meal and on the other hand, 5% of the respondents in BE and 4.4% in ES indicated that they never have such feeling (**Figure 34**).

Figure 34 Feeling of over-eating in Belgian (left) and Spanish (right) households
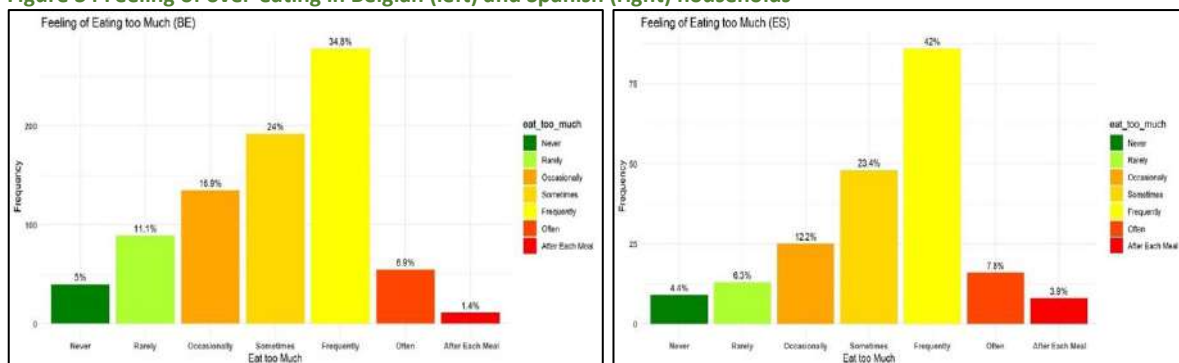
Habits around hosting guests

Transitioning from the exploration of portion sizes, we now shift the attention to considerations involved when hosting guests and the habits of the hosts.

In BE, a majority of the respondents (53.9%) reported that they **receive guests** at least once a month in the household, while 18.4% never receive guests, and 0.6% indicated they receive guests daily. A similar trend is seen in ES where 53.2% of the respondents receive guests at least once a month, 11.7% never receive guests, while 0.5% receive guests every day (**Figure 35**).

Figure 35 Frequency of receiving guests in Belgium (left) and Spain (right)
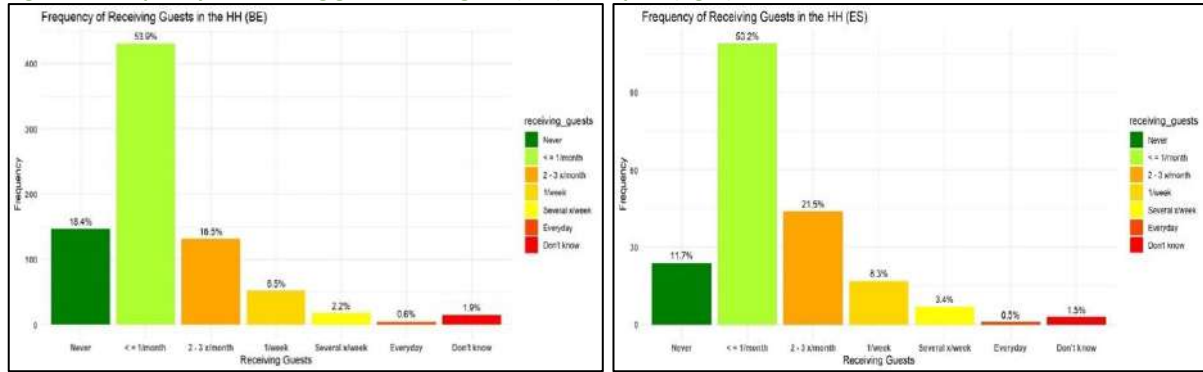
The behaviours related to **hosting guests** in households could impact the amount of food waste generated. The following statements regarding these behaviours were examined at the household levels in Belgium and Spain, and the aggregated results are presented in **Figure 36**:

- *"After we host guests, we always throw away theleftovers"*: In BE, 74% of respondents disagreed (15% somewhat disagreed, 24% disagreed and 35% totally disagreed) to always throwing away food after they host guests while 14% agreed and 12% were neutral. In ES, a similar trend but of slightly higher magnitude of disagreement was observed where a majority (87%) of respondents disagreed (8% somewhat disagreed, 42% disagreed and 37% totally disagreed) to always throwing away food after they host guests while 7% agreed to this statement and 7% were neutral. These results indicated a higher sense of consciousness to not throwing away food after hosting guests in both BE and ES population.

- *"When we have leftovers, we often give them to guests"*: Giving out leftovers to guests could have an implication on household food waste generation. In BE, a significant portion (44%) of the respondents agreed (22% somewhat agreed, 15% agreed and 7% totally agreed) to giving out leftover food to guests while 37% disagreed and 20% were neutral. In ES, a different trend was observed. A majority (54%) of respondents disagreed (7% somewhat disagreed, 19% disagreed and 28% totally disagreed) to giving out leftover food to guests while 29% agreed to this statement and 19% were neutral. These results indicated that BE households are more likely to give out leftover food to visitors and probably prevent them from been wasted compared to ES households.

- *"We sometimes let guests determine/scoop their desired portion themselves"*: In BE, 78% of respondents agreed (28% somewhat agreed, 27% agreed and 23% totally agreed) to sometimes let the guests determine their portion sizes while 10% disagreed and 12% were neutral. In ES, a similar trend but of slightly higher magnitude of agreement was observed where a majority (82%) of respondents agreed (21% somewhat agreed, 31% agreed and 30% totally agreed) to allow guest to determine their portion sizes sometimes while 4% disagreed and 15% were neutral. These results indicated a higher sense of freedom and social capital in ES than BE. This might however have negative repercussions on food waste generated by households in ES as portion sizes are less controlled.

- *"We always serve large portions"*: In BE, 54% of respondents agreed (33% somewhat agreed, 17% agreed and 4 % totally agreed) to always serving large portion sizes while 19% disagreed and 27% were neutral. In ES, a similar trend but of slightly higher magnitude of agreement was observed where a majority (59%) of respondents agreed (33% somewhat agreed, 16% agreed and 10% totally agreed) always serving larger portions while 16% disagreed and 26% were neutral. Larger portion sizes can increase the chances of food waste been generated.

- ***"We always prepare/order many different types of food to please everyone"***: In BE, 46% of respondents agreed (24% somewhat agreed, 16% agreed and 6% totally agreed) to always prepare or order a variety of dishes to satisfy all members of the household while 35% disagreed and 19% were neutral. In ES, a similar trend but of higher magnitude of agreement was observed where a majority (58%) of respondents agreed (29% somewhat agreed, 16% agreed and 13% totally agreed) to always prepare or order a variety of dishes to satisfy all members of the household while 26% disagreed and 18% were neutral. These results indicates that ES households are more inclined to having a variety of food choices than BE households. This could rather lead to more potential for food waste creation in ES than BE.

- ***"We always prepare/order more food than is strictly necessary for the expected number of guests":*** In BE, 73% of respondents agreed (31% somewhat agreed, 30% agreed and 12% totally agreed) to always prepare and/or order more food than is strictly necessary for the expected number of guests while 15% disagreed and 12% were neutral. In ES, a similar trend but of slightly lower magnitude of agreement was observed where a majority (68 %) of respondents agreed (29% somewhat agreed, 20% agreed and 19% totally agreed) to always prepare or order more food than is strictly necessary for the expected number of guests while 21% disagreed and 12% were neutral. However, it was observed above that ES households would prepare or order a variety of food for households' members more than BE households.

- ***"We always know in advance how many guests will join us for the meal"***: In BE, 89% of respondents agreed (12% somewhat agreed, 28% agreed and 49% totally agreed) to always know in advance how many guests will join for a meal while 7% disagreed and 5 % were neutral. In ES, a similar trend but of slightly lower magnitude of agreement was observed where a majority (79%) of respondents agreed (12% somewhat agreed, 22% agreed and 45% totally agreed) to always know in advance how many guests will join for a meal while 8% disagreed and 12% were neutral. Knowing in advance the estimated number of guests is often crucial for planning. Adequate planning helps to curb food waste. These high level of awareness from both BE and ES households be considered an important factor of how they prevent food waste.

Treatment of expiration dates and leftover

Finally, insights on household behaviours associated with the **treatment of expiration dates and leftovers** are discussed below, while the aggregated results are presented in **Figure 37**:

- ***"We often freeze food that is not consumed quickly enough":*** Freezing food is a good way to prevent food waste. In BE, 77% of respondents agreed (20% somewhat agreed, 28% agreed and 29 % totally agreed) to always freeze food that is not consumed quick enough while 14% disagreed and 7% were neutral. In ES, an almost exact trend of agreement was observed where a majority (77%) of respondents agreed (16 % somewhat agreed, 22 % agreed and 39 % totally agreed) to always freeze food not consumed quickly while 13% disagreed and 10% were neutral.

- ***"If the expiration date has passed, we always throw away the product anyway":*** Expiration dates are an important factor that determines the quality and safety of food. In BE, 63% of respondents disagreed (27% somewhat disagreed, 19 % disagreed and 17% totally disagreed) to always throwing away food when the expiration date has passed while 25% agreed and 12% were neutral. In ES, 71% of respondents disagreed (19% somewhat disagreed, 22% disagreed and 30% totally disagreed) to always throwing away food when the expiration date has passed while 17% disagreed and 9% were neutral. These results show that ES household are more inclined to using food products that have exceeded their expiration dates.

- *"We often store leftovers in the refrigerator with theintention of eating them later, only to find out sometime later that we have to throw them away":* Storing leftovers in the refrigerator can help prevent food waste and increase the shelf life of food. In BE, 51% of respondents disagreed (16% somewhat disagree, 16% disagree and 19% totally disagree) to often storing leftovers in the refrigerator with the intention of eating them later, only to find out sometime later that they have to throw them away while 36% agreed and 12% were neutral. In ES, 62% of respondents disagreed (13% somewhat disagreed, 20% disagreed and 29% totally disagreed). This is 11% more disagreement as seen with BE households, while 29% disagreed and 9% were neutral.

- *"Food often gets past date or spoiled (for example, because we forgot or bought too much)":* In BE, 62% of respondents disagreed that (16% somewhat disagreed, 22% disagreed and 24% totally disagreed) that food often gets past date or spoiled (for example, because it was forgotten or too much was bought) while 25% agreed and 14% were neutral. In ES, 73% of respondents disagreed (15% somewhat disagreed, 27% disagreed and 31% totally disagreed). This is 11% more disagreement as seen with BE households while 16% disagreed and 11% were neutral.

- *"We always have leftovers after a meal":* In BE, 46% of respondents agreed (33% somewhat agreed, 10% agreed and 3% totally agreed) to always have leftovers after a meal while 35% disagreed and 19% were neutral. In ES, 42% of respondents disagreed (17% somewhat disagreed, 16% disagreed and 9% totally disagreed) to always having leftovers after a meal while 37% agreed and 17% were neutral. These results show that taking every other factor out of the equation, BE households would generate more food waste from leftovers compared to ES households on average.

- *"How many people will join for the meal is always subject to last-minute changes":* In BE, 61% of respondents disagreed (10% somewhat disagreed, 14% disagreed and 37% totally disagreed) to last-minute changes to the number of people joining for a meal while 17% agreed and 22% were neutral. In ES, an almost exact trend of disagreement was observed where a majority (61%) of respondents disagreed (10% somewhat disagreed, 18% disagreed and 33% totally disagreed) to last-minute changes to the number of people joining for a meal, while 21% agreed and 18% were neutral.

Crisis impact on food waste behaviours

Increase in food prices due to the current inflation and economic crisis can have a **more general impact** on consumers habits and choices. The population of BE and ES are no exception. The statements that were used to ascertain these impacts, are presented in **Figure 38**. The findings can be summarized below:

- Regarding being aware of food waste, about 40 % of Belgian and 44% of Spanish respondents did not report a change, whereas around 55% of both the Belgian and Spanish respondents reported to have become more aware about the issue.
- Regarding the reuse of leftovers, in Spain (61%) and in Belgium 44% did not indicate a change. More people in Belgium (54%) indicated to do this more after a crisis period.
- The crisis period for most households did not affect how often guests were invited (60% in BE and 67% in ES). However, around one fourth of the households did this less often since the crisis period.
- Regarding buying only the amounts needed, for many households no change occurred (41 % in BE and 51 % in ES), nevertheless, at the same time in many households this did become a greater focal point (53% in BE and 42% in ES).
- Regarding making shopping lists, for around 60% of respondents there was no change in behaviour, yet for some households it was more often done due to the crisis period (46% in BE and 34% in ES).

- The perception of food quantity thrown away did not change according to many respondents due to the crisis period (46% in BE and 51% in ES). In both regions, roughly 40% of the households indicated to throwing away less food though.

Regarding the **impact of crisis and increasing food prices** on HH choices and patterns **regarding buying and preparing food**, the results of the respondents are presented in **Figure 39.** In Belgium, about 56% of the respondents indicated to feel rather or a lot of impact from the food price increases, while about 44% indicated to feel rather no or not any impact. In Spain, it was a similar pattern of 60/40.

Figure 36 Agreement on throwing away food after hosting guests in Belgium (up) and Spain (down)

Perception on receiving guests at home (BE)

Perception on receiving guests at home (ES)
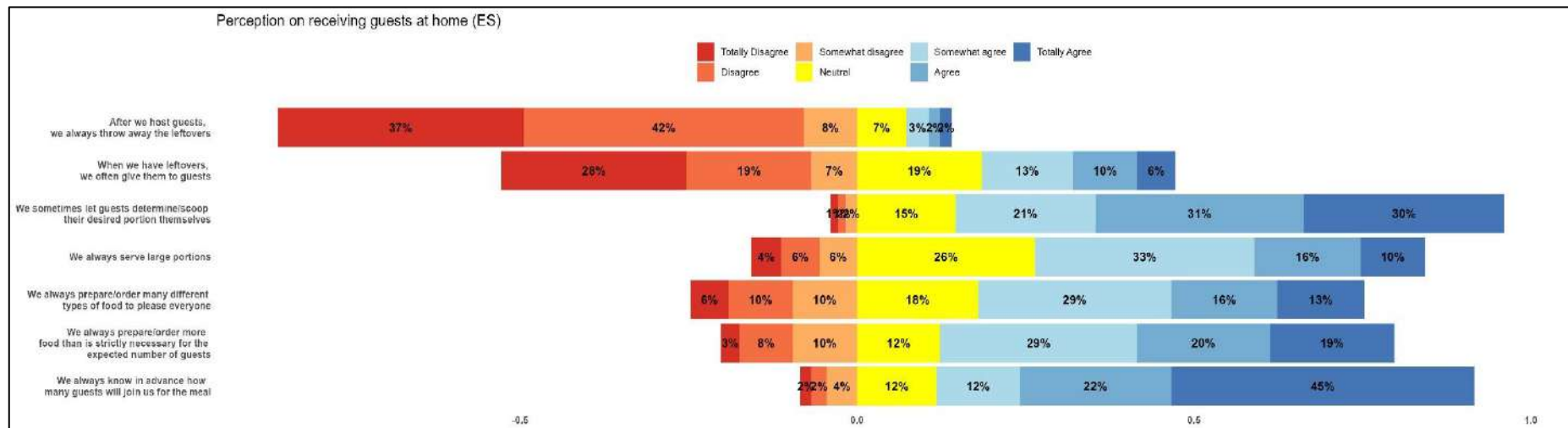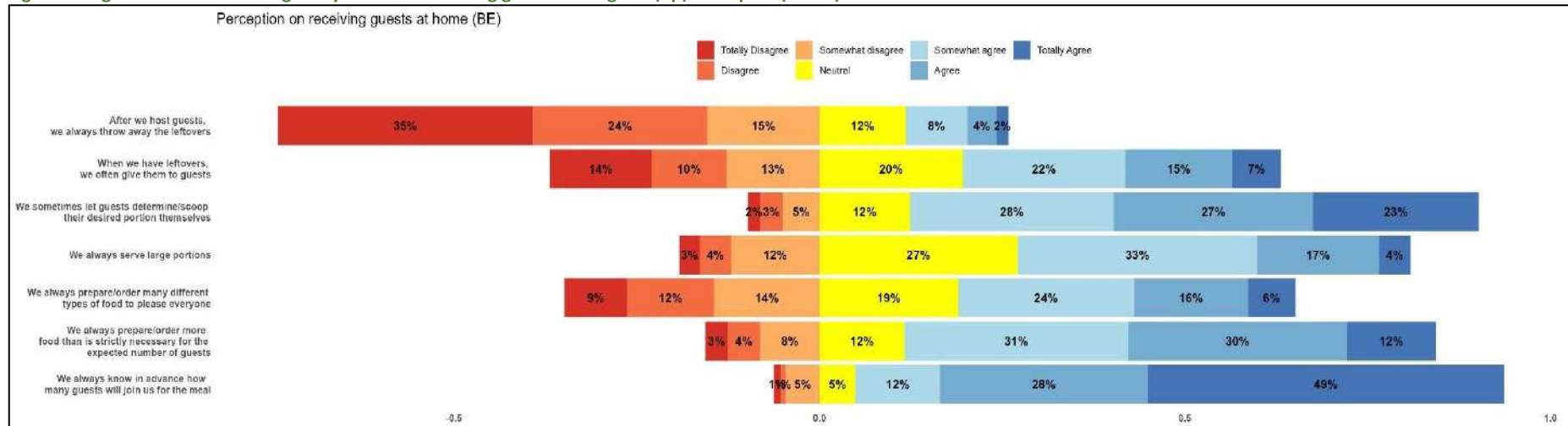
Figure 37 Perspective on household habits around expiration dates and leftovers in Belgium (up) and Spain (down)
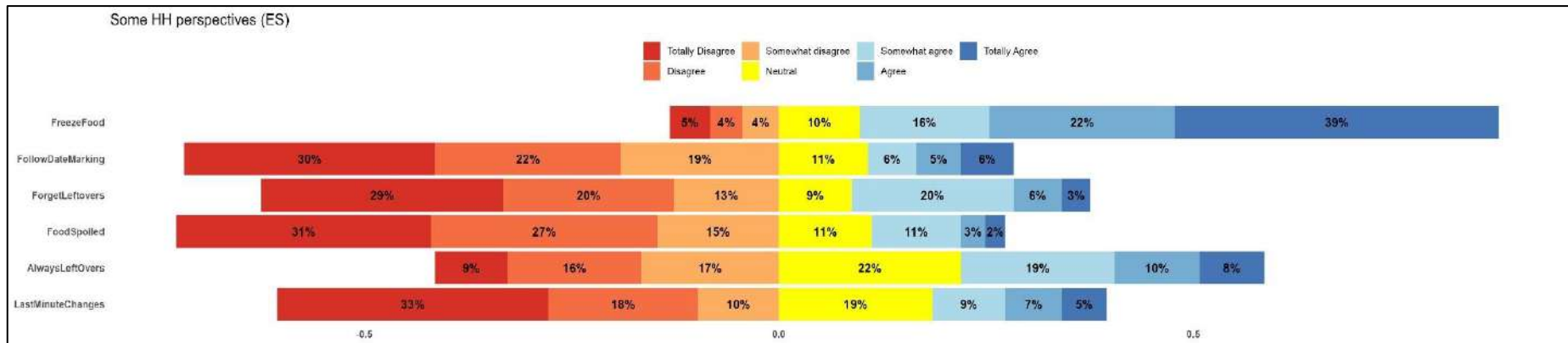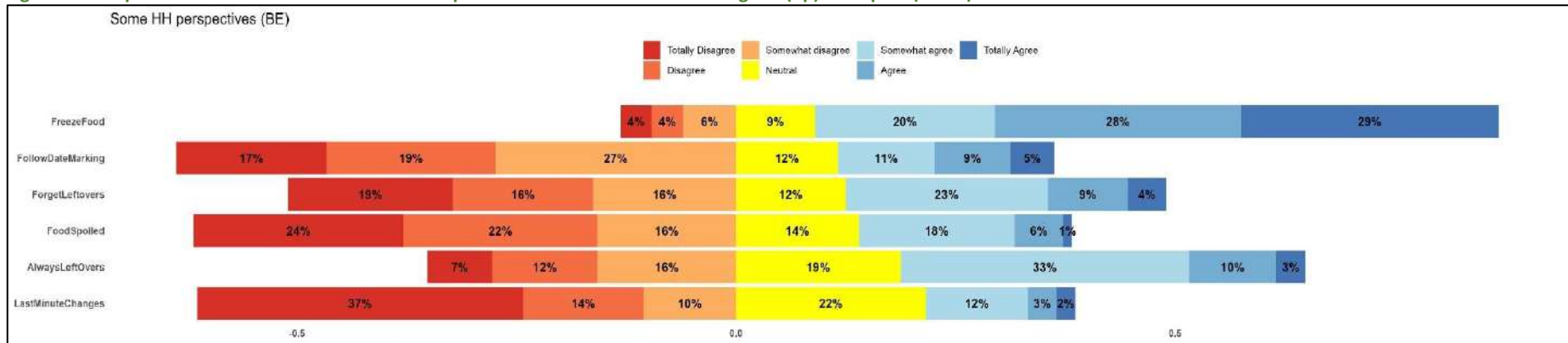
Figure 38 Extend of change of practices and habits due to current crises and increased food prices in Belgium (up) and Spain (down)
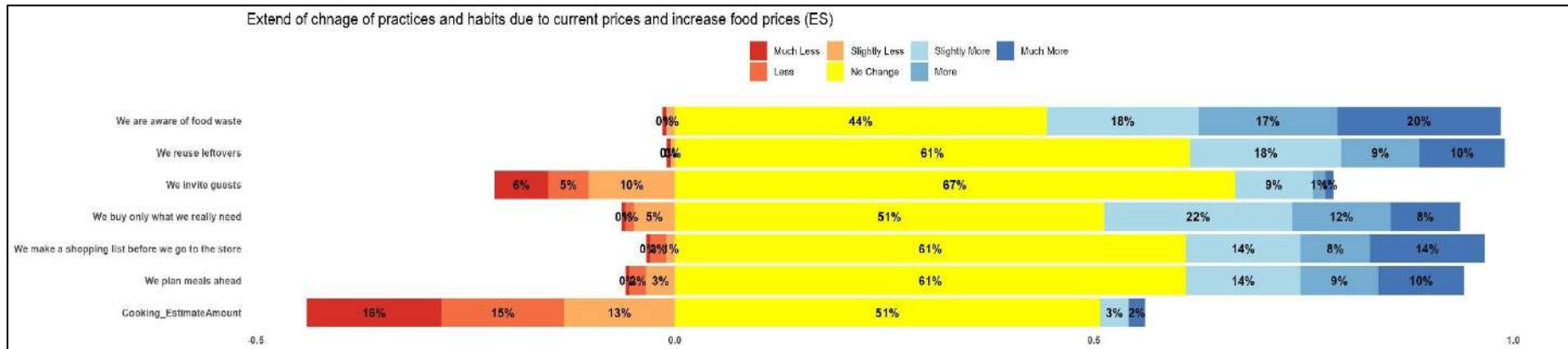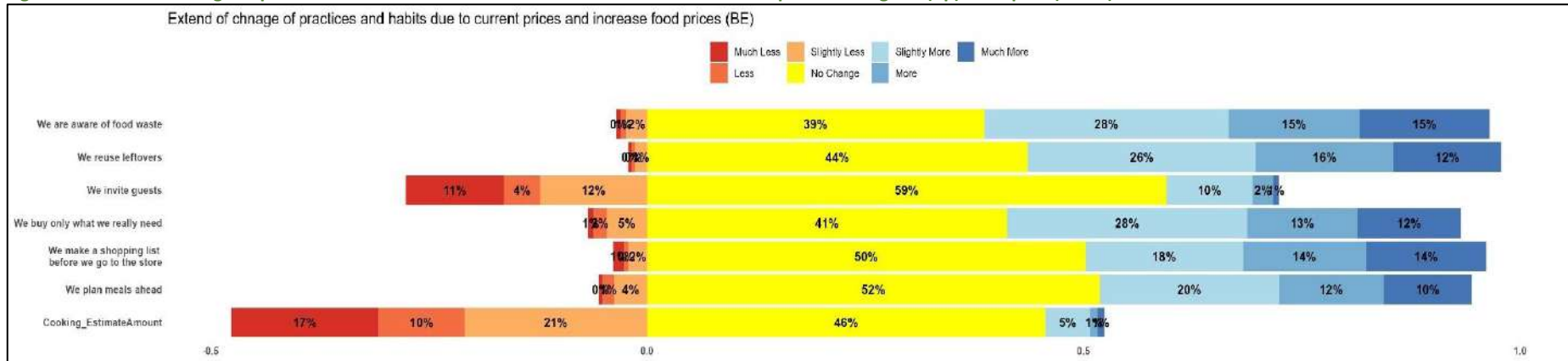
Figure 39 Impact of economic crisis and increased food prices on HH choices when buying and preparing food in Belgium (left) and Spain (right)
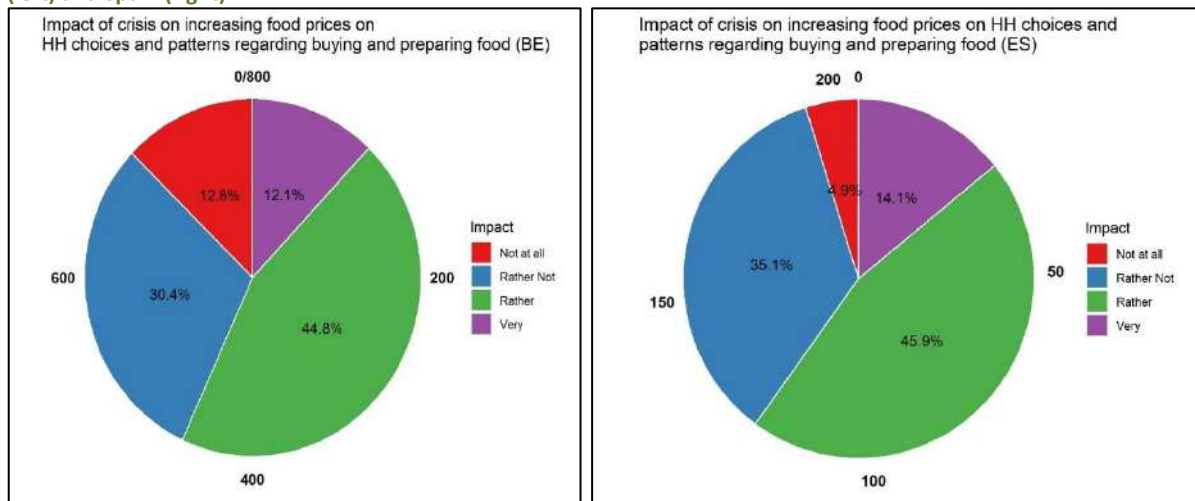
Discussion on food waste behaviour from the survey results in Belgium and Spain

Before summarizing the shopping behaviours and habits below, it should be remarked that half of the Belgian respondents indicated to **find it hard to estimate how much food to buy.**

Making grocery lists and **checking the cupboards and fridge** before going for food purchases seems to be a fairly common practice both in Spain and Belgium, with more than 80% of the sampled respondents indicating that they do this to some extent or even as a very regular habit. **Planning the meals and making up weekly menu**s was a bit less common, with between 50 and 60% of the respondents indicating this as a moderate to strong routine. These survey statistics are fully in line with the Belgian focus group interviews where participants concluded that making grocery lists and checking cupboards is already a habit in many households. However, a need for aligning this grocery list with a menu plan for the week was recommended as a promising household routine for avoiding food waste that is not yet widely implemented according to the respondents.

In the store, **buying the food packages with longer shelf life** is reported as a regular to very frequent practice both in Spain and Belgium. These results indicate that buying the food items with a longer shelf life happens remarkably often. On the one hand, this behaviour can potentially **contribute to food waste**, especially in the case of products with a "best before" date marking. If consumers consistently select items from the back of the shelf, this may increase chances that food items at the front that have passed the expiration date remain, leading the store to be obliged to discard them (even if there is no risk to food safety). Retailers could mitigate this phenomenon by adopting a practice of stocking and displaying food items with the same shelf life together. By providing products from the same batch at once, retailers can minimize the chances of premature disposal due to consumers consistently choosing items with further expiration dates. This strategic stocking approach not only aligns with food safety regulations but also helps reduce unnecessary food waste in retail settings. On the other hand, this behaviour can be **beneficial for FW**; particularly for food products with a "use by date" in case consumers do this because they plan to consume the product later and they already take this time into account in the store (preventing to need to throw it away at home). However, if it is because of wrong interpretation of date marking (in case they associate longer shelf life with higher quality), then this may be problematic for FW.

Just as with the planning and shopping behaviours, also the cooking behaviours generally indicate that it seems to be the norm for most people to **anticipate and reflect** on how much food should be bought and prepared in order to avoid food waste. This is the case both in Belgium and Spain.

In both countries, around 90% of the people indicate to have a habit of making sure **food that will expire first is prepared/consumed first**, of which approximately 45% indicates to always do this. A similar trend was observed for making sure to **use leftover ingredients** in a later meal. Regarding the **usage of tools** while preparing food, the samples where more distributed, with about 40% to 50% of the respondents in Belgium and Spain respectively indicating to not often or very seldomly using tools to estimate ingredient amounts and portion sizes. Interestingly, this practice seemed to be more rare in Spanish compared to Belgian households. Both in Belgium and Spain, most households seem to **rather avoid cooking a meal that (some of) a household members do not like**, although it sometimes happens.

Both in Belgium and Spain, household members getting to **decide their own portion size** seemed to be rather the norm; especially in Belgium where only a very small share of the sample explicitly disagreed to this practice. **Serving larger portion sizes** than what household members will likely be able to eat seems to happen to some extent, but in Spain clearly more people disagreed to this compared to Belgium. Belgian people are known for their "bourgondish eating culture" and these results thus support that serving large portions is associated with taking care for those who eat, a norm which may be more present and decisive in Belgium compared to Spanish food serving behaviours.

In BE almost 1 in 5 households reports to never **receive guests**, while a bit more than half of the Flemish households receives guests once a month. Approximately 16% does so 2 to 3 times a month and almost 1 in 10 receiving guests happens weekly or more often. In Spain, also a bit more than half of the households receives guests once a month. Compared to Belgium, never receiving guests is more rare in Spanish households, with a bit more than 1 in 10 households. A bit more than 1 in 5 Spanish households receive guests 2 to 3 times a month. For over 12% of Spanish households, receiving guests occurs once or more per week. In conclusion, receiving guests for dinner seems slightly more common in Spain compared to Belgium.

When receiving guests, **knowing beforehand how many guests to expect** seemed in both countries largely the norm. The observed trends regarding **serving large portions** or not were very similar in Spain and in Belgium, with a strong tendency of serving large portions (In Belgium 1 in 5 indicates not or rarely to do so and in Spain a bit less). At the same time, **letting the guests determine their own portion sizes** seemed quite common, with in Belgium 1 in 10 indicating never or rarely to do so and in Spain almost 1 in 5. This is in accordance with the Belgian focus group results, where it was declared by the participants that having control over your own portion size should absolutely become the norm – if it isn't already. With regards to the **'good food provider identity'**, serving a variety of foods to please everyone seems to be a habit to some extent, with 46% in Flanders and 58% in Spain (somewhat) agreeing to the statement that they always serve different types of food. This trend may also indicate that hosts (try to) take into account the food restrictions/preferences of their guests. In Spain, considerably less people indicated not to provide various foods compared to Belgium, which could be explained by cultural differences in national kitchens (tapas to share in Spain vs. 1 dish for everyone in Belgium). Furthermore, in both countries about 7 in 10 households indicates to **prepare or order more quantity of food than what would be strictly necessary** for the expected number of guests. This supports the injunctive prescriptive norm of food affluence that was also largely discussed during the Flemish FG to be deeply rooted and responsible for food affluence related norms and behaviours. **Throwing away leftovers after hosting guests** happens (to some extent) in 14% of the Belgian and 7% of the Spanish households. In approximately three fourths of the Flemish households and almost 9 in 10 Spanish households, throwing away leftovers after having received guests was indicated to never or rarely happen. These trends are in accordance with the proscriptive norms (you should not waste food) evident from other survey questions – suggesting that people in their FW behaviours actually follow the norms that they indicated to agree with. At the same time, **giving away the leftovers with the guests** after the party seems more

common in Belgium (44% does so often or sometimes and 37% never or rarely) compared to in Spain (29% vs. 54% never or rarely).

Both in Belgium and Spain, more than 70% indicated **reflection on how much food should be prepared** in order to anticipate that everything gets consumed. Remarkably, 45% in Belgium and 38 % in Spain indicated finding it regularly to very often **difficult to make this estimation**. Estimating this is only possible if you know how many people will join for the meal and if you can estimate correctly how much they will eat. In 17% (BE) and 22% (ES) of the households this is uncertain, as knowing **how many people will join for a meal** is in these households regularly to very often is **subject to last-minute changes**.

In Belgium, more or less half of the respondents seemed to (either occasionally or often) **have leftovers after the meal**. In Spain, only about 40% were neutral or agreeing to this statement of always having leftovers after a meal. The fact that 35% (BE) to 42% (ES) of the respondents disagreed (partly or completely) to this statement, may have different reasons. First, it could be the case that in these households the buying of food and/or the cooking is organised in a way to attempt to not end up with leftovers after the meal. Second, it could be the case that these households don't like leftovers, and that they would rather overeat or throw away the leftovers than to store them for later consumption. Third, it could be the case that these households donate their leftovers (e.g., to friends or neighbours) after the meal.

With regard to what happens with leftovers, should they occur, several strategies were inquired. **Freezing food** that will otherwise not be consumed quickly enough also seems to be a regular strategy, both in Spain and Belgium. The results also suggest that **date marking** is not by default blindly followed neither in Spain nor in Belgium (indicated by 63% (BE) to 71 % (ES) of respondents). In both countries, more than half of the respondents indicated to not (often) **forget about leftovers from previous meals** that had been stored in the fridge for later consumption. Strictly, given the statement formulation questioned in the survey, this could however also mean that they do not have the habit to store meal leftovers for later usage. In both countries, a lot of respondents deny that **food often becomes spoiled or past the indicated date**. In Belgium, 1 in 4 admits that this sometimes or often happens, while in Spain only 16% admits to this.

4.1.4   Social norms

<u>Qualitative Analysis</u>

Spain:

Social norms are the most critical factors influencing the respondents' motivation not to waste food. In the respondents' declaration, injunctive norms about food are imprinted in a family of origin (mainly by mothers). Two of them were reported in most of the interviews. The first is prescriptive norms, which guide **eating everything on one's plate**. It seems to be a solid norm built, especially in the older generation, because of **hunger anxiety**. Some of the respondents, as well as all of the respondents' mothers, lived during a time when there was a shortage of access to food due to the war. Due to that trauma, they firmly believed that they needed to eat everything on their plate, otherwise, it was disrespectful and showed a lack of gratitude. The respondents' family built their food-associated behaviours and norms based on their generation's reality of limited access to food resources. Similarly, the family of origin created another norm, a very general **proscriptive** one to **"not waste food."** This norm is connected to the previous one, but it is mainly influenced by economic reasons. It is more about saving resources, rather than preparing oneself for possible lack of access to food.

In some cases, one norm that could increase food waste despite high motivation to avoid it, was the "**good provider identity**" norm. This entails the desire to be a good parent and host, and therefore, emphasis is placed on the amount of food provided, often exceeding what is needed. Most of the respondents (13 out of 15) mentioned that they tend to overbuy and overcook when they have guests. The same situation more commonly occurs in households with children or households visited frequently by children (e.g., grandchildren). This norm, however, is only potentially dangerous in terms of increasing food waste, since the final amount of waste after a party will depend on one's abilities to manage the leftovers or conscientiously address other prevalent norms, such as those discussed here-above. When it came to addressing leftovers, there were several responses: some respondents threw away leftovers from the party, some froze or ate them another day, while other respondents declared that they always ate their children's leftovers.

Belgium – Focus Group Interviews (3 groups)

Group 1

"A good host/hostess serves more food than is strictly necessary for the number of guests". Out of the eight statements, the participants agreed that this statement was a good expression of an underlying norm behind it, a norm of "one should be overproviding food" (good provider identity). **This is unanimously perceived as a norm that is very present in different layers of society and the most impactful one in terms of food waste generation.**

"As a member of the household, emptying your plate is polite and respectful to the family member who cooked." One respondent highlighted that if you establish this norm within your household, it can be a good lever to lower food waste at the household level. Another respondent wanted to nuance this statement: nowadays, more and more ready-to-eat meals are bought. Therefore, the "respect for who cooks" norm becomes less applied. The loyalty towards bought meals might be lower compared to if a family member has prepared the food. This also applied to food boxes, according to several participants.

"A good head of household ensures that all family members can eat what they like". There was a general consensus on this point, with participants noting the importance of providing variety throughout the week to accommodate everyone's preferences. Respondents also noticed that people are spoiled, and used to get the type of food they prefer.

"A good head of household ensures that food is not wasted." There was general consensus from the group on this statement. However, the participants proposed to formulate it as follows: "A good household makes sure not to waste food". This modification addresses concerns regarding the term "head of the family", which carries historical connotations. Nowadays, a household is managed in a more dynamic and collective way. Remarks from participants:

- The head of the household is usually the one who cooks, hence this role encompasses the most actions (buying food and tracking that it gets consumed in time) that may result in food waste. Therefore, there is general agreement to the statement. Also, communication is important. The head of the family should function as "a bridge" and interpret the dates correctly, and coordinate the household member(s) who will buy the food.
- All participants agreed that it should be a collective responsibility.
- Every member should have the skills (ability) to manage food waste. According to some participants, this was in sharp contrast to the need for convenience food and how retailers are capitalizing on this demand.

"Fathers should eat the leftovers from the children's' plates". Everyone in a household should receive the message: food should not be wasted; food has value. Participants agreed that food is being undervalued. This extended beyond monetary value to include emotional and religious value. All participants believed that there should be a renewed awareness of the labour and energy that is required to bring food to the plate, resulting hopefully in a greater appreciation of food. The conflict between overconsumption and food waste was also raised. The discussion moved onto another concerning norm: with young children the emphasis lies on teaching them new flavours and to keep presenting them vegetables etc. (although the parent knows they don't like it) to achieve a healthy consumption pattern. However, this norm competes with and tends to take precedence over the norm around diminishing food waste.

"Parents should oblige their children to eat all the food on their plates". Among the participants there was disagreement on this statement. Instead, they suggested that the norm should be that if individuals serve themselves, they should eat what they take. Additionally, it was proposed that parents decide what food is eaten while children decide the portion size they take. It was noted that single-person households tend to have relatively more food waste per capita due to a scale effect, as there are fewer opportunities to utilize leftovers.

"As a guest, it is better to overeat than to leave food on your plate". There was disagreement with this statement. The idea of pleasing others with large portions was considered old-fashioned, although there were recognized cultural differences in this regard.

"Freshly prepared meals are healthier than leftovers". Participants did not reach a consensus. One member proposed revising the statement, but others disagreed with the suggested change. However, there was a consensus that society tends to associate leftovers with being less healthy. This norm may be present, but it could be confined to specific groups within society.

Conclusions from Group 1

- The link of social norms with age should be further explored – i.e. maybe there are specific issues/normative aspects linked to age groups through which food waste could be addressed in a more tailored way.
- Similarly, historic dynamics could be further explored. For example, in the period following World War II, when there was often only one breadwinner per household the **monetary value of food** was more apparent. During this time, the norm of emptying your plate was prevalent in households. Another example is the present-day scenario where many people have less affection and connection with agriculture compared to some decades ago. With a tendency to eat more ready-to-eat and convenience meals instead of home-made meals, there appears to be a diminishing **emotional value of food** and a lower level of positive attitude and appreciation towards the resources (time, work) that were invested in the food/meal generation. Convenience food may impact food waste because either the portion sizes are not appropriate, or they impact the perception on the value of food.
- The consensus on **portion sizes was to let people decide themselves** and to serve more only upon request.
- According to the WRAP research project, **single-person households waste relatively more (per capita waste).** This probably has to do with opportunity. The assumption is that single-person households may have more flexibility in their food planning and routines, which could be influenced by changes in plans, unexpected invitations etc.
- Supermarkets might want to follow the trend of the increasing share of single-person households.

- There is a link of social norms with **nutritional considerations** such as obesity. Consuming the leftovers from the plates of your household members might potentially contribute to obesity. The above could be perceived as a form of FW too.
- Food **skills** tend to be less present amongst younger people and this impacts availability.

Group 2

"A good head of household ensures that there is always enough food in the house". The respondents generally agreed that effective household management involved knowing the appropriate amount of food to have on hand. However, they emphasized different aspects:

- Respondent 1 highlighted the importance of balance, avoiding both scarcity and excess, with planning as a key factor.
- Respondent 2 suggested that older children can contribute to food procurement, stressing the importance of planning for unexpected events.
- Respondent 3 expanded on shared responsibility within the household, advocating for a broader perspective beyond the head of the household.
- Respondent 4 emphasized continuous monitoring and proactive planning as essential elements of effective household management.
- Respondent 5 emphasized the need for flexibility, recognizing that individual circumstances vary, while stressing the importance of shared responsibility and effective planning to minimize waste.

"A good parent respects it when his/her child does not want to finish his/her plate". The respondents generally agreed that portion sizes should be adjusted based on age and individual preferences to minimize food waste. They emphasize the importance of parental guidance in teaching children about portion control and encouraging them to taste different foods. Additionally, they discuss the practice of anticipating children's preferences and adjusting portion sizes accordingly to prevent waste. However, they also note that household norms regarding finishing food on the plate may vary, with some suggesting that portion sizes should be decided based on individual preferences rather than strict rules.

"Girls/women must be skinny to be beautiful." The respondents highly disagreed with this statement and stated that it should not be a norm. However, they agreed that this might be an existing norm in some subgroups of the population but they did not see how this contributed to food waste. One respondent wondered: "This is a provoking statement. It is so different from the others; how did it end up here?" Another respondent explained: "I think that some girls do not get to decide how much food is served on their plate, and then they do not eat it because they think that they will become fat" (a social norm wherein they relate finishing your whole plate with being greedy and risk becoming fat). The moderator answered the first respondent's question explaining that this statement is extreme to trigger discussion. The main reason that the statement was included was to explore if there were any gender-related norms around behaviours that eventually lead to food waste. Maybe, implicitly, or unconsciously, this norm influences our behaviours. For example, parents might serve larger portions to boys than to girls. A respondent reacted by saying: "But I think that such girls/women who follow this norm, in the first place do not take much food on their plate. Another respondent asked: "Am I the only one for whom the norm is not that another household member decides the portions? At our place, we put the food in the middle of the table and then everyone serves themselves (i.e. everyone gets to decide his own portion)".

For other respondents this norm depended on the context - i.e. it is different for guests, where one person typically serves, versus for parents with younger children or older children. Leftovers from pots are easier to consume later, whereas if they were already on the plate, they are more likely to become waste.

***"A good head of household does not waste money on food that gets thrown away"*.** The respondents generally agreed that responsibility for minimizing food waste in a household should be shared among family members. They emphasized the importance of teaching children about the value of food and involving them in efforts to reduce waste. While some highlighted the financial aspect of waste, others prioritized environmental and ethical considerations. Overall, they advocated for a collective effort to minimize food waste at home.

***"As a guest, it is polite and respectful to the cook to eat your plate empty"*.** The respondents agreed that it was important for cooks to facilitate appropriate portion sizes for guests, considering individual preferences and dietary needs. They suggested offering options like different portion sizes or buffet-style service to accommodate varying appetites. Effective communication between cooks and guests could help ensure that portions are suitable and minimize food waste.

***"A good cook serves a varied meal so that everyone at the table can eat what they like"*.** The written notes from respondents suggested that a good cook should provide variation in the weekly menu and consider appropriate portion sizes. They emphasized the importance of accommodating dietary preferences and encouraging healthy eating habits, particularly for children. There is consensus that while not every meal needs to be highly varied, overall variation across the week is important. Respondents also discussed the importance of allowing household members to choose their portion sizes. In the group discussion, participants agreed on the importance of offering choices in portion sizes, such as small, medium, and large options, both in home-cooked meals and in restaurant settings.

***"A good cook uses only the freshest ingredients"*.** Respondents generally agreed that fresh ingredients are not always necessary, with some noting that older vegetables and fruits can still be used to create delicious meals. They highlighted the value of frozen or canned options, which can be both healthy and tasty, particularly for soups. While fresh ingredients are preferred for salads and raw vegetables, frozen alternatives are seen as suitable for various dishes. Overall, there is consensus among respondents that freshness is not always a strict requirement, especially considering the convenience and taste of frozen options.

***"A good head of household ensures that food is not wasted"*.** It is hard for the cook or household manager to estimate the amount of food that should be prepared, leading to a higher fraction of waste at this stage compared to what's left on the plate. This places a lot of responsibility on this person. However, the problem can be solved by managing the leftovers - put them in a container for lunch the next day. Sometimes, individuals intentionally cook more to have leftovers. One respondent hesitantly admits: "I finish the plates of my household members". Another respondent questioned: "But if you are satisfied, isn't this also a form of food waste? The moderator asked: "What do you think the norm is regarding planning, grocery lists, etc.?" Participants answered:

- Weekly supermarket visits.
- The norm perceived by this group was to make a grocery list based on what is finished, rather than what will be needed that week. Checking the cupboards and fridge before preparing to go grocery shopping was not perceived as a common practice/habit.
- Weekly planning was not perceived to be very common, with the main problem being opportunity: time and change of schedules.

Conclusions from Group 2

- **Encourage flexible portion sizes instead of standardized ones**. Make sure that **portion sizes** are not too large. Let people decide themselves their portion sizes with exceptions for very young

children and people who need supervision for health reasons, such as elderly, or those with anorexia. Make it possible to buy smaller portions.

- Opportunity: There is a need for **alternative packaging sizes** for single-person households (e.g. students) who don't require large quantities like 4 sausages or a whole cauliflower. One respondent remarked that there is already increased attention on this, such as "singles bread" from Albert Heijn.
- Make sure not to get too much food in the house. In the supermarket environment, one can often get **tempted** by promotions that encourage food waste at the household level.
- Give tools to consumers, chefs, etc. to manage food waste.
- **Meal planning** & **grocery lists** are key.
- The participants thought that the norm was to do **weekly groceries**.
- Many people checked the cupboards to see what was missing and should be bought. Also, many people **bought "on intuition".**
- Many people also use a grocery list, however, it is often not based on a weekly menu. These are two different approaches, and menu planning should ideally determine the grocery list.
- The norm that there should be **enough food** (especially for parties etc) is very strong. However, it should become more the norm that people bring their containers, and that leftovers are distributed at the end of the party. Alternatively, inviting family members over the day after the event could also help reduce food waste. In other words, there should be a **shared responsibility** about food waste minimization practices.
- **Participants acknowledged that the norm of ensuring there is enough food is strong, nevertheless**, they also **recognized the strength of the norm against wasting food.** Hence, they advocate for **building capacity** in the opportunity and ability area of the MOA framework.
- A host feels very uncomfortable if all the food is consumed **("good provider identity")**.
- There are segments where overeating is the norm ("eating for the hunger that will come").

Group 3

"A good parent respects when his/her child cannot finish his/her plate". Respondents generally agreed that a child should finish their meal if they can, with some conditions and nuances. They emphasized the importance of encouraging children to serve themselves appropriate portions and to try different foods. In the group discussion, consensus was reached on the statement, with participants noting that the context and frequency of unfinished meals should be considered.

"Boys/men should eat larger portions than girls/women". Respondents unanimously disagreed with the statement that men should eat more than women. They emphasized that portion sizes should be based on individual factors rather than gender. In the group discussion, consensus was reached on the disagreement with this societal expectation, although some noted that this belief may still exist among older generations.

"Mothers should eat the children's leftovers". Respondents generally disagreed with the notion that parents, particularly mothers, should finish the leftovers of their children's meals. They emphasized the importance of encouraging children to finish their own plates and advocated for appropriate portion sizes. There was consensus on the idea that parents should teach their children not to take more food than they can eat, starting with smaller portions and raising awareness about food waste.

"Serving large portions equals taking good care of those who eat". Respondents generally disagreed with the notion that serving large portions is a form of showing care. They believed that portion sizes should be tailored to individual preferences and needs. While there may be cultural or generational influences at play, they emphasized the importance of offering choices and ensuring that guests and family members have enough to eat without overindulging. Despite their

disagreement in written notes, they acknowledged that the practice of serving large portions is still prevalent in certain social contexts, such as events or parties, and may reflect lingering cultural norms.

"One should always eat one's plate empty". Respondents generally agreed with the idea that one should try to finish their plate, but they also acknowledged situations where this may not be feasible or appropriate. They emphasized the importance of avoiding food waste and making efforts to consume what has been served. However, they noted that the expectation to finish one's plate may have evolved over time, transitioning from a strict obligation to a more flexible approach that encourages tasting and trying without imposing strict requirements. The discussion highlighted how social norms around finishing one's plate have shifted, influenced by upbringing, cultural changes, and societal attitudes towards food waste.

"A good parent ensures that his/her children have enough food available to them". Respondents generally agreed that parents should ensure their children have enough food, particularly emphasizing the importance of having enough healthy options available. However, they also acknowledged the need for balance, recognizing that children may also desire snacks and variety in their diet. The consensus among the group was to reformulate the statement to emphasize the provision of "enough healthy food" rather than simply "enough" food. They also considered the financial constraints that some parents may face in providing healthy options, emphasizing effort over perfection in this regard.

"A good cook does not use products that are expired". Respondents expressed nuanced perspectives regarding the use of expired food products. While there was agreement that in commercial settings, adherence to expiration dates was critical for food safety, opinions varied in private contexts. Some argued that many products remain edible beyond their best-before dates and emphasized the importance of using sensory judgment to assess freshness. Suggestions for refining the statement included specifying the type of expiration date and highlighting the importance of planning purchases and menu preparation to avoid wastage. In group discussions, participants highlighted the differences between professional and home cooking contexts, the distinction between "use by" and "best before" dates, and considerations of risk when consuming expired products.

Conclusions from Group 3

Moderator: Where do you think we could work on social norms with impact in terms of food waste? What in this row or series is alive and well that we could change?

(1) The expectation that there should always be plenty of food on the table should change, since this implicates that often there is too much food.

(2) It should become the norm that an individual himself/herself can determine the portion size. For example, this flexibility should be available in restaurants. If this becomes a norm, children would naturally learn to estimate their needs regarding portion size, as mentioned by one respondent.

The moderator noted that, despite the disagreement in the written exercise regarding *"Serving large portions is equivalent to taking good care of those who eat"* discussions suggest that this is an implicit, tacit norm still present in society and many contexts. The participants agreed that this norm remain implicit. It was suggested that portion sizes should initially be smaller, however, there should be an option to have more. In other words, smaller portions should not be the default.

There was a consensus that expectation towards men regarding food waste is no longer considered a norm.

In a private context, a respondent observed a lot of waste in her surroundings because people blindly followed expiration dates. However, it might be the expectation that they throw it away after the date. This issue is closely tied to knowledge about food safety and quality. There is room for improvement in this area:

- **Improve knowledge, norms, and expectations around 'best before' and 'use by dates.**
- **Expectations and norms around expiration dates**: There is knowledge about "best before" versus "use by" dates, however, people still tend to waste products that are past the "best before" date. Although they know it is safe, they may still throw it away just to be sure.
- **Expectations and norms around portion sizes**: Move towards more self-determination and give the opportunity to individuals to decide themselves.
- **Food affluence**: The expectation that "you should have enough food to present to household members/guests" remains. However, the expectation around portion sizes has already changed in a positive direction.
- Highlight **other methods to manage leftovers** while avoiding overconsumption (e.g., fermentation, feeding the chickens, composting the leftovers).
- Distinguish norms regarding leftovers on the plates vs leftovers in the pots and pans.

Overall conclusions from the focus group interviews

- Nowadays, the norm around portion size varies according to different subgroups in population. There is a consensus amongst participants from focus group that the norm should be that individuals can decide on their portion size, regardless context (restaurant vs household) or age category.
- Between the three discussion groups, it was evident that societal norms play a significant role in influencing food-related behaviours and attitudes towards food waste. However, the specific norms discussed, and their influence varied among the groups.
- In Interview Group 1, participants focused on norms such as food affluence and the good provider identity. They explored how these norms contribute to food waste generation and discussed the relationship between food security, household food management strategies, and waste. Norms surrounding serving sizes, emptying plates, and obligations to finish food were analysed in depth. There was a consensus on the importance of shared responsibility within households to minimize food waste, with cultural influences and parental roles also considered.
- Interview Group 2 delved into similar themes, including the role of the head of household, portion control, and respect for individual preferences in reducing food waste. Participants also considered societal norms, such as beauty standards for women, and their impact on food-related behaviours. The group emphasized the need for flexibility, planning, and awareness in waste reduction efforts, highlighting shared responsibility, meal planning, and grocery list management as key strategies.
- Lastly, Interview Group 3 examined various aspects of food consumption and waste, focusing on parental responsibility regarding children's plates, household waste management, and portion sizes based on gender. Participants disagreed with norms suggesting that mothers should eat children's leftovers or that serving large portions equals care. They emphasized the importance of teaching children about portion control and involving all household members in waste management. The group also discussed the use of expired products and the need for education on expiration dates.

Descriptive Statistics and Correlation Analysis

While there were intrinsic social norms in the statements discussed in the previous section, the social norm associated with the **head of the household** was examined separately through the following statements, while the aggregate results are presented in **Figure 40**:

- *"A good head of the household does not waste money on food that is thrown away":* In BE, 90% of respondents agreed (17% somewhat agreed, 28% agreed and 45% totally agreed) to the statement "A good head of the household does not waste money on food that is thrown away" while 2% disagreed and 8% were neutral. In ES, a similar trend of agreement was observed where a majority (90%) of respondents agreed (9% somewhat agreed, 23% agreed and 58% totally agreed) to the statement "A good head of the household does not waste money on food that is thrown away" while 2% disagreed and 8% were neutral.

- *"A good head of the household ensures no food is wasted":* In BE, 88% of respondents agreed (18% somewhat agreed, 29% agreed and 41% totally agreed) to the statement "A good head of the household ensures no food is wasted" while 3% disagreed and 9% were neutral. In ES, an almost exact trend of agreement was observed where a majority (90%) of respondents agreed (9% somewhat agreed, 23% agreed and 58% totally agreed) to the statement "A good head of the household ensures no food is wasted" while 4% disagreed and 6% were neutral.

- *"A good head of the household makes sure there is always enough food in the house":* In BE, 93% of respondents agreed (26% somewhat agreed, 38% agreed and 29% totally agreed) to the statement "A good head of the household makes sure there is always enough food in the house" while 1% disagreed and 6% were neutral. In ES, an almost exact trend of agreement was observed but with slightly lower magnitude where a majority (86%) of respondents agreed (20% somewhat agreed, 25% agreed and 41% totally agreed) to the statement "A good head of the household makes sure there is always enough food in the house" while 4% disagreed and 10% were neutral.

- *"A good head of the household ensures that all family members can eat what they like":* In BE, 70% of respondents agreed (26% somewhat agreed, 28% agreed and 16% totally agreed) to the statement "A good head of the household ensures that all family members can eat what they like" while 11% disagreed and 19% were neutral. In ES, a different trend was observed since a lower portion (46%) of the respondents agreed (17% somewhat agreed, 14% agreed and 15% totally agreed) to the statement "A good head of the household ensures that all family members can eat what they like", while almost a quarter (24%) of the respondents disagreed and 20% were neutral.

Regarding **food waste generation**, both in Spain and Belgium it seems to be the norm that food waste is avoided and minimized as much as possible. Throwing away food is in both regions to a very large extent perceived as irresponsible behaviour. At the same time, **ensuring that there is always enough food in the house** is also a very common norm. These two norms could lead to counteracting behaviours in practice. Remarkably, a large majority (about 85%) of the Belgian respondents and 92% of the Spanish respondents declared to act in accordance with this norm by actively avoiding food waste generation in the daily life. Only 12% of the Flemish respondents **don't feel bad when throwing away food**.

Respondents were asked if they are thinking of the environment, the needy, or money, when throwing away food. People who express consideration for these type of consequences, as well as those who rarely do so, vary. In both countries, a majority (about 50-60%) indicated that they considered these consequences (sometimes or often), while a minority (at most around 1 in 4)

admitted that they do not really think about such **environmental, social or monetary consequences**. However, these answers may be prone to social desirability bias.

Regarding the descriptive norm "I notice that people close to me make an effort to waste less food", 35% of the Flemish respondents were neutral. A possible explanation is that people don't really know the practices in other households, as it was expressed by focus group interview participants who positioned themselves at this part of the scale. This suggests that there is room for addressing FW behaviours by using descriptive norms.

Figure 40 Perception on social norms related to head of household in Belgium (up) and Spain (down)
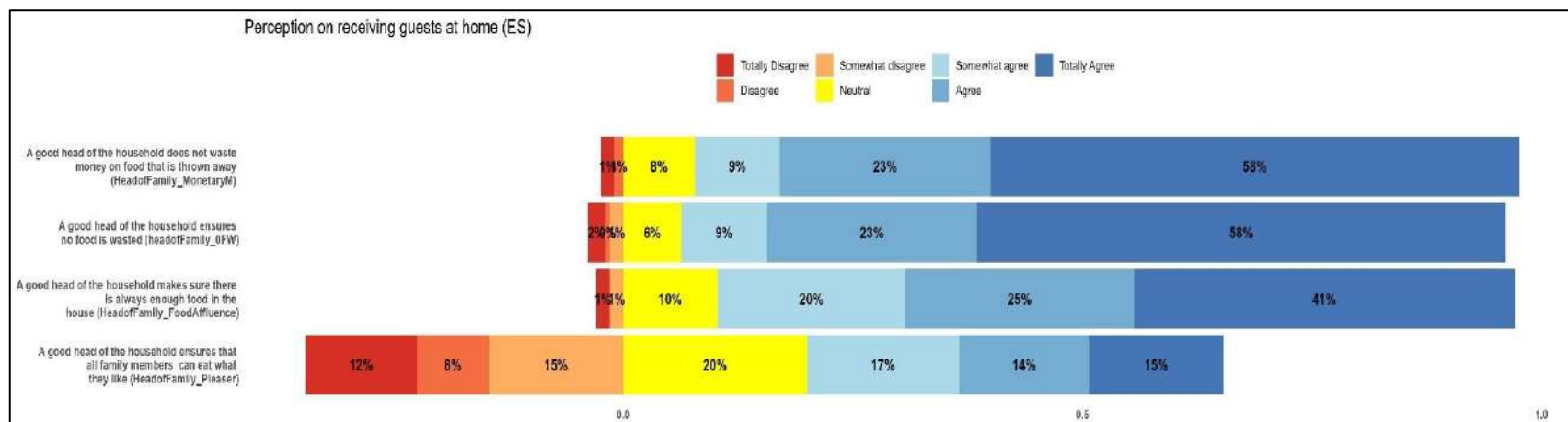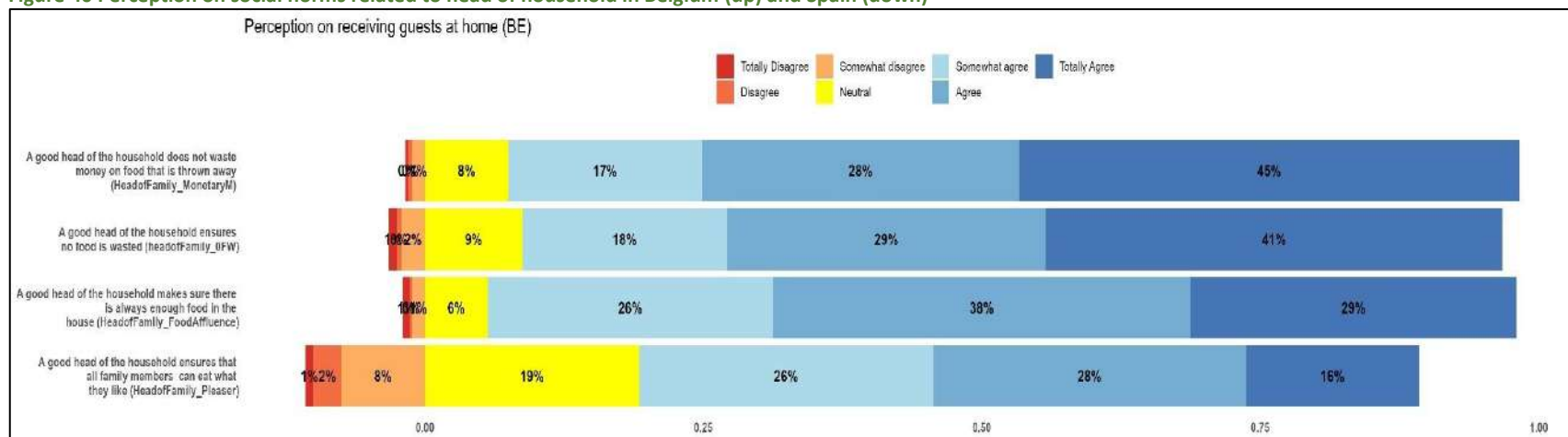
Regarding the injunctive norm "I feel people close to me expect me not to waste food", about 40% agreed, 40% were neutral, and a bit more than 1 in 5 did not perceive this expectation. This spread is again in accordance with the results from the Belgian focus group. Using injunctive norms to tackle FW in households may therefore require targeted approaches. Remarkably, 34% believed that people in their close circle throw away a lot of food, 38% are neutral, and 27% did not think this. Together with the relatively low food waste reporting from the first part of the survey, these results may illustrate the "**better than average bias**" (a bias of believing you do better than average). Not many people (14%) in Belgium fear to be labelled as being stingy when throwing away food, again fully in accordance with the focus group.

Some norms seem to be different in Spain versus Belgium. For example, looking at beliefs related to '**good food provider identity**', in Spain there tends to be a lower expectation that the head of the household ensures that all family members can eat what they like compared to Belgium, where this seems to be largely expected.

4.1.5   Gender and intersectional differences

Gender - Focus group interviews (Belgium)

During the focus group interviews in Belgium, there was debate about **gendered portion sizes** (after a group of participants was presented with the statement "Girls/women must be skinny to be beautiful"). A respondent remarked: "*Am I the only one where the norm is not that another household member decides the portions? At our place, we put the food in the middle of the table and then everyone serves themselves (i.e. everyone gets to decide his own portion)."* So she observed a descriptive norm during the FGI that she previously was not aware of. Later on during the discussions, participants unanimously agreed that it should become the norm that people get to decide their own portion sizes (exception: little children, elderly, anorexia: in such groups, an external who determines the portion size is needed for health reasons).

It was remarkable how the **gendered aspects** in the statements "Fathers/mothers should eat the leftovers from their children's plates"; "mothers should eat the leftovers from their children's plates"; "boys/men should eat larger portions than girls/women" and "girls/women need to be skinny to be beautiful" **were disapproved** by the respondents. Nevertheless, during the small discussions of each of these four statements, it became apparent that gendered behaviours do happen according to the respondents. For example, one participant remarked that if there are leftovers, and a consumer for those leftovers is being identified, the first "instinct" is to first look at the male people in the room to check their interest. Also during the coffee break the respondents talked further about their food habits at home, and a participant told about a recurrent family joke of the father of the family being named "the bin" as he gets to eat the leftovers. The expectation is that firstly the men would finish it. Gendered behaviours were disapproved by the focus group participants, however, at the same time they acknowledged that they happen.

Cultural and temporal differences for the norms "As a guest, it is polite and respectful to the cook to eat your plate empty" and "As a guest, it is better to overeat than to leave food on your plate". In some cultures it is not polite to leave food on the plate, while in other cultures it is totally the opposite.

Gender - Household interviews (Spain)

The most notable **generational difference** was that of older people who lived through the war and had been deprived of food, who report that they value food more and are more accustomed to

doing whatever it takes not to throw food away, as well as a predisposition never to be deprived of food. (Spain)

Gender - Food waste levels (Spain and Belgium)

The association between demographics and perceived food waste level compared to the average of 1.7kg/week was determined with a bivariate analysis and Fisher's exact test. The p-value resulting from the Fisher exact test indicates the probability of observing the observed data or more extreme results if there were no true association between the variables.

The results for Belgium are demonstrated in **Figure 41**. With a p-value of 0.6197, it was deducted that there is no statistically significant evidence to reject the null hypothesis, suggesting that there is no association between food waste level and gender in the Belgian population.

Figure 41 Bivariate relationship of food waste level and gender for Belgium
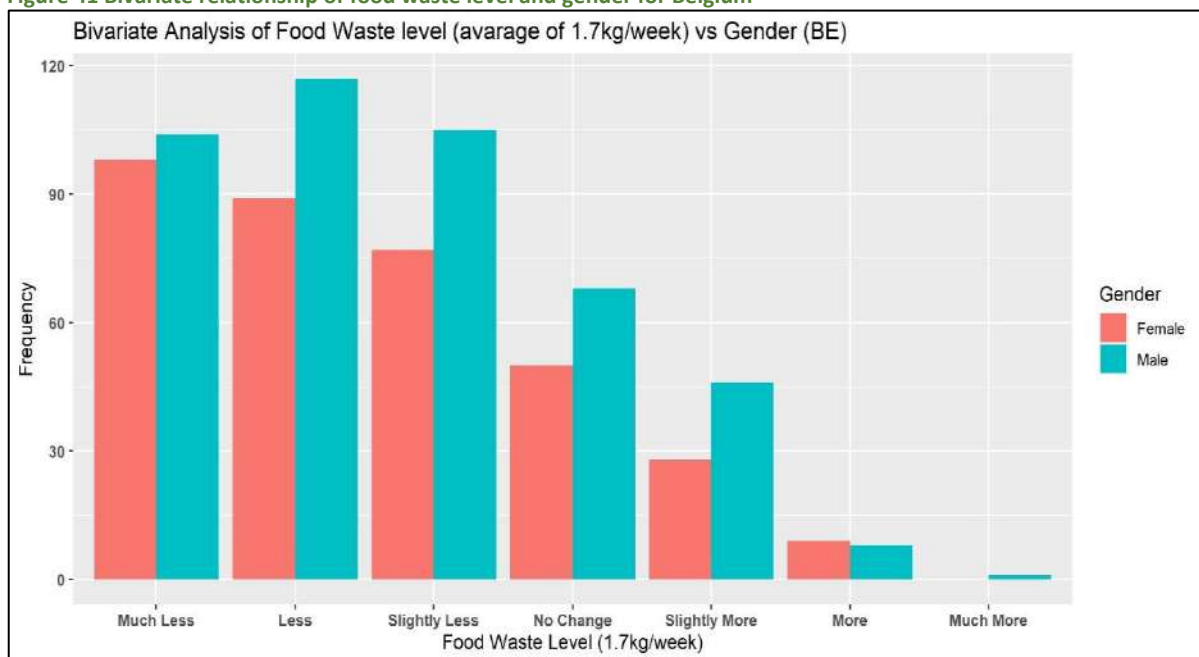
The results for Spain are demonstrated in **Figure 42**. The p-value of 0.06647 suggests that there is a statistical significance at the p < 0.1 level. It is evident from the graph, that while the distribution of the responses is relatively uniform, it is quite disproportionate for the "Much Less" response. In other words, women in Spain are more likely compared to men to perceive that their food waste is very low compared to the average value of 1.7kg/week.

Figure 42 Bivariate relationship of food waste level and gender for Spain
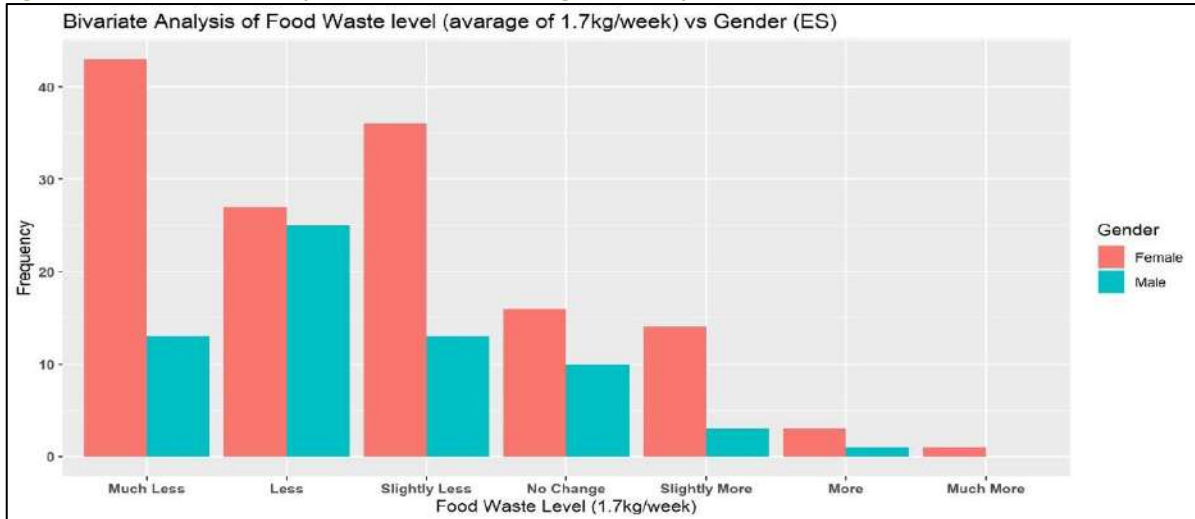
Age and food waste (Spain and Belgium)

The results for Belgium are demonstrated in **Figure 43**. With a p-value of 0.00, here it is deducted that there is association between food waste level and age in the Belgian population. Older individuals (age group of 55+) are reporting a much lower food waste amount compared to young and middle-aged individuals.

Figure 43 Bivariate relationship of food waste level and age for Belgium
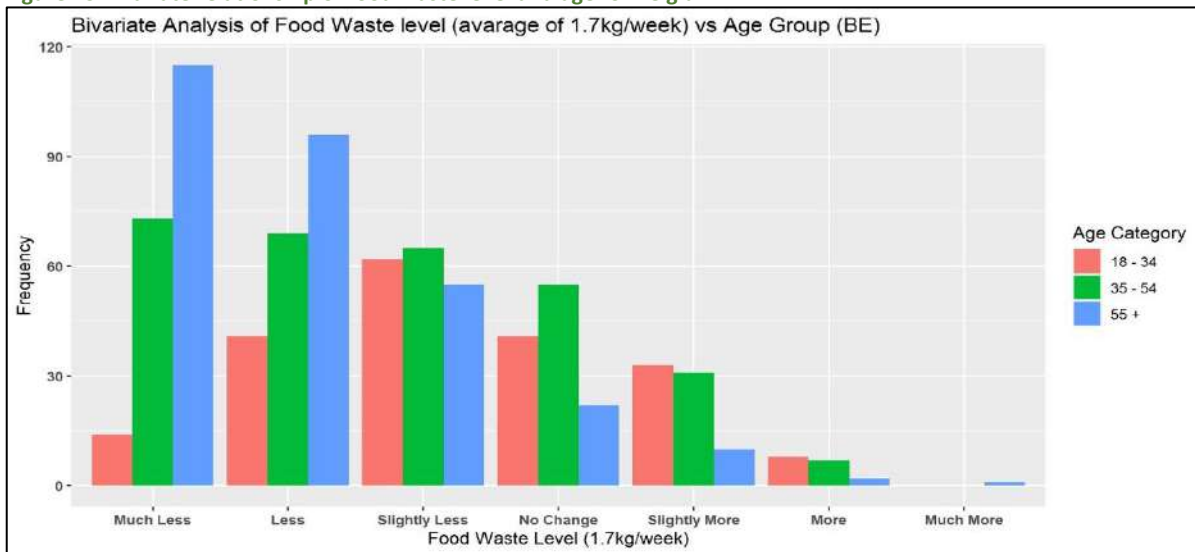
On the other hand, the p-value for Spain is 0.5417 (**Figure 44**), suggesting that there is no statistically significant relationship between food waste level and age.

Figure 44 Bivariate relationship of food waste level and age for Spain
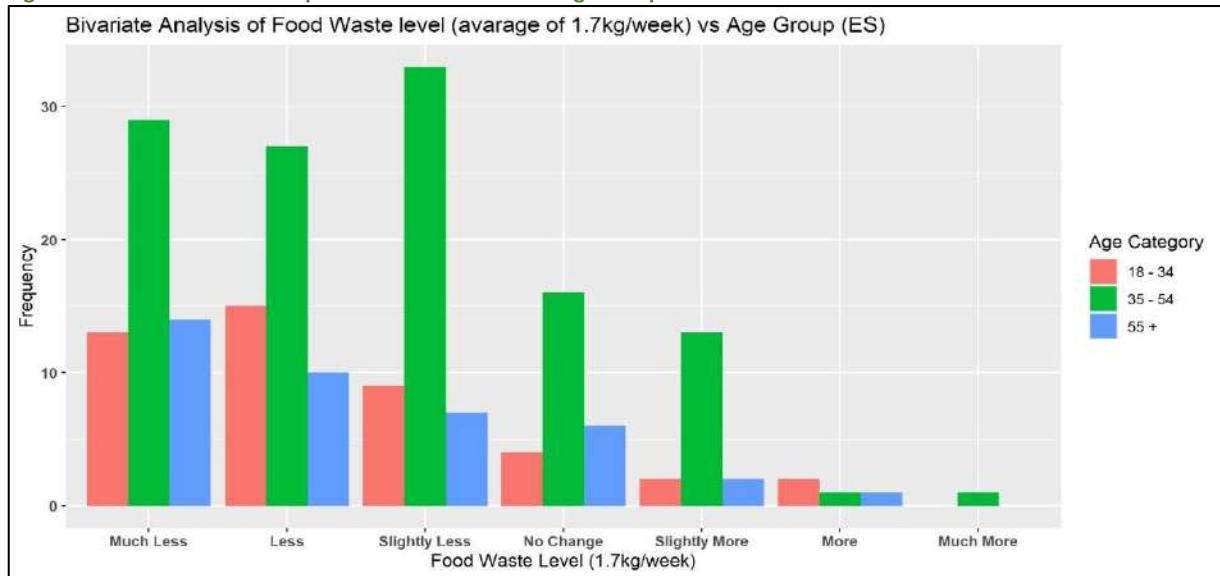
Income and food waste (Spain and Belgium)

The results for Belgium are demonstrated in **Figure 45**. With a p-value of 0.002, here it is deducted that there is association between food waste level and income in the Belgian population. Higher-income individuals (people that live comfortably and those that make ends meet on current income) are reporting a lower food waste amount compared to lower-income individuals.

Figure 45 Bivariate relationship of food waste level and income for Belgium
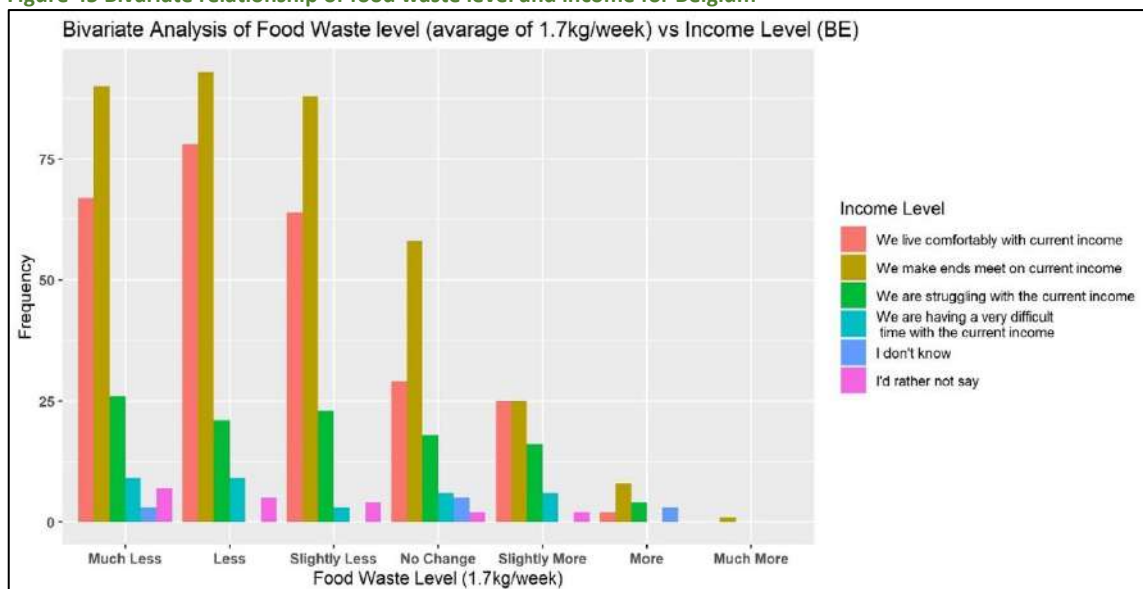
On the other hand, the p-value for Spain is 0.2514 (**Figure 46**), suggesting that there is no statistically significant relationship between food waste level and income.
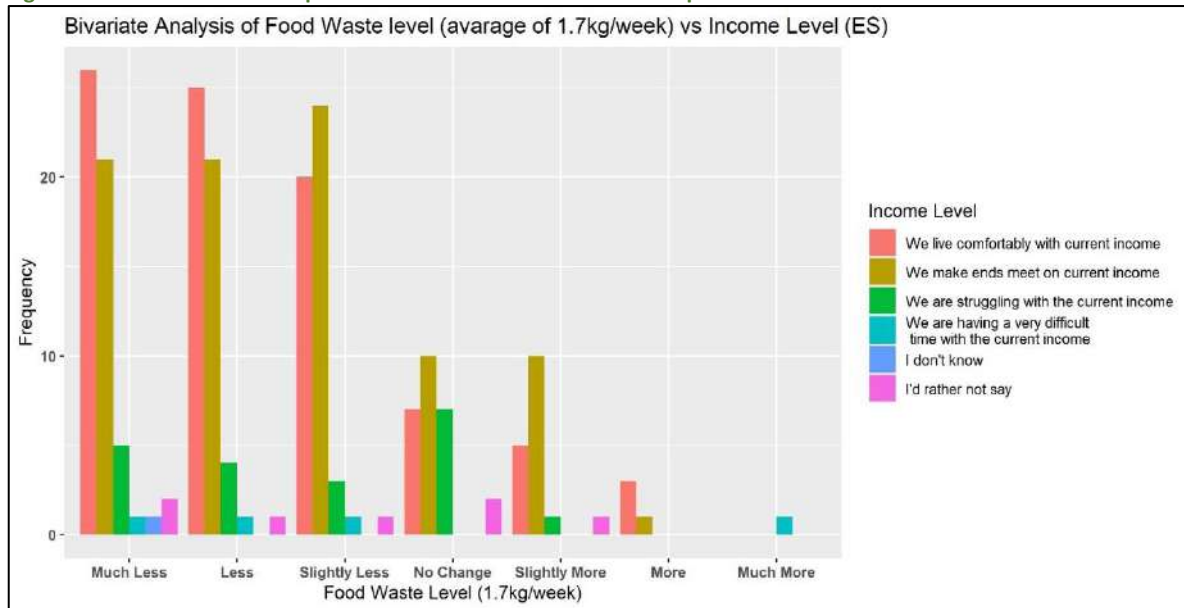
4.2   Case Study 2: Hospitality sector in Norway – hotels

The following points offer a concise **summary of the main findings from the breakfast buffet and lunch experiments**:

- **Variability in Breakfast Buffet Attendance**: The two Clarion hotels (Gardermoen and Trondheim) exhibit the highest variance in the number of guests at their breakfast buffet.

- **Average Breakfast Buffet Waste:** On average, each guest generates approximately 40g for of waste during breakfast.

- **Effect of Messages on Breakfast Waste**: Analysis reveals that while the control group (no message) aligns closely with the overall waste average, positive messages seem to lead to reduced waste per guest (31.85g), whereas provocative messages seam to lead to increased waste per guest (51.76g). Given that there are potential influencing factors (e.g. month, hotel type or guest count), more elaborate analysis is performed in the next chapter to understand this effect.

- **Impact of Lunch Service Type on Waste**: Waste per guest during lunch service is higher when guests receive plated service compared to self-service buffet. This effect is more pronounced at the Clarion Trondheim.

- **Hidden Waste in Buffet Service**: The waste data solely represents waste left on guests' plates, irrespective of the service type. However, at Quality Riverstation Hotel, the only hotel with measurements including service waste, shows that buffet service leads to significant unmeasured waste.

4.2.1   Overview of data collected

This section provides an overview of the data that was collected for the breakfast buffet experiment, the breakfast staff survey, and the lunch experiment. For the remainder of this chapter, the analysis for case study 2 focuses primarily on the two experiments, occasionally incorporating supplementary

insights from the breakfast staff survey, and the in-depth interviews conducted with the chefs. The hotels where data collection took place were the following:

- The Thief
- Quality Hotel Riverstation
- Quality Hotel Airport Stavanger
- Clarion Trondheim
- Clarion Gardermoen
- Clarion Collection Tollboden
- Comfort Hotel Union
- Comfort Hotel Trondheim

Breakfast buffet experiment

The breakfast experiment, on a high level, is aimed at investigating the **effect of messaging on food waste** at the breakfast buffets of the hotels above-mentioned. Messaging, as it was explained in Chapter 2, was either 'positive' or 'provocative'. More specifically, the hotel guests encountered one of the following scenarios:

- No message was displayed
- A 'positive' message was displayed
- A 'provocative' message was displayed

By weighting the waste at the breakfast buffet, the objective of this study was to understand if messaging reduced waste and by how much. Previous research conducted by Strawberry (formerly Nordic Choice) indicated that messages can cut waste by a fifth (Kallbekken and Sælen 2013). Nevertheless, the number of hotels that participated in the previous experiment was much higher (52 in total). The treatment involved displaying a sign at the buffet encouraging guests to help themselves more than once. Therefore, it is more relatable with the positive message category of the current study and not the provocative one.

The initial plan had only two groups: positive and provocative messaging. However, as time progressed, it became evident that a third group (no message) would add valuable insights as a control group. Therefore, each hotel rotated through the three display options for the duration of the experiment.

Unfortunately, due to noise, miscommunication, and logistical constraints, hotels sometimes switched between the options too early or too late. As can be seen in **Figure 47**, there were instances (during early June and August) where some hotels that were supposed to remove the messaging did not do so. Additionally, there are some periods with missing data points for two of the hotels, Gardermoen and Trondheim. Nevertheless, the final dataset contains 1,428 valid observations in total.

Figure 47 Message display per hotel over time
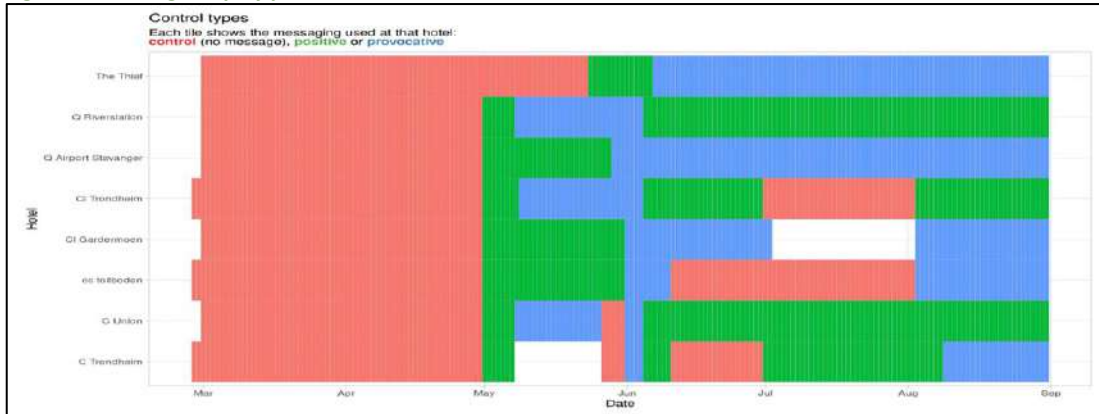
While the total **number of guests** is known, the count of buffet attendees remains uncertain. Since in Norway these buffets are open for all guests and they are free of charge, it was assumed that most of the guests would visit them. Moreover, it is worth noting that hotels typically have more activity during summers months, which is when the experiment took place. To account for this potential bias, later in the analysis we are controlling for guest counts, months, and weekends.

This case study stands out as the only one where the food waste levels are quantitatively measured through a meticulously designed experiment, and not self-reported by the individuals. As a result, the analytical focus for this case study is more on the aspects of the food waste levels and the factors that attribute to these levels, and less on the behavioural and social norms aspects that we delve into with other case studies.

The number of guests per hotel are presented in **Figure 48**. The hotels with the highest variance are the two Clarions (Gardermoen and Trondheim), the same ones for which we reported the missing values above.

Figure 48 Number of guests per hotel over time for breakfast experiment
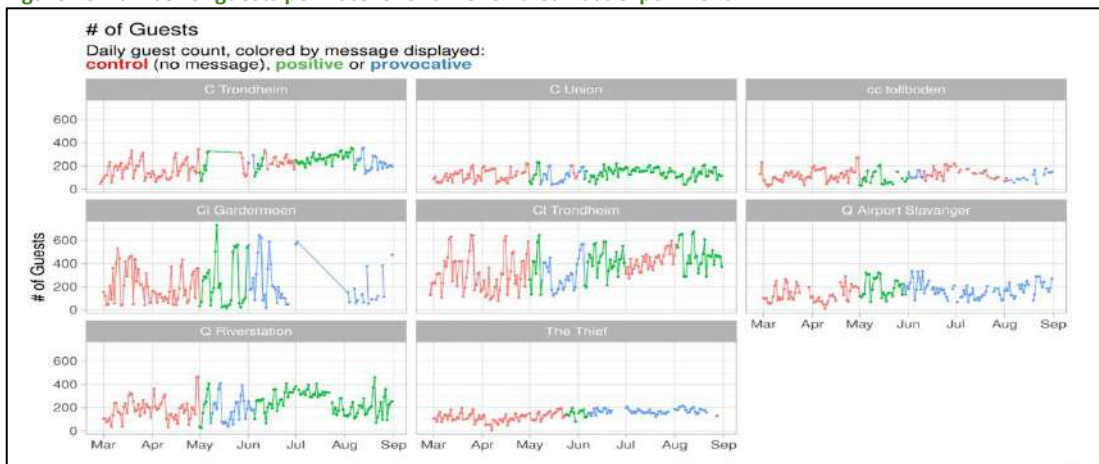
Lunch experiment

The objective of the lunch experiment was to investigate the **effect of servicing form on food waste** by weighting the food waste on three hotels: Clarion Trondheim, Comfort Hotel Runway and Quality Hotel Riverstation.

The raw dataset consisted of 62 data points but after cleaning for missing data, there are 53 valid observations between April and August 2023. The number of guests that have lunch at the hotels

present a significant daily variability, but overall, the number tends to be higher when they are self-served from the buffet (**Figure 49**). On a particular day in April there was an unusual spike of more than 1,000 guests in Cl Trondheim, but other than that, the unpredictability is similar across the different hotels.

Figure 49 Number of guests per hotel over time for lunch experiment
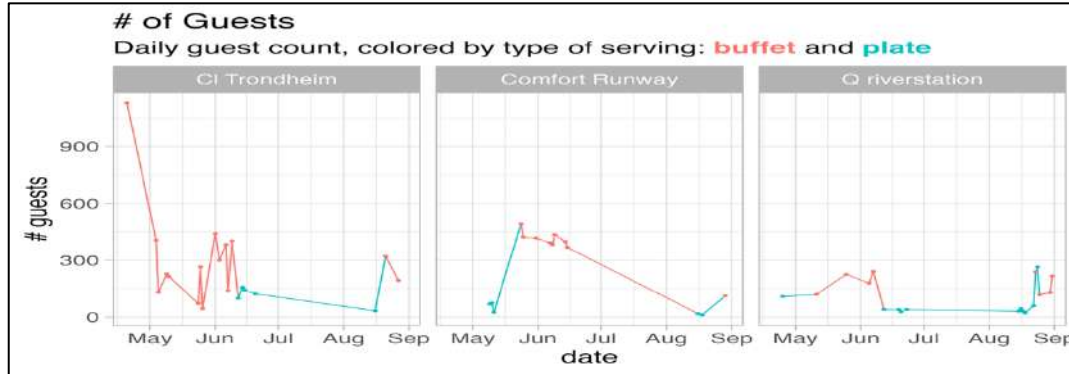
Breakfast communication survey

Staff impressions could share additional insights to the interpretation of food waste weighting for the breakfast experiment, which was achieved with eSmiley. Consequently, hotel staff were asked to observe the behaviour of hotel guests during breakfast for the day that they were surveyed. There were 35 responses in total, spanning from March 2023 to December 2023, but the majority of them are concentrated between May and August (30 out of 35). The survey took place in 8 different hotels and as it can be seen in **Figure 50**, the responses are evenly distributed across the hotels.

Figure 50 Proportion of hotel staff participants by hotel
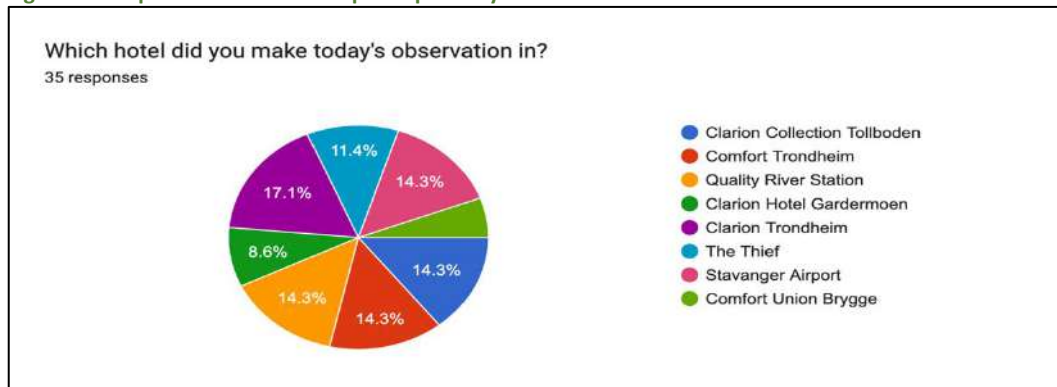
4.2.2 Food waste measurement

Descriptive Statistics and Correlation Analysis

Breakfast Buffet Experiment

The unit of measurement for food waste was grams per day per hotel location. One important detail of the experiment is that food waste is weighted collectively from the **breakfast tables** but not from the buffet itself. The value per guest was calculated by dividing the grams of total waste by the number of guests that were allowed to have breakfast that day, while the guest count information was obtained from hotel management.

According to the survey conducted among hotel staff, the majority of food waste during breakfast originates primarily from **bread**, as reported by 26 out of 35 respondents. This is followed by **eggs**, identified by 22 out of 25 respondents and **fruits**, which was identified by 16 out of 35 respondents.

The waste per guest and per hotel location is depicted in **Figure 51**. The variance of the measured value is mostly concentrated in a few key periods:

- For the 'Union' hotel in May, when it switched to provocative messaging.
- For the 'Tollboden' hotel in May, when it switched to positive messaging.
- For the 'Thief' hotel in July, during the display of the provocative messaging.
- For the 'Gardermoen' hotel in August, after coming back from the period that it was not reporting data and resumed its provocative messaging.

Figure 51 Food waste per guest (in grams) per hotel over time for breakfast experiment
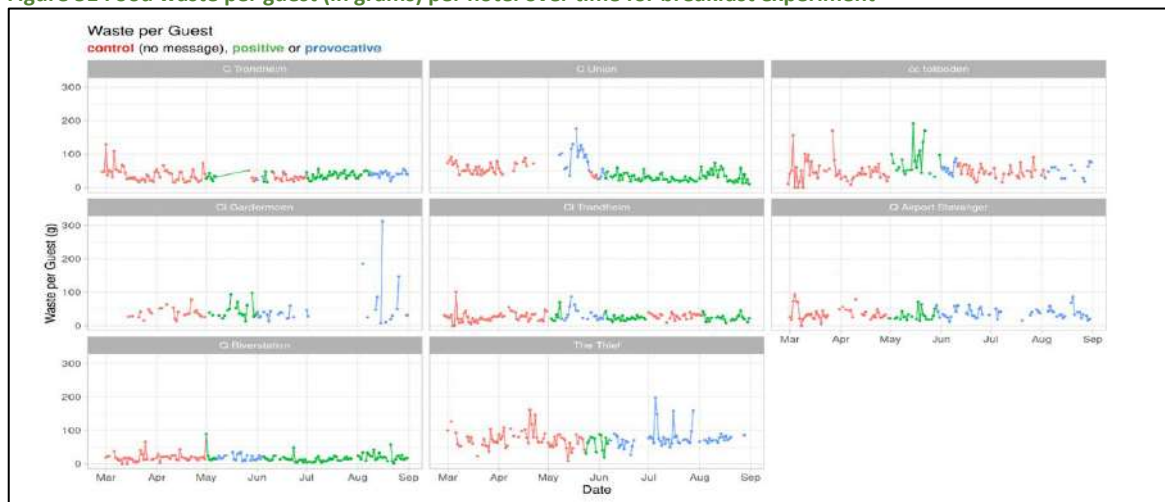
The occurrence of abrupt increases in waste remains a point of perplexity. Consider Gardermoen as an example; on a particular day in August there was an unusual spike of 300g of waste per guest. Overall, the data from Gardermoen exhibit a higher degree of **unpredictability.**

Figure 51 shows that on average, each guest wastes about 40g for their breakfast buffet. The average and standard deviation for each of the three groups is presented in **Table 6**. While the control group (no message) is closer to the overall average, positive messages seem to lead to less waste per guest (31.85g), while provocative messages seem to lead to more waste per guest (51.76g). It is important here to be cautious when interpreting these raw figures, as they entail a substantial degree of variability. Employing a basic t-test is insufficient in this context, considering the potential influence of factors such as month, hotel type, or guest count. To address these confounding variables, the regression analysis applied in the following chapter, affords a more nuanced examination of the relationships at play.

Table 6Descriptive of food waste for the three groups of the experiment

	Waste per guest(g)		
Control	Average(g)	Standard Deviation	# of Observations
control	41.20	25.52	633
positive	31.85	22.84	409
provocative	51.76	35.58	386

Lunch Experiment

The unit of measurement for food waste was grams per day per hotel location. One important detail of the experiment is that food waste is weighted collectively from the **breakfast tables** but not from the buffet itself, in a similar manner to the breakfast experiment.

The waste per guest and per hotel location is depicted in **Figure 52**. The depicted values exhibit considerable diversity from 5g to 204g. At first glance, there appears to be no significant differentiation between the two servicing forms.

Figure 52 Food waste per guest (in grams) per hotel over time for lunch experiment
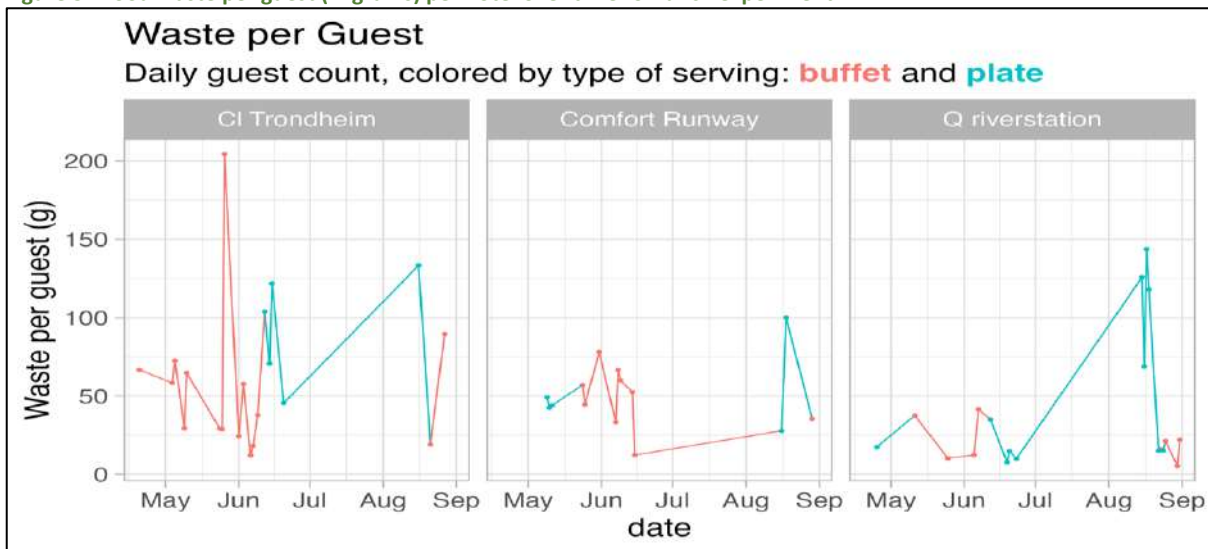
The boxplots in **Figure 53** compare waste per guest when the type of service is plated and when it is self-serving buffet. It is observed that the waste from buffet service presents a lower mean, median and variance compared to waste generated when food is served on plates.

Figure 53 Food waste per guest (in grams) for different types of service
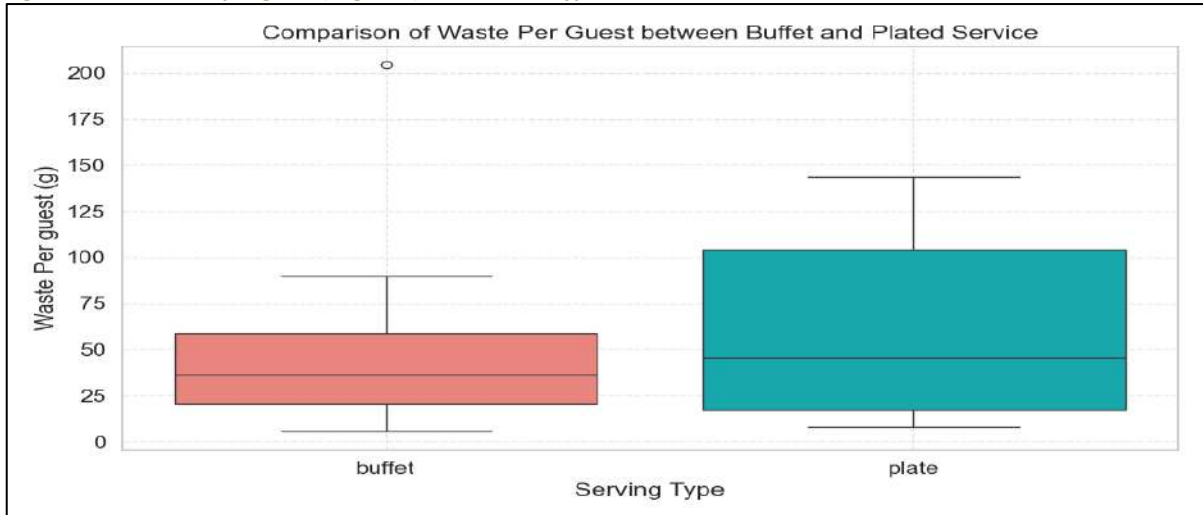
When examining waste per guest broken down by the hotels participating in the experiment (**Figure 54**), the increased waste for plated service becomes more pronounced for Cl Trondheim. On the other hand, in Quality Riverstation the median waste for plated service is lower compared to days that food was served in the buffet but mean and variance are still higher for the plated service.

Figure 54 Food waste per guest (in grams) for different types of service and different hotels
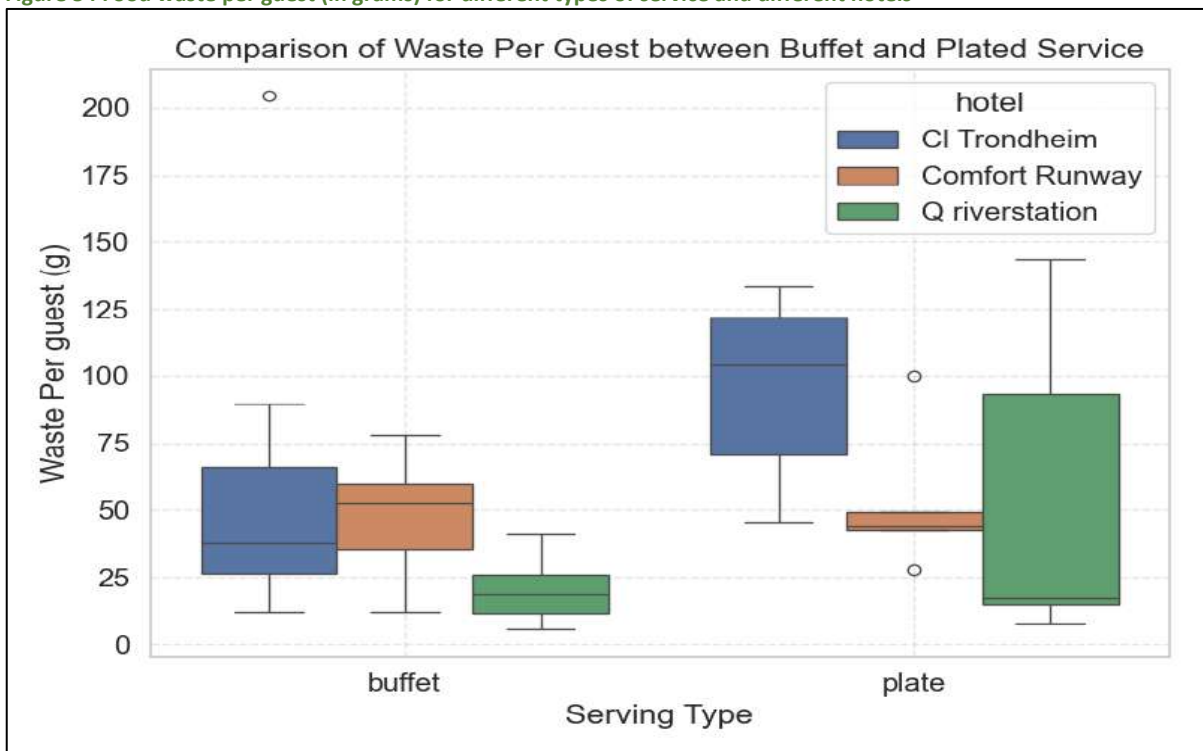
Shifting from the individual-level waste to the total waste generated in the different hotels, it is demonstrated that the average daily waste is higher for Cl Trondheim, followed by Comfort Runway, while Quality Riverstation reported less than half food waste compared to Cl Trondheim (**Figure 55**). Interestingly, the waste composition differs, and Quality Riverstone is the only hotel where the weighted waste from plates is higher compared to the waste generated from the service/buffet.

Figure 55 Average Daily Food Waste (in kg) and its composition for different hotels
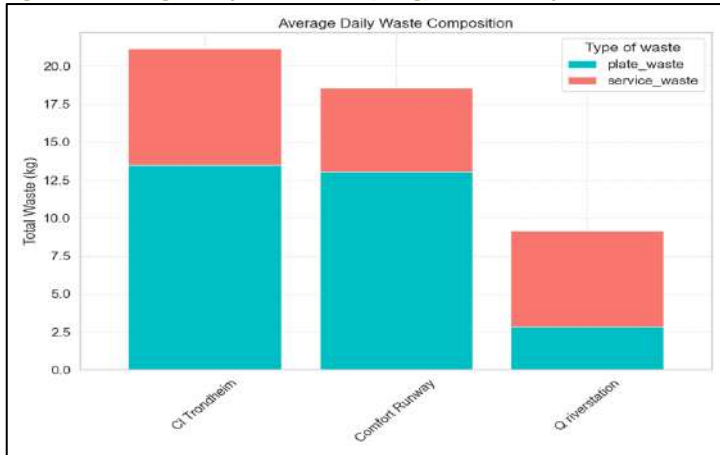
Finally, there was an additional measurement for Quality Riverstation, analysing waste per guest inclusive of service-generated waste. When isolating data from this hotel and comparing waste per guest with and without service waste, an interesting pattern emerges (**Figure 56**). While a relatively linear relationship is observed on days when the service type is plated, this trend does not hold for days that guests self-serve from the buffet. It suggests that solely weighting plate waste in buffet scenarios likely results in under-reporting, prompting a cautious interpretation of previous results. Nonetheless, these findings underscore the potential impact of service format on food waste management within hospitality settings. They also emphasize the importance of further and more extensive data collection to better understand and address the complexities of this problem.

Figure 56 Scatterplot of food waste inclusive and not inclusive of service-generated waste by daily serving format
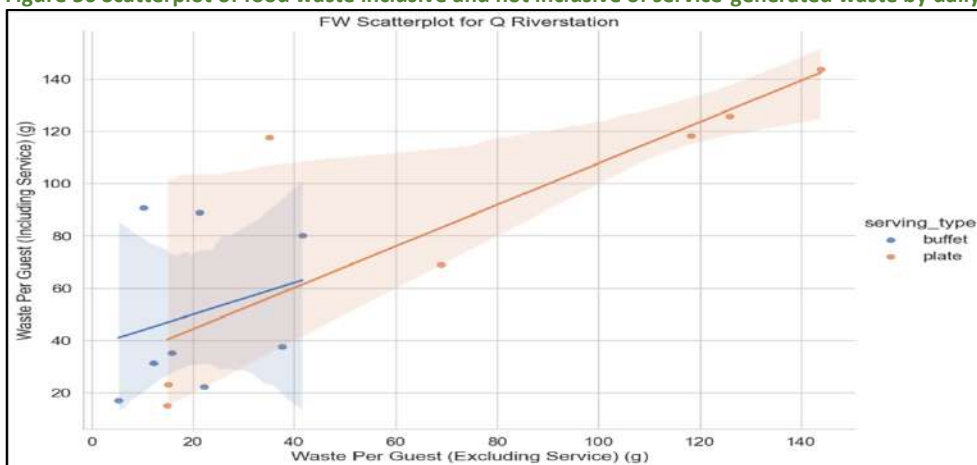
4.2.3   FW-related behaviour

<u>Qualitative analysis</u>

For the interviews with chefs, 3 with formal and 6 without formal education were selected with non-probability sampling, and an in-depth interview protocol was followed. The main variables of interest were food preparation routines, planning, and formal education.

Motivation

The Chefs' motivations and responses to social norms regarding food waste reduction vary, reflecting both **personal convictions** and **external influences**. One of the respondents acknowledged

being influenced by societal awareness, media coverage, and workplace initiatives, demonstrating a strong personal commitment to minimizing waste, even in small actions like cutting ginger. Another speaker emphasized the personal responsibility of reducing food waste, driven by the conviction that wasting food is detrimental, especially when it could have been served to guests. They also recognized the influence of expectations from management and colleagues. In another interview, the chef highlighted the importance of informing people about food waste, noting both positive and dissenting opinions among guests. They considered reducing food waste very important and felt influenced by societal expectations and workplace culture. One chef believed that reducing food waste was significant for many individuals in Norway, acknowledging positive and indifferent reactions to waste reduction initiatives. They emphasized the personal importance of waste reduction and felt influenced by societal expectations and workplace culture. One of the chefs personally considered it very important to limit food waste and felt influenced by societal expectations, as well as by colleagues and management. Another chef demonstrated a commitment to minimizing food waste instilled from childhood, influenced by personal and societal values. They emphasized intervening if they saw excessive waste among co-workers. Some chefs expressed a commitment to limiting food waste but scepticism about specific practices. They believed the hotel is already doing its best in waste reduction and are hesitant to discuss potential improvements, citing concerns about politeness and confidentiality. One chef specifically highlighted the importance of limiting food waste due to economic and environmental impacts and acknowledged the influence of co-workers' actions in food waste reduction efforts. Meanwhile another chef emphasized the need for more education regarding food waste reduction and expressed uncertainty about colleagues' desires to take more action in waste reduction. They did not believe invisible food waste would significantly change behaviour. Overall, the interviewees' motivations stem from personal convictions, societal expectations, workplace culture, and the influence of colleagues and management. While some expressed solid personal commitments to waste reduction, others demonstrated **varying scepticism** and uncertainty, highlighting the complexity of addressing food waste at individual and organizational levels.

Differences:

- **Motivational Drivers:** For example, one chef was primarily influenced by societal awareness and workplace initiatives, while another's motivation stemmed from personal and societal values instilled from childhood.
- **Response to Social Norms:** One chef emphasized personal responsibility and the influence of management and colleagues, whereas another expressed scepticism about specific practices and was hesitant to discuss potential improvements due to concerns about politeness and confidentiality.
- **Perception of Workplace Efforts:** One chef highlighted positive and dissenting opinions among guests regarding food waste reduction. Another interviewee acknowledged the influence of co-workers' actions but expressed scepticism about guests' acceptance of certain waste reduction practices.

Similarities:

- **Personal Commitment:** Many of the interviewees demonstrated a solid commitment to minimizing food waste driven by personal values or convictions.
- **Influence of Societal Expectations:** Several interviewees acknowledged being influenced by societal expectations regarding food waste reduction.
- **Impact of Workplace Culture:** Two interviewees felt influenced by colleagues and management in their approach to food waste reduction, highlighting the importance of workplace culture in shaping behaviour.

Abilities

When comparing the chefs' backgrounds, practices, level of ability, and food literacy in minimizing food waste, several similarities and differences emerged. Chefs employed **various strategies to minimize waste**, such as careful storage management, evaluating leftovers for usability, and incorporating leftovers into meal planning. Many emphasized the significance of proper **labelling, organization**, and **rotation of items** in storage to prevent waste. There was a common theme of **practical experience** playing a significant role in shaping their approach to reducing food waste, with **formal education** in culinary arts only sometimes directly addressing this issue.

The interviewed chefs varied in their formal culinary education, with some having received formal training as chefs, while others lack formal training (see **Table 7** for details). Some interviewees had taken specific courses or received education on food waste prevention, while others had learned primarily through practical experience. While all speakers employed routines to minimize food waste, the specific practices varied, such as repurposing leftovers for cocktails, making last-minute menu changes, or utilizing staff meals to reduce waste. Chefs differed in their level of involvement in meal planning and procurement, with some actively participating in menu development, while others had limited involvement.

The main conclusion is that chefs **with formal culinary education and training** demonstrated a more comprehensive understanding of food waste reduction strategies and may exhibit higher levels of food literacy. Those with primarily practical experience may have a more hands-on approach to minimizing food waste but may benefit from further education and training on best practices.

Table 7 Data at the individual level

R.	Gender	Age	Role	Years of exp.	Training/ education	Motivation (personal)	Opportun ities	Abilities
1	F	21	Chef	4	Formal training, Vocational certificate	High	Moderate	High
2	M	34	Sous-chef	19	Formal training, Vocational certificate	High	Low	High
3	M	35	Chef	9	No formal education	Moderate	High	Moderate
4	F	38	Chef	5	No formal education	Moderate	High	Moderate
5	F	36	Sous-chef	6	No formal education	High	Low	Moderate
6	M	38	Chef	20+	Formal training, Vocational certificate	High	High	High
7	M	40	Chef	15	No formal education	Moderate	High	Moderate
8	F	40	Chef	1,5	No formal education	Moderate	High	Moderate
9	M	50	Chef	1	No formal education	Moderate	Moderate	Moderate

Opportunities

Chefs' opportunities to minimize food waste and storage facilities varied among the respondents.

- **Involvement in Decision-Making:** Several of the chefs (5) were actively involved in decision-making processes related to food procurement and ordering, whereas 2 chefs had less direct involvement.

- **Challenges with Storage Facilities:** Three of the respondents faced challenges with storage facilities, such as malfunctioning freezers, small fridge space, and limitations with fridges and freezers. In contrast, 5 interviewees expressed their satisfaction with or confirmed the adequacy of storage facilities.
- **Approach to Utilizing Leftovers:** While all speakers acknowledged the importance of utilizing leftovers, several of them (4) actively incorporated leftovers into meal planning and staff meals. One interviewee emphasized the systematic storage of leftovers. Four of the respondents discussed using leftovers but did not emphasize active incorporation into meal planning to the same extent.

While there were differences in the level of involvement and challenges faced, there was a shared commitment among the chefs to minimize food waste and optimize food management practices.

R1: Acknowledged the potential for better decision-making during planning and production to reduce waste, mainly through utilizing leftovers. However, more storage facilities are needed.
R2: Faced challenges with small storage space and a need for refrigeration, contributing to potential waste issues. Emphasized the importance of better decision-making authority in planning and production.
R3: Highlighted the need for more control and experience in estimating guest numbers and food types to reduce waste in ordering; is actively categorizing and utilizing leftovers, particularly for staff meals.
R4: Believed that more involvement in planning purchases could lead to less food wastage. Emphasized the importance of checking food before use and systematically storing leftovers.
R5: Emphasized the need for careful control over ordering, guest numbers, and existing inventory to reduce waste; is actively involved in minimizing waste during preparation and utilizing leftovers, focusing on communication and collaboration.
R6: Prioritized using items before expiration dates and efficiently managing storage to minimize waste. Actively used leftovers for staff meals and expressed comfort in using items after their best-before dates based on experience.
R7: Actively minimized waste and utilized ingredients effectively. Expressed confidence in storage facilities and procedures but acknowledged the occasional need for discarding food, especially in a large hotel setting.
R8 Did not directly affect food purchasing decisions but confirmed the adequacy of storage facilities. Prioritized proper storage and rotation to minimize waste.
R9: Faced challenges with suppliers sometimes being sold out of items ordered, leading to potential waste. Actively planned and ordered food to minimize waste and efficiently manage leftovers.

Chefs demonstrated various approaches to minimizing food waste and managing storage facilities; challenges like inadequate storage space and lack of refrigeration were common themes. Chefs, also employ strategies like using older items first, utilizing the whole food, and avoiding over-preparation. Some chefs, especially those without formal education, mention giving leftovers to the staff cantina as a prevalent strategy. Communication and control over ordering are highlighted as crucial to reducing food waste. Chefs consider the expected number of guests when ordering food. Those with formal education emphasize checking existing stock to avoid double orders.

Chefs aim to produce only what is necessary to minimize waste. Repurposing leftovers and avoiding overproduction are common strategies. Chefs are confident in assessing leftover usability but express uncertainty in menu planning with leftovers, especially among those without formal education. Economic and environmental reasons motivate chefs to reuse leftovers, with some also mentioning ethical concerns. Chefs are unsure how guests perceive food waste reduction efforts and express concerns about using leftovers in dishes.

Several key factors influenced food handling practices among chefs. **Education and experience** played a significant role, as preliminary findings indicated their impact on food procurement, planning, preparation, storage, and leftover usage. Cooks without formal education may lack the necessary insight into safe food handling practices, potentially leading to increased food waste.

Regarding **labelling,** particularly the "Best Before Date," chefs relied on **their discretion** as no established guidelines or policies govern its usage. This discretion stems from a concern over guests' reactions if they discover the use of items past their best-before dates, highlighting a balance between practicality and guest perception.

In summary:

- Chefs' motivations for reducing food waste vary based on **personal convictions** and **external influences.**
- Societal awareness, media coverage, workplace initiatives, personal responsibility, and **societal expectations** all play a role in motivating chefs to minimize waste.
- Some chefs express solid personal commitments to waste reduction, while others demonstrate **scepticism or uncertainty**.
- Workplace culture and expectations from **management** and **colleagues** also influence chefs' motivations and actions regarding waste reduction.

Descriptive statistics and correlation analysis

This section is not applicable for CS 2 because behavioural and attitudinal data for consumers in hospitality were not collected.

4.2.4   Social norms

Qualitative analysis

In a broad sense, it was observed that cooks have a strong **quality-oriented focus** when it came to serving food. Due to the focus on quality at the hotels, it was essential to ensure good food quality, but it can sometimes lead to unnecessary food waste. Only the best is good enough for the guests. Food that is **suboptimal** for guests is acceptable to serve for themselves and the staff. Chefs prioritize the quality of food for their guests higher than they do for themselves and their colleagues in this context. This was also the case for leftover food. Chefs wondered about what guests would think about using leftovers or food close to/past its expiration date. On the other hand, they did not hesitate to use leftovers and lower-quality food for themselves or staff in the canteen.

There may be a permissive norm regarding flexibility in how food leftovers and surplus food are handled. This gives chefs a certain degree of freedom to be creative and resourceful in their approach to food waste. There is an implicit injunctive norm regarding the importance of efficiency and quality control in kitchen work. This can be seen in the use of FIFO (First In First Out) and other routines for order and cleanliness. These indirectly contribute to reducing food waste, which is desirable in professional kitchen environments. Practices like FIFO can be considered injunctive norms as they prescribe a specific way to handle food storage to maximize freshness and reduce waste. A permissive norm allowing flexibility in handling leftovers coexists with an injunctive norm emphasizing efficiency and quality control, both contributing to waste reduction efforts. Additionally, cultural backgrounds shape attitudes

towards food waste, with certification possibly instilling injunctive norms aimed at waste reduction. Based on the interviews, here are the similarities and differences regarding the influence of social norms on chefs' practices.

Similarities:

- **Influence from Colleagues:** All speakers mentioned being influenced by their colleagues' attitudes and practices regarding food waste reduction.
- **Lack of Influence from Society:** The majority of (7) speakers stated that societal expectations do not heavily influence their practices regarding food waste reduction.

Differences:

- **Influence from Management:** While some speakers (5) felt influenced by management, others (2) did not perceive a significant influence.
- **Perception of Guests' Reaction to Leftovers and Expired Food:** There were varying opinions on how guests perceive the use of leftovers and food past its best-before date. Some speakers (3) believed guests would be accepting while others (5) anticipated scepticism or dissatisfaction.

Overall, while there is a consensus among chefs regarding the importance of reducing food waste and the influence of colleagues, there are divergent views on the influence from management, guests' reactions to food waste reduction efforts, guests' awareness, and the potential impact of invisible food waste on behaviour.

Descriptive statistics and correlation analysis

This section is not applicable for CS 2.

4.2.5   Gender and intersectional differences

This case study did not identify any relevant gender or cross-sectional differences.

4.3   Case Study 3: Food services sector in Slovenia – restaurants

The following points offer a concise **summary of the main findings**:

- A majority of respondents, regardless of gender, tend to **leave some food as leftovers**, with 84.7% leaving less than a quarter of the plate and 28.7% leaving no leftovers at all.

- Lower income brackets correlate with reduced frequency of dining out, reflecting potential **financial constraints impacting dining habits**.

- **Taste and appearance of food, food options, and portion sizes** are crucial factors for most respondents.

- Men prioritize receiving **larger portion sizes**, while women prioritize **seasonal menu changes**.

- A significant portion of participants is **receptive to pre-ordering meals** to reduce food waste, particularly if it's a requirement for table reservation.

- Males exhibit a greater tendency to **struggle with over-eating** when indulging in preferred foods.

- Of the respondents, 49.7% acknowledge a connection between their dietary aspirations and portion control, revealing a significant proportion who consciously refrain from **finishing what is on their plate when actively pursuing a healthier lifestyle**.

- A significant majority of respondents would take leftovers home, even if they had to **pay for the container**.

- A substantial majority of respondents prioritize the **ethical and environmental aspect** of not wasting food as the most important factor in deciding to bring leftovers home.

- Overall, the **solo dining situation** does not significantly impact the respondents' ordering decisions. Females may be more likely to **leave food uneaten when dining with company**, compared to men.

4.3.1   Overview of data demographics

In this section, we present an overview of the demographics of our survey participants and outline the methodology adopted for our analysis. The survey conducted in 2023 among a diverse cohort of participants, aimed to capture a comprehensive understanding of the food waste patterns, and the motives and social norms that influence these patterns for the consumers in the food service industry.

The sample of case study 3 is evenly split between male (50.9%) and female (49.1%) respondents, indicating **a balanced representation of gender in the study.** The age distribution is presented in **Figure 57** via the year of birth of the respondents. As it is observed in the graph, a small but notable percentage represents the older generation (1936 - 1949), a significant proportion represents the middle-aged demographics (1950 - 1979), the largest segment falls into the 1980 - 1989 birth group, indicating a concentration in the younger to middle-aged population, and finally a 22.3% of the sample is represented by young respondents (1990-2005), showcasing a diverse age range within the study.

The highest level of education completed of the sample is depicted in **Figure 58**. According to the distribution, a very small percentage reports no formal education, suggesting a **generally educated sample**. A notable portion completed only primary education, while the majority holds at least secondary education. A significant percentage has pursued higher education, with both undergraduate and postgraduate qualifications well-represented and a small fraction falls into other education categories, showcasing diversity in educational backgrounds.

Figure 59 shows the family income per month in Euros. It can be seen that the minority falls within the lower income bracket, while the majority falls within a **moderate-income range**, indicating a middle-income sample. Smaller but significant portions represent higher income categories and only 0.4% of the respondents report very high-income levels.

Figure 57 Year of birth bands histogram
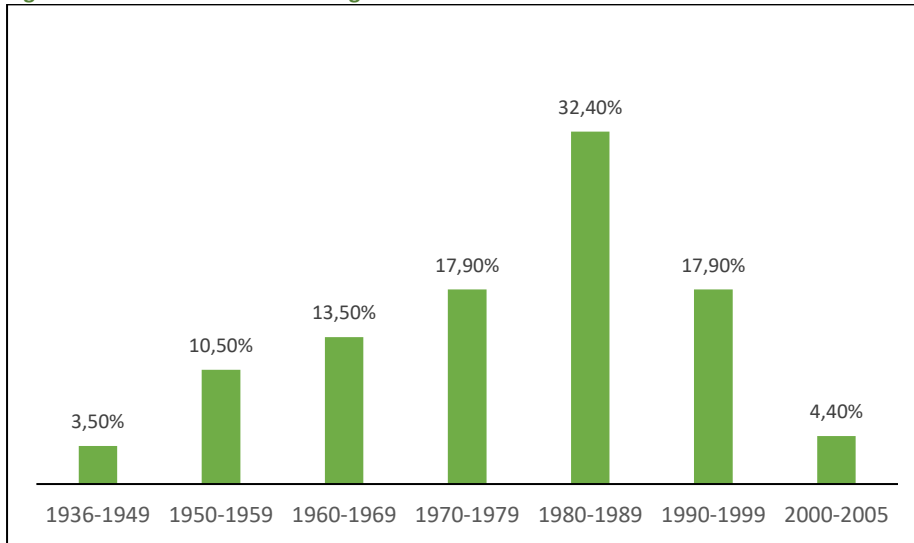
Figure 58 Highest level of education histogram
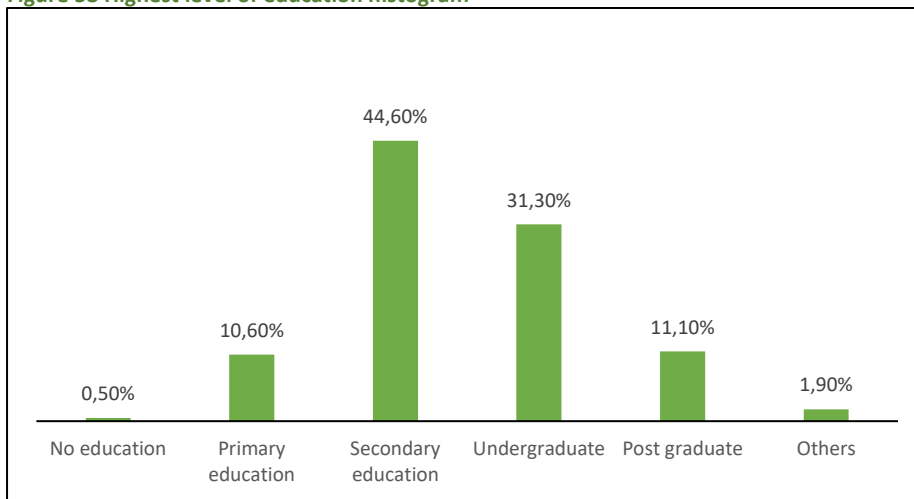
Figure 59 Family income per month (in €) histogram
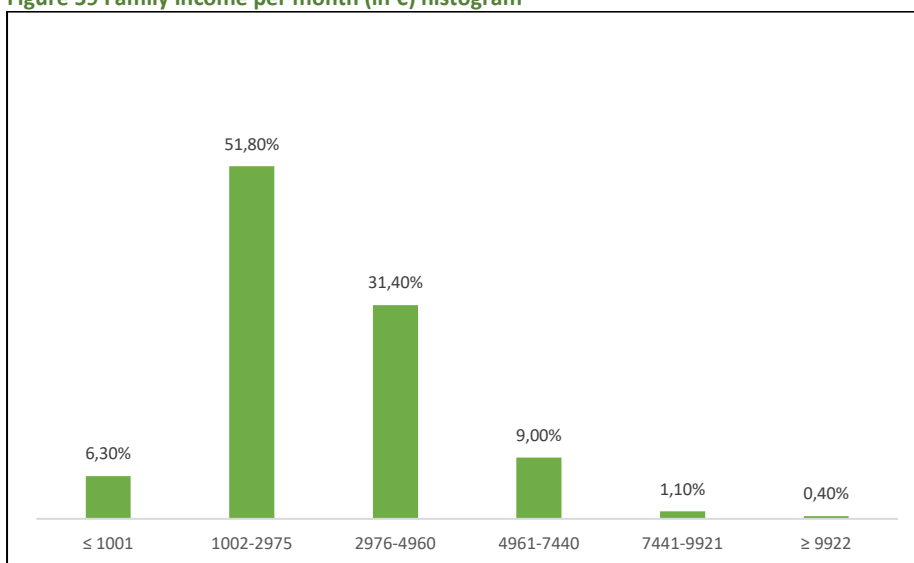
The **methodology** employed in our case study involved a **multifaceted approach to data analysis.** For the quantitative analysis, Statistical Package for the Social Sciences (SPSS) was utilized as the primary tool. The examination of variables under scrutiny was conducted through the creation of frequency graphs, providing a visual representation of the distribution patterns. To delve deeper into potential gender or intersectional variations, crosstabulation were employed, facilitating a comprehensive exploration of relationships within the dataset. Furthermore, correlation coefficients were calculated to identify any potential correlations between specific variables.

The main sources of household income for the respondents are highlighted in **Figure 60**. The **majority relies on employment income**, indicating a **workforce-centric demographic**. A small percentage is engaged in self-employment, a distinct but modest group derives income from agricultural activities, a significant portion relies on pension income and some respondents receive social benefits, reflecting economic diversity. Finally, a smaller group generates income from investments or property ownership and a diverse set of respondents derives income from various sources beyond the afore-mentioned categories.

Figure 60 Main source of household income histogram
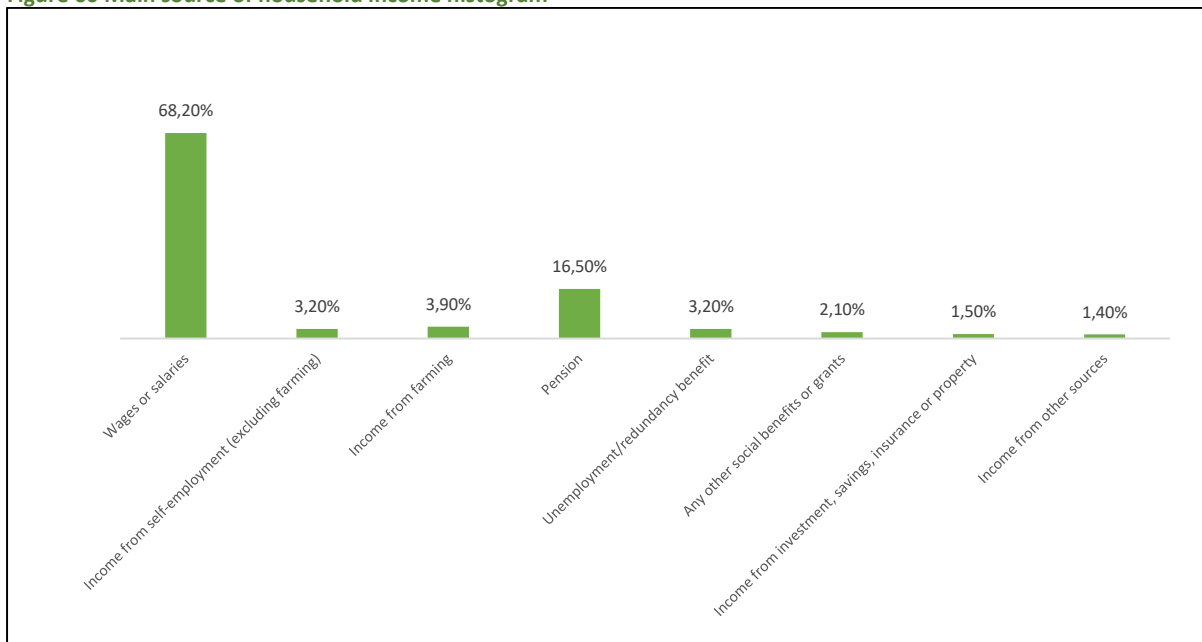
Figure 61 showcases the distribution of household sizes. A notable percentage of respondents belong to single-person households, while the **largest segment falls into two-member households.** Three and four-member households are also prevalent, a smaller but significant proportion resides in five-member households and larger households with six or more members are less common in the sample.

Figure 61 Number of household members histogram
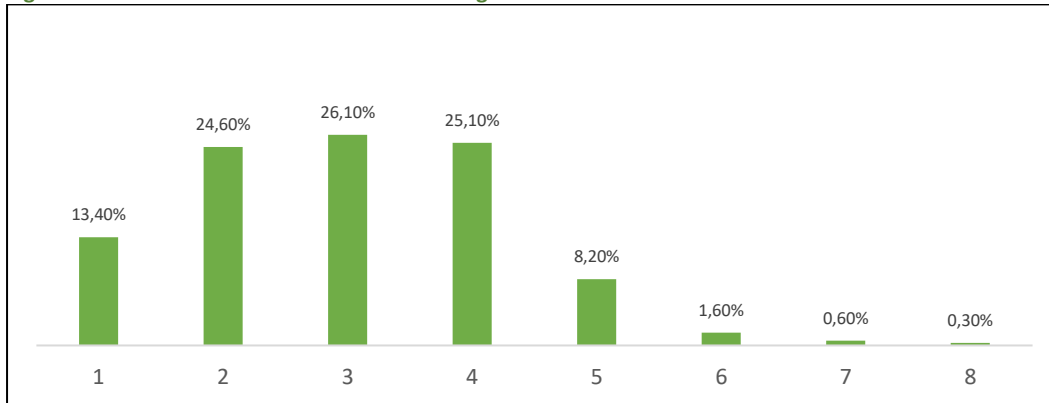
The **methodology** employed in our case study involved a **multifaceted approach to data analysis.** For the quantitative analysis, Statistical Package for the Social Sciences (SPSS) was utilized as the primary tool. The examination of variables under scrutiny was conducted through the creation of frequency graphs, providing a visual representation of the distribution patterns. To delve deeper into potential gender or intersectional variations, crosstabulation were employed, facilitating a comprehensive exploration of relationships within the dataset. Furthermore, correlation coefficients were calculated to identify any potential correlations between specific variables.

There are 5 main topics in the survey:

- Food Waste Amount
- Pre-ordering behaviour
- Portion Size Perceptions
- Motives for (Not) Finishing Meals
- Leftover Decisions

4.3.2   Food waste measurement

Descriptive Statistics and Correlation Analysis

The majority of respondents, regardless of gender, tend to leave some amount of food as leftovers, as evidenced by the percentages within each category. A significant proportion, 84.7% of all respondents, leave less than a quarter of the plate as leftovers, among which, 28.70% of the respondents leave none of their food as leftovers.

The data from In-depth interviews with restaurants managers reveals some variability in daily meal counts, with an overall average falling within the range of 200 to 300 meals per day. Some restaurants consistently mention figures around the 300-meal mark. However, there are notable deviations in the form of outliers. Some restaurants report a notably higher count of 500 meals, while others register a lower range of 80 to 100 meals. Meanwhile interviews with restaurant suppliers, indicates figures ranging from approximately 300-400 tonnes per year to a notable 2% of the produced quantity. It is important to keep in mind that this data primarily consists of qualitative insights, largely based on the perceptions of restaurant managers and suppliers. These insights involve estimations or rough figures provided during interviews.

4.3.3   FW-related behaviour

<u>Qualitative Analysis</u>

The case study carried out in-depth interviews with 5 restaurant suppliers and 14 restaurant managers. The suppliers were chosen based on the participating restaurants and the response rate was 100%. Gender and business size were among the main variables of interest.

Food waste impact according to restaurant managers

The data from In-depth interviews with restaurant managers reveals some variability in daily meal counts, with an overall average falling within the range of 200 to 300 meals per day. Some restaurants consistently mention figures around the 300-meal mark. However, there are notable deviations in the form of outliers. Some restaurants report a notably higher count of 500 meals, while others register a lower range of 80 to 100 meals.

Food waste in restaurants is a multifaceted issue, as highlighted by various restaurant managers. One significant source of waste identified by most restaurant managers is the **self-service buffet.** Here, according to the perception of managers, consumers tend to fill their plates with a variety of items, overloading their plates and leading to leftovers from plates that cannot be reused. Food remaining at such a self-service buffet contributes to food waste in restaurants. Restaurants often face the challenge of accurately predicting and planning for consumption. Surplus food, if it complies with **HACCP norms**, is repurposed for subsequent meals, such as being incorporated into the next day's offerings or used as appetizer ingredients. Some surplus food generated from overproduction is also repurposed on the same day to make lunch for employees.

The **inability to reheat or reuse certain foods** further exacerbates the problem, mainly when there is excess preparation. Although the wasted food in restaurant settings appears to be diverse, **seafood is cited as the least reusable and most common type of discarded food.** The waste generated during food preparation, such as various peelings, eggshells, vegetable cleaning waste, and discarded fruit peels, is identified as another factor contributing to food waste. Poor-quality fruits contribute significantly to waste, suggesting that the **condition of the produce** plays a crucial role.

The consensus among managers is that the highest proportion of food waste comes from what customers leave on their plates, especially with the self-service style. Food left on customers' plates when they order a la carte from the menu is another concern for restaurant managers. This can signal either dissatisfaction with the meal or that the portion sizes need to be bigger. Some restaurants here have implemented a strategy to minimize food waste from plates by either **reducing the portion sizes** in their a la carte menu or providing **smaller plates for the self-service buffets**, which limits the amount of food consumers may load onto their plates.

Motivation of restaurant managers to address food waste

Restaurant managers generally have a negative attitude toward food waste and recognize it as an issue that needs to be addressed. They feel a sense of responsibility to reduce food waste in their establishments and believe that their values and beliefs significantly influence their approach to minimizing waste. When faced with the sight of food left on consumers' plates, managers express discomfort and see it as part of their job to raise consumer awareness about food waste. Managers also recognize the economic impact of food waste, as waste disposal and food waste collection services can be very costly for their operations. Therefore, the economic aspect is also an essential motivator for restaurant managers to minimize food waste.

Opportunities for restaurant managers to address food waste

Some material resources that aid in minimizing food waste were identified through interviews with restaurant managers. Inventory management programs, for example, help maintain optimal stock levels or specialized equipment like a device mentioned in one interview that processes food waste into organic granules. Another measure to reduce food waste, mentioned by all restaurant managers, is the opportunity to order supplies as needed. This approach allows for more frequent and smaller deliveries, which allows restaurants to have fresh ingredients without overstocking. They are enabled to do so as they are working with local suppliers. Keeping low stock also reduces the risk of overstocking perishable items like vegetables and using up their supplies before the expiry date. A few restaurants also indicated that they are able to pick up fresh produce to ensure high quality personally.

Abilities for restaurant managers to address food waste

The abilities of restaurant staff significantly impact the amount of food waste generated in a restaurant setting. Effective planning of purchases ensures that the restaurant orders supply as needed, preventing overstocking and reducing the likelihood of food expiring before it can be used. Proficiency with food preparation skills allows staff to utilize ingredients fully and creatively, turning potential waste into edible dishes. Additionally, having strict controls on food acceptance from suppliers ensures that only quality ingredients that meet specific standards are used, which can prevent waste due to spoilage. By understanding and implementing correct storage methods, the shelf life of ingredients can be extended, which minimizes spoilage and waste. Additionally, inventory management, such as rotating stock so that older items are used first, helps ensure that ingredients are used before they expire. Furthermore, efficient storage planning can reduce overstocking; by only storing what is necessary and maintaining a lean inventory, restaurants can avoid having excess ingredients that may not be used before their "use by" or "best before" dates. This knowledge of storage is part of a larger strategy of supply management, which includes having almost daily deliveries for sensitive foodstuffs like meat and dairy products, ensuring that these items are fresh, and reducing the likelihood of waste. Overall, these abilities contribute to a comprehensive approach to managing food supplies efficiently, essential for minimizing food waste in the restaurant industry.

Food waste impact according to restaurant suppliers

The staggering quantities revealed by suppliers underscore the magnitude of food waste, with figures ranging from approximately 300-400 tonnes per year to a notable 2% of the produced quantity. As a poignant reflection of responsibility, some suppliers opt for conscientious measures to mitigate waste, such as selling products on time or offering items that are losing quality at discounted prices. The commitment to a circular economy, echoed by various suppliers, is an encouraging step towards sustainability, with organic waste being repurposed into electricity, heat, or fertilizers. The overarching sentiment resonates with the need for widespread adoption of circular economy principles to curb the impact of food waste on both our environment and society.

Motivation of restaurant suppliers to address food waste

The interviewed supply managers expressed a shared concern about avoiding food waste, citing environmental and cost considerations. They emphasized the significance of minimizing waste for ecological and financial efficiency. Another perspective emerging from the interviews was the importance of the potential for alternative uses of food products. Some managers acknowledge that long-term contracts with defined quantities could contribute to more efficiently planned orders, or the communication of more specific needs from restaurants might contribute to efficient planning.

When asked what they could be doing differently or better to reduce food waste, some managers emphasized that they are already doing everything they can, and some acknowledge they could better coordinate between production and sales.

Opportunities for restaurant suppliers to address food waste

With all suppliers, the restaurants can buy just the quantity they need. Suppliers adapt the packaging to individual restaurants. Many of the interviewed suppliers indicated offering products close to expiration on sale, but they also emphasized the importance of working within the parameters of food safety, and therefore not selling products after the expiry date. Some managers acknowledged that long-term contracts with defined quantities could contribute to more efficiently planned orders, or the communication of more specific needs from restaurants might contribute to efficient planning. When asked what they could be doing differently or better to reduce food waste, some acknowledged that they could better coordinate between production and sales.

Abilities of restaurant suppliers to address food waste

Supply managers affirm that education and training, especially in sales skills, can contribute to reducing food waste. This may be more needed than training in primary production. However, some suppliers mentioned annual training for employees involved in production and processing. Also, some supply managers stressed the importance of knowing the proper storage technique to reduce food waste.

Descriptive Statistics and Correlation Analysis

In this subsection we focus on four key themes: eating out preferences and pre-ordering behaviour, portion size perceptions, motives for finishing or not finishing meals and leftover decisions. Each theme sheds light on different factors regarding food consumption and waste within a restaurant context.

Eating out preferences and pre-ordering behaviour

The data from case study 3 on how often people **eat out at restaurants** shows that people's dining habits vary significantly. A large proportion (52.6%) only eats out 1 to 2 times a month or less, indicating a moderate level of restaurant dining. About 19.0% dine out 1 to 2 times a week, reflecting a more regular restaurant presence. A smaller but still significant portion (15.7%) dine out 3 to 4 times a week, while a minority (7.4%), eat out 5 to 6 times a week. Furthermore, 5.4% of respondents dine out more than 6 times a week and have a strong preference for restaurant meals. Overall, the data illustrates a diverse range of dining behaviours, with **the majority of respondents** falling into the category of **moderate to regular restaurant dining**. As it is discussed in the next section, the frequency of dining out is affected by income, especially for the lower income individuals.

Consumers stated that the most crucial **reason when dining out (Figure 62)** is the fact that the food tastes good (with 53.2% of the surveyed describing this as "most important" and 33.6% as "important"). Following, the fact that the food must look good on the plate (with 22.9% of the surveyed describing this as "most important" and 52.2% as "important"). The variety of menu options is to 23.6% of the respondents the most important reason and to 38.9% an important one. Similarly, receiving very large portions is an important factor for 32.2% and the most important factor for 21.6% of the respondents. The fact that the menu changes seasonally or periodically seems not of such great importance as other factors, with just 23.8% marking it as the "most important" and 23.9% as "important". Overall, the data shows that while there is some variation in

preferences, the **taste of food** and the **appearance of food** are of great importance to most respondents. Additionally, the **option choices** of food and **portion sizes** also hold significant importance.

Around 35.5% of respondents either disagree or completely disagree with the statement *"I would find it acceptable to order my meal at least 1 day before going to the restaurant if this would contribute to less food waste"*, indicating they have some **reservations or doubts about the idea of ordering ahead** (**Figure 64**). The majority, 43.5% of respondents, fall into the "I partly agree" category, indicating that they are open to the idea of ordering their meals in advance to reduce food waste. However, they may have some conditions or reservations. A combined total of 21% of the participants either "totally agree" or "agree" with the idea of ordering meals in advance. A small percentage of respondents, 15%, agree with the concept, showing support for the idea of pre-ordering to reduce food waste, they may see it as a positive step and are willing to make this change. And only 6% of respondents are highly supportive of the idea, indicating a strong willingness to pre-order their meals to contribute to reducing food waste. When looking at the cumulative percentages, it's evident that the majority (64.5%) of respondents are open to some form of agreement, while a smaller proportion (35.5%) firmly disagrees with the idea. The findings suggest that a significant portion of participants is **receptive to the concept of pre-ordering meals** to reduce food waste, but a **considerable segment still has reservations or disagrees** with the idea.

Figure 65 demonstrates some possible **factors that could encourage the willingness of the respondents to order their meal in advance**. The results show that a significant portion of respondents (36.9%) would be willing to pre-order their meals if it was offered at a slightly discounted price (10% cheaper). However, the majority (63.1%) is not convinced by this discount alone, which might indicate that people value convenience or other factors more than a small price reduction. The condition of a more substantial discount (30% cheaper) is more appealing to respondents, with over half (52.5%) indicating their willingness to pre-order under these terms. This suggests that a significant price reduction can motivate more people to plan their meals in advance. A roughly equal split in responses (49.3% and 50.7%) suggests that offering a variety of different dishes when ordering ahead has potential appeal. This result implies that choice and variety in the menu are important to a substantial portion of customers, but it's not **overwhelmingly preferred over the option to order on the spot**. The condition, making it a requirement to reserve a table when ordering ahead, received strong support from 69% of respondents. It appears that many people are willing to pre-order if it guarantees them a table at the restaurant. This may be due to the added convenience and assurance it provides in securing a dining spot. The findings suggest that **price discounts are effective motivators** for pre-ordering, with a larger discount being more attractive to respondents. **Offering a variety of different dishes** when ordering ahead can also be a compelling factor for some customers, though it's not a decisive factor for everyone. **The strongest motivator for pre-ordering is making it a requirement to reserve a table**, with a significant majority of respondents in favour.

Figure 62 Importance of reasons when dining out
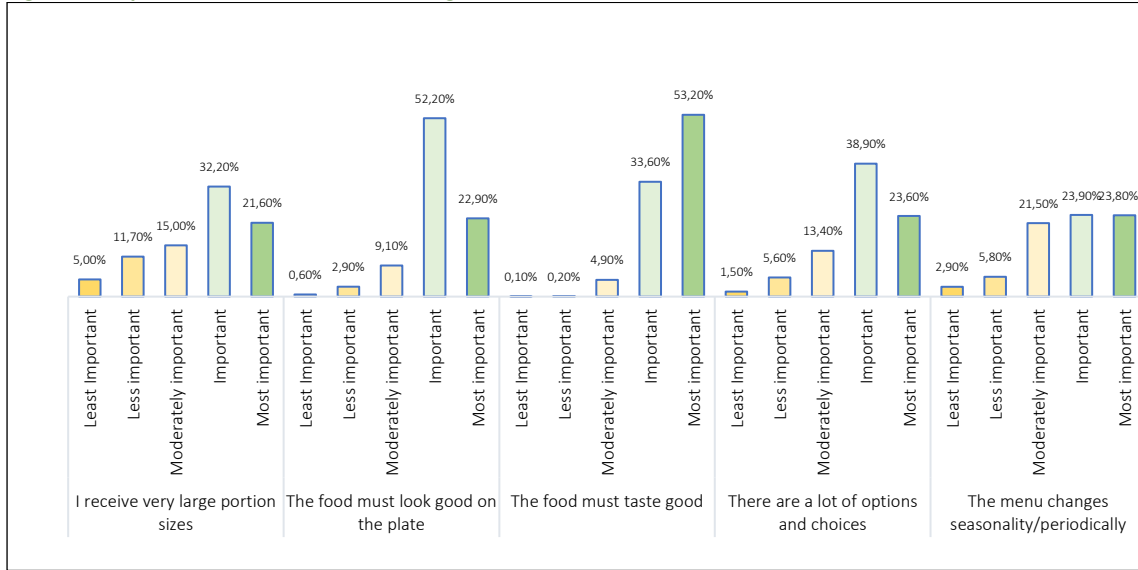
Figure 63 Reasons discouraging a return to the restaurant
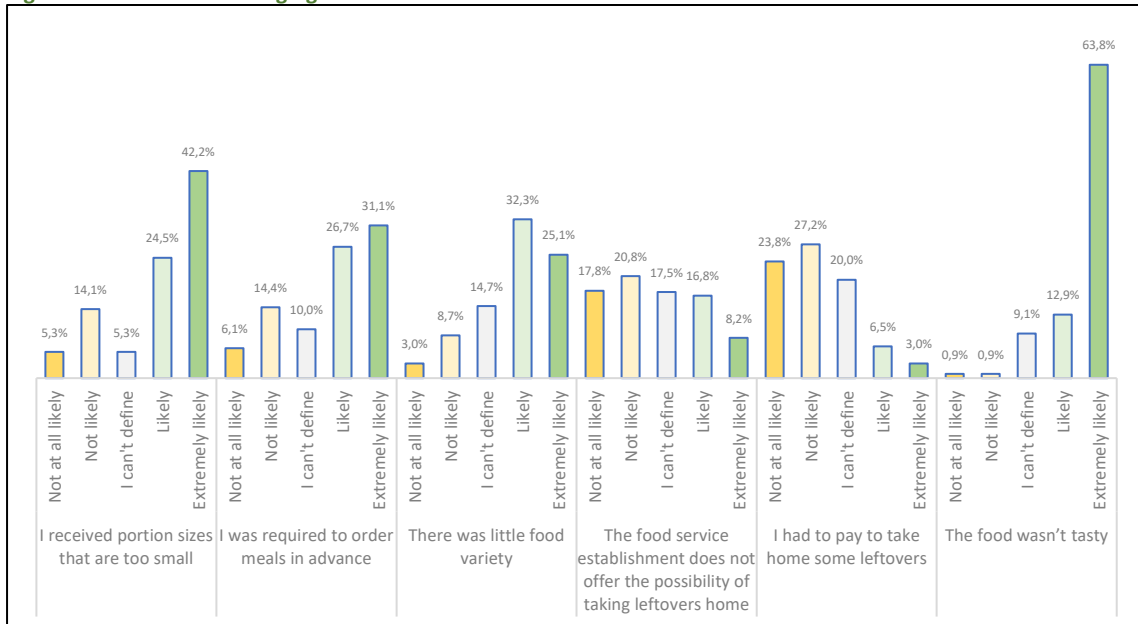
Figure 64 Ordering ahead behaviour

"I would find it acceptable to order my meal at least 1 day before going to the restaurant if this would contribute to less food waste"

18% — I disagree completely
17,5% — I disagree
43,5% — I partly agree
15% — I agree
6% — I totally agree
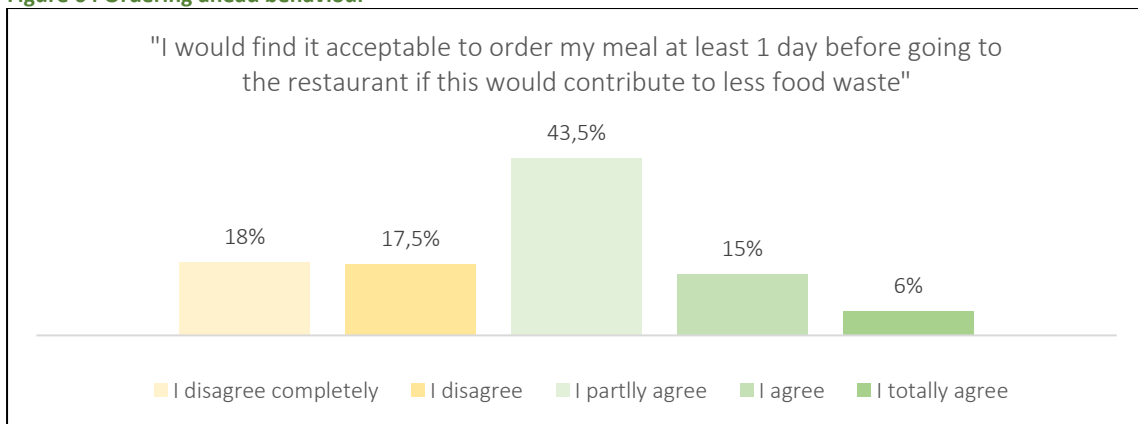
Figure 65 Factors affecting willingness to order ahead
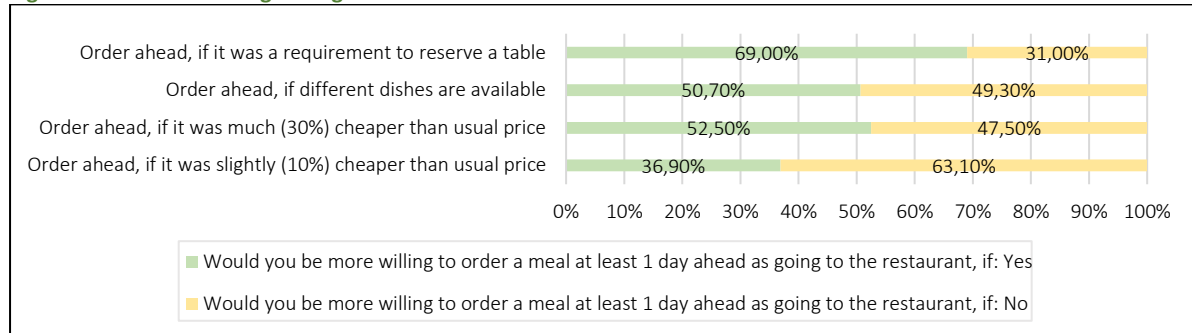
Motives for finishing or not finishing meals

Moving on to **finishing or not finishing meals while at the restaurant**, **the reasons** were captured with the following attitudinal statements:

- *"If the food doesn't taste good, I leave it on the plate"*
- *"I stop eating when I'm full even when I am eating something I love"*
- *"When a portion is too large, I stop eating when I'm full"*
- *"When a portion is too large, I still eat everything"*
- *"When I'm eating one of my favourite foods, I don't recognize when I've had enough"*

Nearly 80% of respondents indicated that they leave unappetizing food on their plates (23.0% answered "it does apply" and 55.2% answered "it does partly apply"). This emphasizes the **importance of taste** in their eating choices. Although the respondents might eat something they love, more than half of them (61.8%) stop eating when they are full, leaving the rest of the portion on the plate.

Also, when not eating a favourite food, half of the respondents (66.6 %: 13.5% + 53.1%) stop eating when they are full and the portion was too large. The respondents' behaviour reflects a level of efficiency in their eating habits. They appear to **prioritize their own sense of fullness and satisfaction over finishing every portion of food**, even if they enjoy the food. It also suggests that they are attentive to portion sizes and won't overeat just because a portion is large or because they are eating a favourite dish. Overall, this statement implies that a significant portion of the surveyed individuals listens to their body's signals of fullness and stops eating when they reach that point, even if they are consuming something they love. It also emphasizes the influence of portion size on their eating decisions, demonstrating a sensible approach to food consumption based on personal satiety rather than social or cultural pressures to finish all the food on their plates. As it is discussed in the next section, the social norm of not leaving food on the plate has significant variation between men and women.

In situations where portions are too large, only 20.7% (5.2% + 15.5%) of respondents still eat everything, while most of them (53.6 %: 16.4% + 37.2%) do not. A minority of the respondents continue to eat and consume the entire portion even when they perceive it as too large. This suggests that some individuals may have a preference for finishing all the food served to them, regardless of portion size. In contrast, the majority of respondents (53.6%) do not finish everything on their plates when they find the portions to be excessively large. This indicates that most individuals exercise portion control and do not feel compelled to consume all the food presented to them, even if they might find it wasteful.

The majority of the respondents (7.9% answered "It absolutely does not apply" and 42.6% answered "It does not apply") feel confident in their ability to recognize satiety when consuming their

favourite foods. This suggests that for a substantial proportion, enjoying favourite foods doesn't lead to overeating or a lack of awareness of their own limits. Of the respondents, 20.7% express uncertainty or an inability to clearly define whether the statement applies to them. And there is a notable subset of respondents who acknowledge some difficulty in recognizing when they've had enough of their favourite foods (20.5% answered "It does partly apply" and 8.3% answered "It does apply").

Portion Size perceptions

The questions associated with **portion sizes at restaurants,** for which the respondents had to state their level of agreement were the following:

- *"From the menu, the portions are larger than I expected/would have preferred"*
- *"Portion sizes are important for me to enjoy my meal"*
- *"When I receive my food, I can tell right away when the portion I've been served is too large for me"*
- *"If it doesn't cost much more, I get the larger size food or drink regardless of how hungry I feel"*

Regarding portion sizes the responses vary somewhat, some respondents (around 29%) saying that **they receive larger portions from the menu than expected**. This could indicate that some restaurants are known for generous servings. Around 44% of respondents state that they do not have a problem with the portion sizes they receive. This suggests that a significant portion of the participants is content with the amount of food they get. Finally, 27% of the respondents can't define if the portion sizes are larger than their anticipations. The responses indicate that there is no unanimous consensus among the participants regarding portion sizes. **Different individuals have different perceptions and experiences related to the size of the food** they are served at restaurants.

Around 41.2% of the respondents **consider portion sizes important** for their meal enjoyment, while the same percent of respondents (41.8 %) do not consider portion sizes important. This suggests that there is a fairly even split among the respondents when it comes to the importance of portion sizes in relation to their enjoyment of a meal. The fairly equal division between those who do and do not consider portion sizes important indicates that individual preferences and priorities vary widely. Some diners may focus on quantity, while others may prioritize different aspects of the dining experience.

A significant portion of respondents (42.4%) claim that they **can immediately tell if the portions they receive are too large**. This group appears to have a clear and quick sense of whether the amount of food served exceeds what they consider reasonable. On the other hand, a sizable portion (41.1%) of respondents cannot define or are uncertain about whether the portion size is too large. This group may not have a clear or immediate judgment about portion sizes and may need more time or context to make a determination. A smaller group of respondents (15.5%) admit that they can't really tell from the beginning if the portions are too large. This suggests that some individuals may not notice or assess the size of the portions until they begin eating.

A substantial proportion of individuals **do not opt for larger-sized food or drinks** simply because they are available, irrespective of cost or hunger levels (32.9%: 11.9% + 21.0%). A considerable percentage of respondents (30.0%) express uncertainty or an inability to clearly define their behaviour in relation to the statement. Of the respondents, 21.2% partially agree with the statement. They might consider factors such as cost but may also be influenced by other considerations when deciding on the size of their food or drink. Finally, a smaller percentage of

respondents (15.8%) tend to choose larger sizes, even when not particularly hungry, as long as the cost difference is minimal.

According to the responses, over 50% (15.2% + 42.0%) of the respondents do not tend to load their plates with more food than usual at self-service restaurants and 'all you can eat' buffets. Moreover, 57.9 % (15.1% + 42.8%) of the respondents state that they do not tend to overeat at such buffets, highlighting a more restrained approach to dining out.

The data portrays a fascinating spectrum of eating behaviours, reflecting the diversity in individuals' approaches to food. It's evident that **many factors come into play,** from **social influences to taste preferences and awareness of portion sizes.** While some people are highly attuned to their hunger cues and the quality of their food, others may struggle with portion control.

The opinions of respondents regarding the suggestion that the food service owners want to **reduce meal portions in order to minimize food waste** vary **(Figure 66):**

- A total of 39% of the respondents agree (24.3% agree and 14.7% strongly agree) that reducing meal portions is justified because it will reduce food waste**.** This indicates that a substantial portion of the surveyed individuals sees merit in the proposed measure and believes that it would have a positive impact on minimizing food waste. However, 24.9% disagree with this. This suggests that there is a significant portion of the surveyed population that questions the efficacy of reducing portion sizes as a means to address food waste.

- Of the respondents, 43.0% believe that this measure will actually not reduce food waste (21.4% agree and 21.8% strongly agree), while 27% of the respondents believe it will reduce food waste.

- Most of the respondents (67.7%: 36.2% agree and 31.5% strongly agree), find this proposal more acceptable if the price of the meal is reduced. This indicates that a substantial portion of individuals is willing to **support the reduction of portion sizes if it is accompanied by a corresponding reduction in meal prices.** However, 8.3% of the respondents (2.2% strongly disagree and 6.1% disagree) express discomfort or disagreement with the proposal even if the price is reduced.

Figure 66 Opinion on the reduction of meal portion by food service owners

The food service owners want to reduce their meal portions to reduce waste...

This measure is justified because it will reduce food waste: 14,70% / 24,30% / 36,10% / 10,20% / 14,70%

This measure seems acceptable if the price of the meal is also reduced: 31,50% / 36,20% / 24,10% / 6,10% / 2,20%

This measure will not actually reduce food waste: 21,80% / 21,40% / 29,90% / 18,50% / 8,50%

■ Strongly agree ▢ Agree Neither agree nor disagree Disagree ■ Strongly disagree

Leftover Decisions

Transitioning from the exploration of portion size perceptions, we now shift the attention to considerations involved in leftover decisions.

An interesting behaviour that is related to food waste in restaurants is the **willingness of the customers to request their leftovers to be wrapped**. The answers of the respondents to this question are the following:

- A significant portion of respondents (around 35.8%) indicates that they consistently request leftover food to be wrapped **most of the time**. This suggests a proactive and mindful approach toward managing food waste. Individuals in this group are likely conscious of not wasting food and prefer taking leftovers home to be consumed later.

- The majority of respondents (approximately 38.4%) falls into the category of requesting leftover food to be wrapped **sometimes**. This indicates that a substantial portion of the surveyed population occasionally opts to take home leftovers, but it may not be a consistent practice for them.

- About 25.8% of respondents indicate that they **do not request leftover** food to be wrapped. This group may choose not to take leftovers home for various reasons.

In summary, the results reflect a range of behaviours when it comes to requesting leftover food to be wrapped. While a significant portion of respondents actively seeks to minimize food waste by consistently taking leftovers home, a slightly larger group does so only on occasion. The subgroup that does not request leftover food to be wrapped might have different attitudes toward leftovers, or external factors may influence their decision not to take food home.

The **willingness-to-pay to reduce food waste** was evaluated with the following question: *'Would you still take leftovers home if you had to pay for the container, in order to bring leftovers home?'*. The results of this survey suggest that a **significant majority of respondents (80.2%)** *would still take leftovers* **home even if they had to pay for the container.** This indicates a strong inclination towards valuing the convenience and practicality of bringing home leftover food, despite the additional cost associated with the container. On the other hand, a relatively small percentage, around 8.7%, expressed a preference *not to take leftovers home* if they had to pay for the container. This could imply that some individuals are more cost-conscious and weigh the expense of the container against the perceived value of bringing leftovers. Additionally, 10.9% of respondents were *unsure* (responded with "I don't know"), indicating a level of indecision or lack of a clear stance on whether they would take leftovers home if there was a cost associated with the food container. In summary, the majority of respondents seem willing to pay for the convenience of taking leftovers home, highlighting the importance of this practice for many individuals. However, a small percentage is more cost-sensitive, and a fraction remains undecided or indifferent on the matter.

4.3.4   Social norms

Qualitative Analysis

Most restaurant managers addressed the issue of leftovers on plate, by actively offering to customers to take any remaining food home. It was clear from the interviews that, when asked about this practice of taking **leftovers** home, most managers estimated that only about 10 to 20 percent of customers take up on the offer of taking leftovers home. Some mentioned that there may be social norms in the background as being **ashamed** to take leftovers home or being judged by other customers as **greedy**. Restaurant managers also estimated that it was mostly young people, or families with children who ask for leftovers to take home. Another initiative taken to reduce leftovers on the plate, was to **reduce the plate size**. The consensus among managers was that the highest proportion of food waste comes from what customers leave on their plates, especially with **self-service style eating,** such as buffets. With buffets providing smaller sized plates seemed like a

good option, because with self-service there was a tendency to **feel the need to provide the guest with an extensive range of food options** (**good provider identity**).

Descriptive Statistics and Correlation Analysis

Eating out preferences and pre-ordering behaviour

The sole question pertaining to this theme revolves around behavioural changes observed when transitioning from dining alone to dining with other people. Respondents seem to prioritize their personal preferences and comfort over the potential judgment of others regarding their eating habits. While most respondents **do not alter their food choices when dining with friends** (around 80.8% answered "It absolutely does not apply" and "It does not apply"), suggesting that a significant majority of the surveyed individuals maintain consistent food choices when they dine with friends. In other words, they do not feel the need to change their food preferences or selections based on the presence of their friends. There is no significant difference between responses of men and women.

Motives for finishing or not finishing meals

The majority of the respondents **do not feel the need to leave some food on their plate to avoid appearing greedy** (around 72.7% answered "It absolutely does not apply" and "It does not apply"). This suggests that most respondents feel that they are not compelled to overeat or finish their meals to conform to social norms or avoid negative judgments from others. In other words, they don't feel obligated to eat more than they want or need just to avoid appearing greedy.

Finishing food on the plate at the restaurant may well be dictated by various social norms as well as other personal motives. The following reasons were explored in the survey (**Figure 67):**

- **Finishing to Avoid Food Waste**: *"I finish what is on my plate because I believe that food waste is bad"* - A significant portion of the respondents (19.5%) strongly believe in finishing what is on their plate because of the perception that food waste is bad. Additionally, a larger percentage (44.7%) indicates that this belief partly applies to them, suggesting that a substantial number of people consider the avoidance of food waste as a factor in their decision to finish the food on their plates. Overall, these numbers imply that **there is a noteworthy awareness and consideration of the issue of food waste** among the surveyed individuals.

- **Finishing Due to Upbringing**: *"I finish what is on my plate because I was taught to finish everything on my plate"* - A 10.2% of the respondents strongly adhere to the practice of finishing what is on their plate because they were taught to do so. Additionally, a larger percentage (42.80%) indicates that this statement partly applies to them, implying that a significant number of people have been **influenced to some extent by the idea of finishing everything on their plate due to cultural or parental influence.** Overall, it reflects a connection between individuals' eating habits and the values instilled in them through upbringing or cultural norms. The fact that a significant portion of individuals continue to follow behaviours from their childhood, even if they don't completely align with them, shows the lasting influence of upbringing on eating habits.

- **Finishing to Get Value**: *"I finish what is on my plate because I paid for it and I want to get my money's worth"* – About 11% of the respondents strongly believe in finishing what is on their plate because they paid for the food and want to get their money's worth. Additionally, a significant percentage (30.6%) indicates that this statement partly applies to them, implying that a considerable number of people **consider the financial aspect as a factor in their decision to finish the food on their plates.** This perspective highlights the influence of economic

considerations on individuals' eating behaviour, as they seek to maximize the value of their purchase.

- **Finishing due to social pressure**: *"I finish what is on my plate because others at the table may judge me as wasteful otherwise"*- A relatively small percentage of respondents (around 4.4%) directly attribute their habit of finishing what is on their plate to social pressure. An additional 15.8% indicate that this social pressure partly applies to them, suggesting that there is some influence from the judgment of others at the table. However, the majority of respondents (67.20%) state that social pressure does not apply to them at all. This information implies that, while some individuals may feel influenced by the perceptions of others, a substantial portion of the surveyed group **does not consider social judgment to be a major motivator in their eating behaviour.**

- **Finishing due to hunger:** *"I finish what is on my plate because I was hungry when I came to the restaurant"* - A significant portion of the respondents (about 29.8%) directly attribute their habit of finishing what is on their plate to hunger, indicating that they finish their meals because they were hungry when they came to the restaurant. Additionally, 32.8% of respondents state that this reasoning partly applies to them, implying that a substantial number of people **consider their initial hunger as a factor in deciding to finish the food on their plates.** Finally, a relatively low percentage (16.2%) states that this does not apply to them.

Figure 67 Reasons for finishing food on the plate
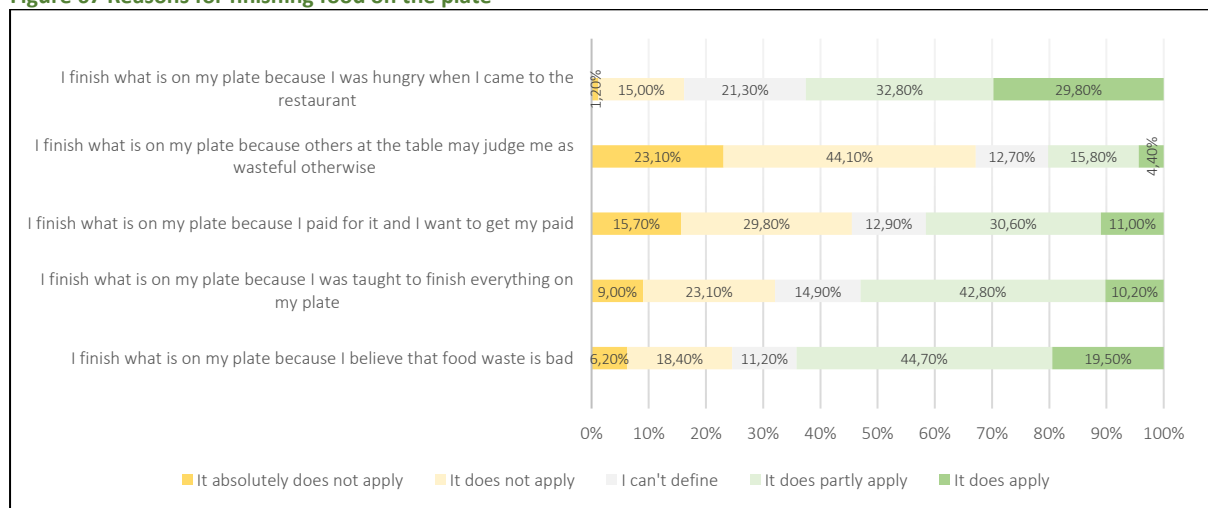
On the opposite side, **not finishing food on the plate** at the restaurant could also be influenced by a wide variety of reasons, including social norms. Below are the findings from the survey **(Figure 68):**

- **Not Finishing Due to Large Portions:** *"I don't finish what is on my plate when the portion provided is too much (even though the food is good)"* - The majority of respondents, around 54.70%, state that this partly applies to them, while 22.7% state that it does apply to them. This suggests that a significant portion of diners **acknowledge the challenge of dealing with large portions**, even when the food is enjoyable. Only a small percentage (5.5%) absolutely does not apply this behaviour.

- **Not Finishing Due to Poor Food Quality:** *"I don't finish what is on my plate when the quality of food is poor"* - The most common response is "it does partly apply," with 52.2% of respondents indicating that **food quality influences their decision to not finish**. A relatively small proportion (2.3%) absolutely does not apply this behaviour.

- **Not Finishing Based on Personal Choice:** *"I don't finish what is on my plate because I feel like it, even when other people finish theirs"* – Only 8.2 % of respondents say that this statement does apply, indicating that **personal choice plays a role in whether they finish their food.** However, nearly 24.9% state that it doesn't apply.

- **Not Finishing Due to Politeness:** *"I don't finish what is on my plate because it is polite to do so"* - The majority of respondents (74.3%) indicate that this behaviour absolutely does not apply to them, suggesting that **politeness is not a primary motivator for not finishing food**. A small percentage (11%) applies or partly applies this behaviour.

- **Not Finishing by Design:** *"I don't finish what is on my plate because I ordered too much on purpose"* - A significant proportion (81.1%) does not apply this behaviour, meaning they typically **do not intentionally order excess food**. In contrast, 6.2 % of respondents say it does or does partly apply.

- **Not Finishing Due to Unintentional Overordering:** *"I don't finish what is on my plate because I ordered too much unintentionally"* - The majority of respondents (66.2 %) absolutely do not apply this behaviour, indicating that **unintentional overordering is not a common reason for not finishing food.** However, 16.6 % of the respondents say that it applies or partly applies to them.

- **Not Finishing While on a Diet:** *"I don't finish what is on my plate when I am on a diet"* - A significant portion of respondents (49.7%) say that this applies, **reflecting that dietary goals influence their portion control.** However, 27.4 % absolutely do not apply this behaviour.

- **Not Finishing to Be Seen Spending Money:** *"I don't finish what is on my plate because I want to be seen spending and wasting money"* - Most respondents (81.8 %) do not apply this behaviour, meaning they **do not intentionally waste food to project a certain image.** Only 2.1% applies this behaviour.

- **Social Influence on Finishing:** *"Only if other people don't finish their food, it's okay for me not to finish mine"* - A substantial number of respondents (74.1 %) absolutely do not apply this behaviour, indicating that they **do not require the behaviour of others to justify not finishing their own food.** Only 1.2 % applies this behaviour.

Figure 68 Reasons for NOT finishing food on the plate
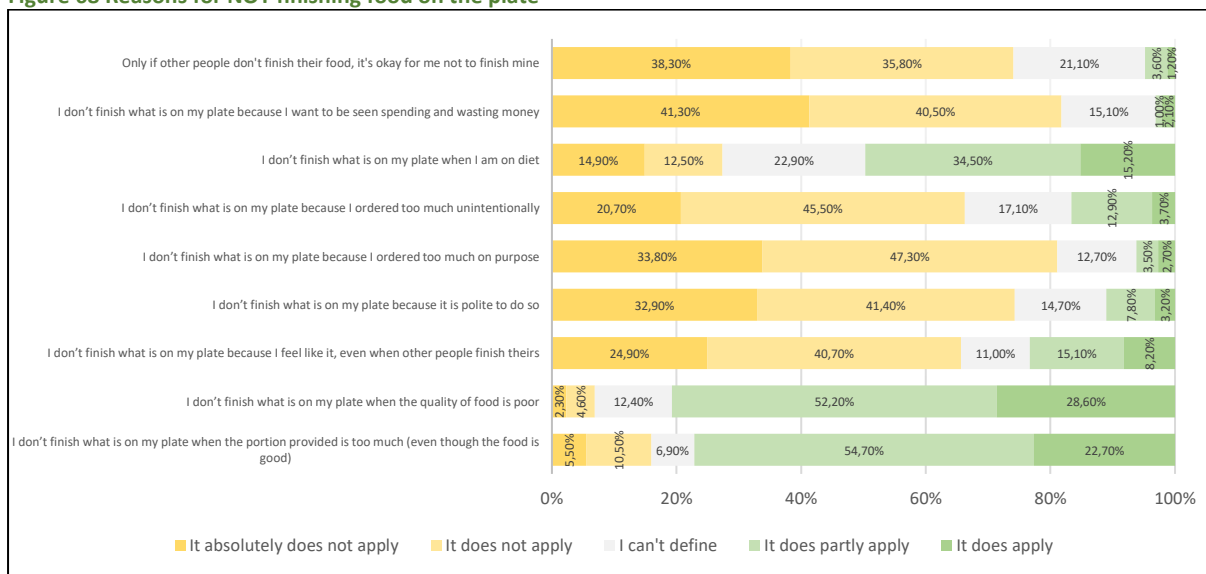
The survey results unveil a multifaceted landscape of reasons behind individuals' decisions not to finish their meals. A substantial number of respondents acknowledge the challenge of coping with large portions, with 54.7% partially applying and 22.7% fully applying the behaviour of not finishing the meal when the portion is too large. Food quality emerged as a significant factor, influencing 52.2% of the respondents to partly abstain from finishing. Politeness, intentional and unintentional overordering, dietary goals, and the desire to project a certain spending image have varying degrees of impact, demonstrating the intricate interplay of factors shaping individuals' dining habits.

The prevalent social norm of **advocating for the deliberate ordering of larger portions**, allowing for the intentional leaving of food on the plate, has been examined through the survey, yielding insightful results. Strikingly, a substantial 81.1% of the respondents diverged from this norm, indicating a prevailing inclination among the majority to **refrain from intentionally overordering**. This suggests a widespread departure from the notion that larger portions are universally embraced for the purpose of intentionally leaving uneaten food. In contrast, a modest 6.2% of participants acknowledged adherence to this behaviour, underscoring a distinct minority who intentionally opt for excess when placing their orders.

The survey has examined the dominant societal expectation that connects one's physical appearance to their dietary preferences, revealing insights into the complex *correlation between self-perception and eating habits*. Notably, 49.7% of the respondents acknowledged a connection between their dietary aspirations and portion control, revealing a **significant proportion who consciously refrain from finishing what is on their plate when actively pursuing a healthier lifestyle.** This underscores the impact of aesthetic considerations on eating habits, as individuals align their consumption patterns with the desire to look good. Interestingly, 27.4% of the participants firmly rejected this behaviour, emphasizing a substantial minority who suggest that their dietary choices are not influenced by appearance-related motivations.

Additionally, the majority (81.8%) does not intentionally leave food unfinished to project an image of wasting money. Only 2.1% apply this behaviour, indicating that the desire to be seen spending and wasting money is not a prevalent motivator.

A substantial 74.1% do not base their behaviour on the behaviour of others to justify not finishing their own food. Only 1.2% apply this behaviour, suggesting that social influence is not a significant factor for most individuals. And only 11% state that politeness is a factor for not finishing their meal. While politeness and social influence are less prevalent motivators, the results underscore the diverse and nuanced considerations influencing the decision to leave food unfinished.

Portion Size perceptions

While there are indirect connections between portion size and the social norms related to motives for finishing or not finishing meals, there are no direct social norms specifically associated with the theme of portion size perception.

Leftover Decisions

The motives and social norms that drive respondents' decision to **take leftovers home** are summarized below **(Figure 69):**

- **Bringing Food Home Saves Money:** A notable percentage of respondents (16.8%) consider saving money as the most important factor in deciding to bring food home from the restaurant leftovers. This suggests a **financial motivation** among this subgroup, where the economic benefit of not having to purchase another meal is a significant factor. The majority of respondents (38.7%) find saving money to be an important factor, indicating a widespread recognition of the cost-saving aspect of bringing leftovers home.

- **Food Left on the Plate Was Tasty:** A significant percentage of the respondents (31.6%) prioritize the taste of the leftover food as the most important factor in their decision to bring leftovers home. The majority of respondents (39.4%) consider the **tastiness of the food** to be an important factor, reinforcing the idea that the quality of the meal influences the decision to take leftovers home.

- **It's Good Not to Waste Food:** A substantial majority of respondents (45.8%) prioritize the **ethical and environmental aspect** of not wasting food as the most important factor in deciding to bring leftovers home. This indicates a strong sense of responsibility and awareness regarding food waste among this subgroup. The importance assigned to not wasting food is reinforced by the high percentage of respondents (39.2%) who consider it an important factor. This suggests a widespread recognition of the value of minimizing food waste for ethical reasons.

- **People May Think I Am Wasteful for Leaving Food on the Plate:** Only a small percentage of respondents (4.8%) consider what the others will think as the most important factor. This suggests that, for a minority, social judgment plays a significant role in the decision to bring leftovers home. While a larger portion of respondents (11.8%) considers the perception of others to be important, it is still a minority view. This indicates that, **for most individuals, social judgment is not the primary consideration.**

- **Eating Leftovers Saves Time and Is Convenient:** A significant percentage of respondents (26.4%) prioritize the **convenience and time-saving aspect** of eating leftovers, while the majority of the respondents (33.5%) also find this factor to be important. This suggests that for many, the practical benefits of having a readily available meal play a crucial role.

On the opposite side the results on motives and social norms for **NOT taking leftovers home** from a restaurant shed light on the diverse reasons behind this behaviour, offering insights into the decision-making processes of individuals **(Figure 69):**

- **Quality of Food Left on the Plate**: The most commonly cited reason for not taking leftovers home is the fact that **the food was not good to begin with**. This emphasizes the importance of taste and satisfaction, as individuals opt not to take home food that they did not enjoy initially.

- **Economic Considerations**: A substantial number of respondents indicate that they leave food behind because of **the perception that bringing food home saves little money.** This suggests a belief that the financial savings from taking leftovers may not be significant enough to justify the effort.

- **Health Concerns**: A smaller group of respondent's express **concerns about the healthiness of eating leftovers**, indicating that some individuals may choose not to bring food home due to perceived health risks associated with reheating.

- **Restaurant Policies**: The majority of the respondents report that they do not take leftovers home because **restaurants do not allow it**. This external constraint suggests that restaurant

policies play a significant role in the decision-making process, regardless of individual preferences.

- **Societal Perception**: A notable but smaller percentage of respondents express **concerns about the societal perception of looking poor** if they take leftovers home. This reflects the influence of social norms and potential stigmas associated with being seen with restaurant leftovers.

- **Preference for Homemade Cooking**: Another motive for not taking leftovers home is the belief that **one can cook better at home.** This suggests a preference for freshly prepared homemade meals over restaurant leftovers.

Figure 69 Motives and social norms for taking leftovers at home
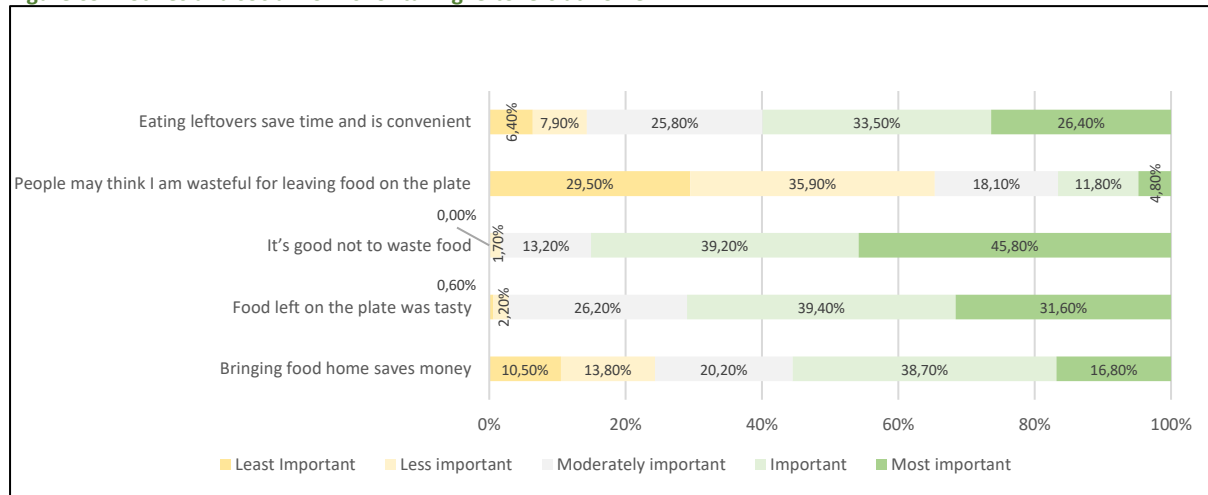
Figure 70 Motives and social norms for NOT taking leftovers at home
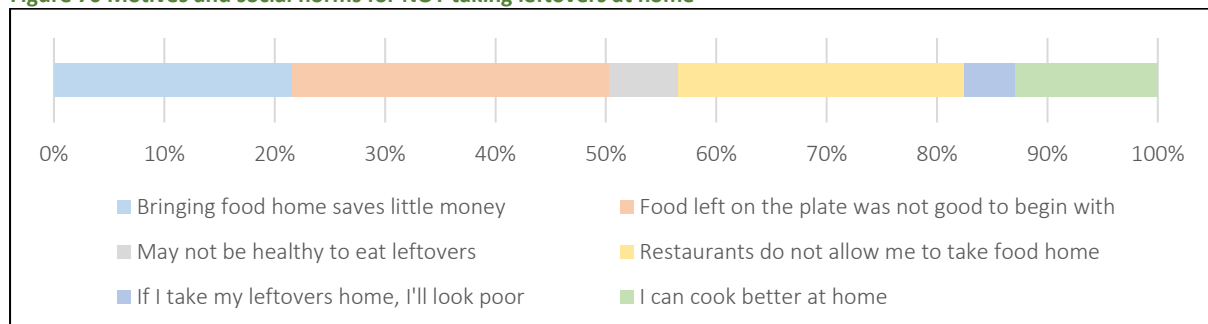
Apart from their personal behaviour, the survey explored the respondents' attitudes towards their **peers taking leftover food**. The available options and the distribution of the responses is as follows:

- **"I am glad that food will not go to waste"** (85.9%): The overwhelming majority of the respondents express a positive attitude, indicating that they are **pleased when someone takes leftover food to prevent it from going to waste.** This suggests a strong sense of valuing food and minimizing food wastage among the surveyed individuals.

- **"I imagine the person is poor and therefore asks for the rest of the meal to take home"** (1.7%): A very small percentage of the respondents associate the act of taking leftover food with potential financial constraints. This perspective may reflect some level of **socioeconomic consideration** or empathy toward individuals who might be perceived as facing economic challenges.

- **"It is acceptable to me to leave the food you cannot eat on your plate"** (5%): A small percentage of the respondents find it acceptable to leave uneaten food on their plate. This suggests that a portion of the surveyed individuals is **neutral or indifferent towards the idea of leaving uneaten food behind.**

- **"I do not care"** (7.4%): A small but notable percentage of the respondents express a more indifferent attitude, stating that they do not care about the peer's decision to take leftover food or leave it behind.

Overall, the predominant sentiment is positive, with the majority **expressing gladness that food is not going to waste**. This aligns with a broader societal emphasis on reducing food wastage and promoting sustainability. The small percentages in other categories indicate some diversity in perspectives, including considerations of financial situations or more neutral attitudes toward the act of leaving food on the plate.

The effect of social norms on the respondents' behaviour at the restaurant, and more specifically on their **decision making with respect to leftovers** is indirectly explored with the behavioural change if people were to eat alone at the restaurant. The following behavioural shifts were explored **(Figure 71):**

- **"Effect on the Amount of Food You Order":** The majority (77.5%) expects no change in the amount of food they order when eating alone at a restaurant. This suggests that, for most respondents, the **solo dining situation does not significantly impact their ordering decisions.** A notable percentage (15%) anticipates an increase in the amount of food ordered when dinning alone. This could be influenced by factors such as wanting to try more dishes or the convenience of having leftovers when dining alone.

- **"Effect on the Amount of Food Left on the Plate":** The majority (81%) foresees no change in the amount of food left on the plate when dining alone. This indicates that, for a significant portion of respondents, **the presence or absence of dining companions doesn't significantly affect how much they leave uneaten**. A smaller percentage (9.2%) expects a decrease in the amount of food left on the plate, suggesting that dining alone might encourage individuals to finish more of their meal.

- **"Effect on How Many Times You Will Ask for a Leftover Bag":** The majority (78.3%) expects no change in the frequency of asking for a leftover bag when dining alone. This implies that, for most respondents, **the option to take leftovers is not significantly influenced by the solo dining experience.** A smaller percentage (15.2%) anticipates an increase in asking for a leftover bag, indicating that some individuals may care about what their peers think when they take leftovers home.

- **"Effect on How Many Times You'll Order Food in Advance":** The majority (78.3%) expects no change in the frequency of ordering food in advance when dining alone. This suggests that, for most respondents, **the decision to order in advance is not strongly influenced by the solo dining context.** A smaller percentage (10.8%) anticipates a slight decrease in ordering food in advance when dining alone.

Figure 71 Solo dining effects on leftovers behaviour

If you were to eat alone at a restaurant how would the following be affected?

Effect on how many times you'll order food in advance: 6,80% | 4,00% | 78,30% | 8,50% | 2,40%

Effect on how many times you will ask for a leftover bag when you are done: 1,60% | 4,90% | 78,30% | 10,10% | 5,10%

Effect on the amount of food left on the plate: 2,70% | 6,50% | 81,00% | 8,00% | 1,80%

Effect on the amount of food you order: 2,50% | 4,90% | 77,50% | 10,30% | 4,70%

Legend: ■ It would decrease by a lot ■ It would decrease a bit ■ No change ■ It would increase a bit ■ It would increase by a lot

4.3.5 Gender and intersectional differences

Food waste

The data suggests that a slightly higher percentage of females (61.1%) leave less than a quarter of the plate as leftovers compared to males (50.9%). Conversely, a higher percentage of males (36.6%) leave none of their food as leftovers compared to females (20.6%) (**Figure 72**). This suggests that, proportionally, **more males tend to finish their entire meal without leaving any remnants**.

Figure 72 FW amount by gender

TOTAL: None 28,70% | Less than a quarter plate 56,00% | Quarter plate 13,50% | Between a quarter and a half plate 1,70% | Half a plate 0,10%

MALE: None 36,60% | Less than a quarter plate 50,90% | Quarter plate 11,30% | Between a quarter and a half plate 1,00% | Half a plate 0,20%

FEMALE: None 20,60% | Less than a quarter plate 61,10% | Quarter plate 15,80% | Between a quarter and a half plate 2,50% | Half a plate 0,00%

Legend: ■ Half a plate ■ Between a quarter and a half plate ■ Quarter plate ■ Less than a quarter plate ■ None

Dining alone

Most of the respondents (77.5%) expect no change in the amount of food they order when eating alone at a restaurant, compared to eating with peers. However, a slightly higher percentage of females (17.9%) anticipate an increase compared to males (12.1%). This could suggest that **females may be slightly more sensitive to social norms in that respect**. Also, the majority (81%) foresees no change in the amount of food left on the plate when dining alone. Nevertheless, females show a slightly higher expectation of a decrease (12%) in the amount of food left on the plate compared to males (6.1%) when dining alone. This indicates that **females may be more likely to leave more food uneaten when dining with company, compared to men**. Furthermore, 78.3% of respondents expect no change in the frequency of asking for a leftover bag or ordering food ahead of time when dining alone. In general, these results highlight subtle differences in anticipated behaviours between

genders. Nonetheless, these gender-specific variations are minimal and could also be influenced by a range of factors such as individual preferences, cultural norms, or perceptions.

Eating out – frequency, portion size and ordering behaviour

When examining the **frequency of dining out** data via a gender-specific lens, it becomes apparent that the percentage of men who eat out is slightly more, as 7.4% (compared to 3.3%) dine out more than six times per week, 8.8% (compared to 5.9%) dine out five to six times per week, and 18.4 % (compared to 12.7%) dine out three to four times per week. While merely 3.3 % of women report dining out more frequently than six times per week, 5.9% eat out five to six times per week, and 12.7 % dine out three to four times per week. Therefore, there is a **slight to moderate influence of gender on the frequency of dining out**.

Figure 73 Frequency of eating out by gender
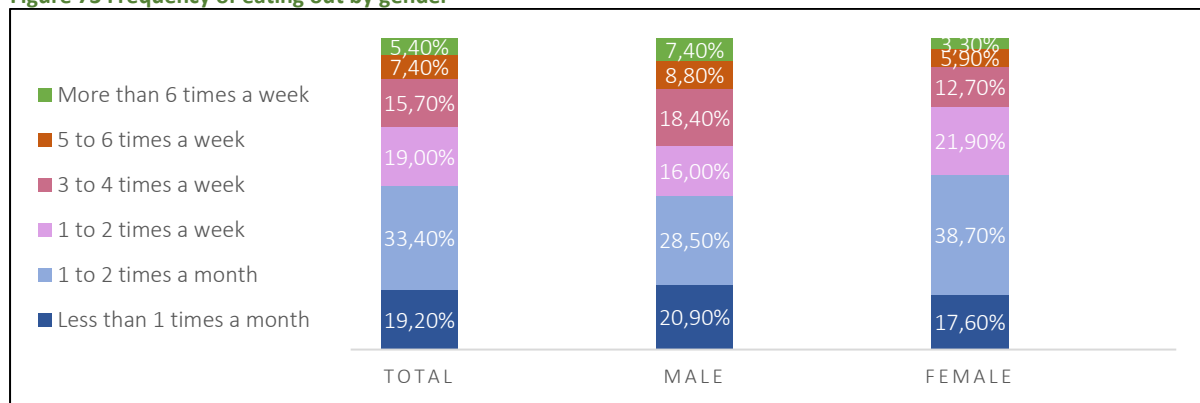
Analysing the cross-tabulation results detailing the frequency of dining out against family income reveals the following pattern: Individuals with very low family income, defined as less than 1,001 Euros per month, tend to dine out less frequently, often consuming meals outside their homes less than once a month **(Figure 75).** This observation suggests a correlation between lower income brackets and reduced frequency of dining out, indicating a **potential financial constraint impacting dining habits.**

When considering the relationship between the **importance of reasons for eating out** and gender, two factors emerge as particularly notable. Specifically:

- **Men place greater importance on receiving larger portion sizes** compared to women (Table E1 in Appendix E indicates a moderate to strong effect).

- **Women place greater importance on the seasonal or periodic changes in the menu** compared to males (Table E2 in Appendix E indicates a moderate effect).

Figure 74 Solo dining effects on leftovers behaviour by gender
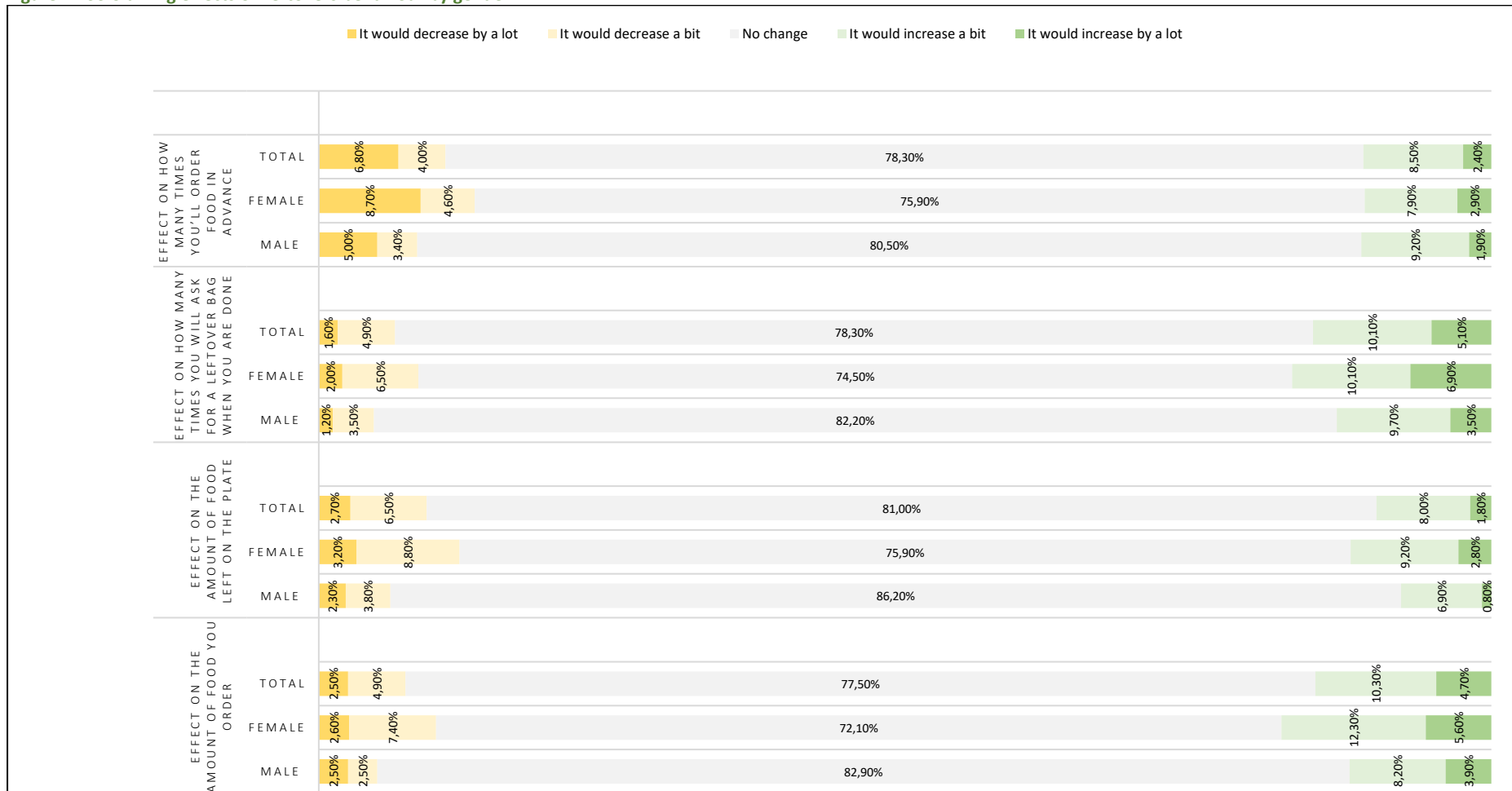
Figure 75 Frequency of eating out by income
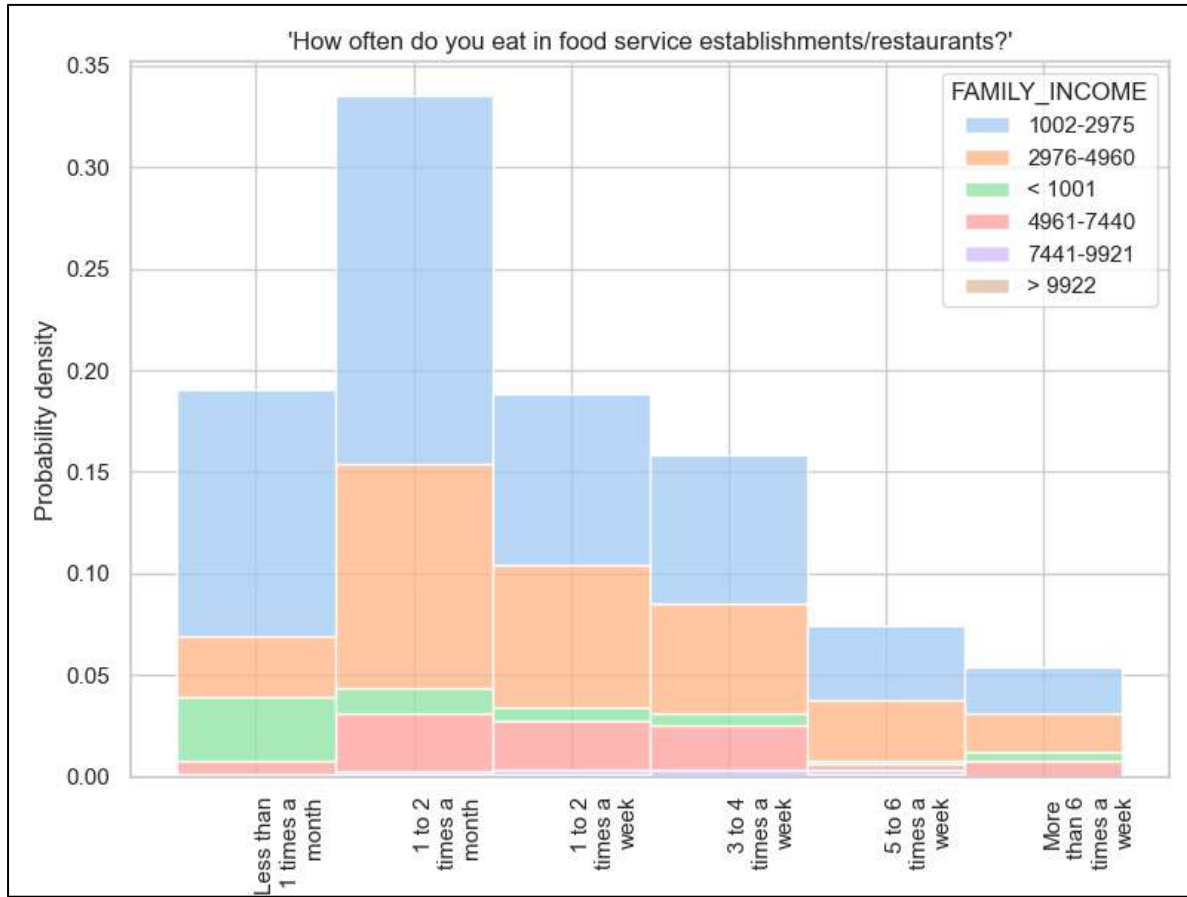
A significant percentage of females (37%) express surprise with larger-than-anticipated portions from the menu, surpassing the proportion among males (20.8%). Interestingly, a considerable portion of males (45.6%) emphasize the importance of portion sizes for their meal enjoyment, compared to females (36.9%). A significant portion of respondents (42.4 %) claim that they **can immediately tell if the portions they receive are too large**. This group appears to have a clear and quick sense of whether the amount of food served exceeds what they consider reasonable. Results clearly show that it is **predominantly women** (52.5 %) who can tell right away if the portion they receive is too large. While a significantly smaller proportion of men (32.9 %) can say that.

One notable gender disparity is this of plate completion habits based on **taste satisfaction and satiation levels.** Specifically, a significantly higher percentage of **females** (32.30%) refrain from finishing their plates when the food does not meet their taste expectations, compared to males (14.20%). Moreover, when consuming favourite dishes, females (17.20%) are more likely to stop eating when they reach fullness, as opposed to males (7.30%). An interesting discrepancy is the **self-awareness regarding satiety** while consuming favourite foods. Specifically, a significantly lower percentage of males (3.6%) report that they always recognize when they've had enough, contrasting with a higher percentage of females (12.60%) expressing the same sentiment. Therefore, males exhibit a greater tendency to struggle with over-eating when indulging in preferred foods.

When asked about **reasons that would discourage a revisit to the restaurant**, gender indicates a moderate influence on the reason "I received portion sizes that are too small", with men attributing greater significance to this discouraging factor (Table E3 in Appendix E) indicates a moderate effect). Once again demonstrating that men place more significance on portion size compared to women.

Figure 76 Restaurant attitudes and behaviours (aggregate and by gender)
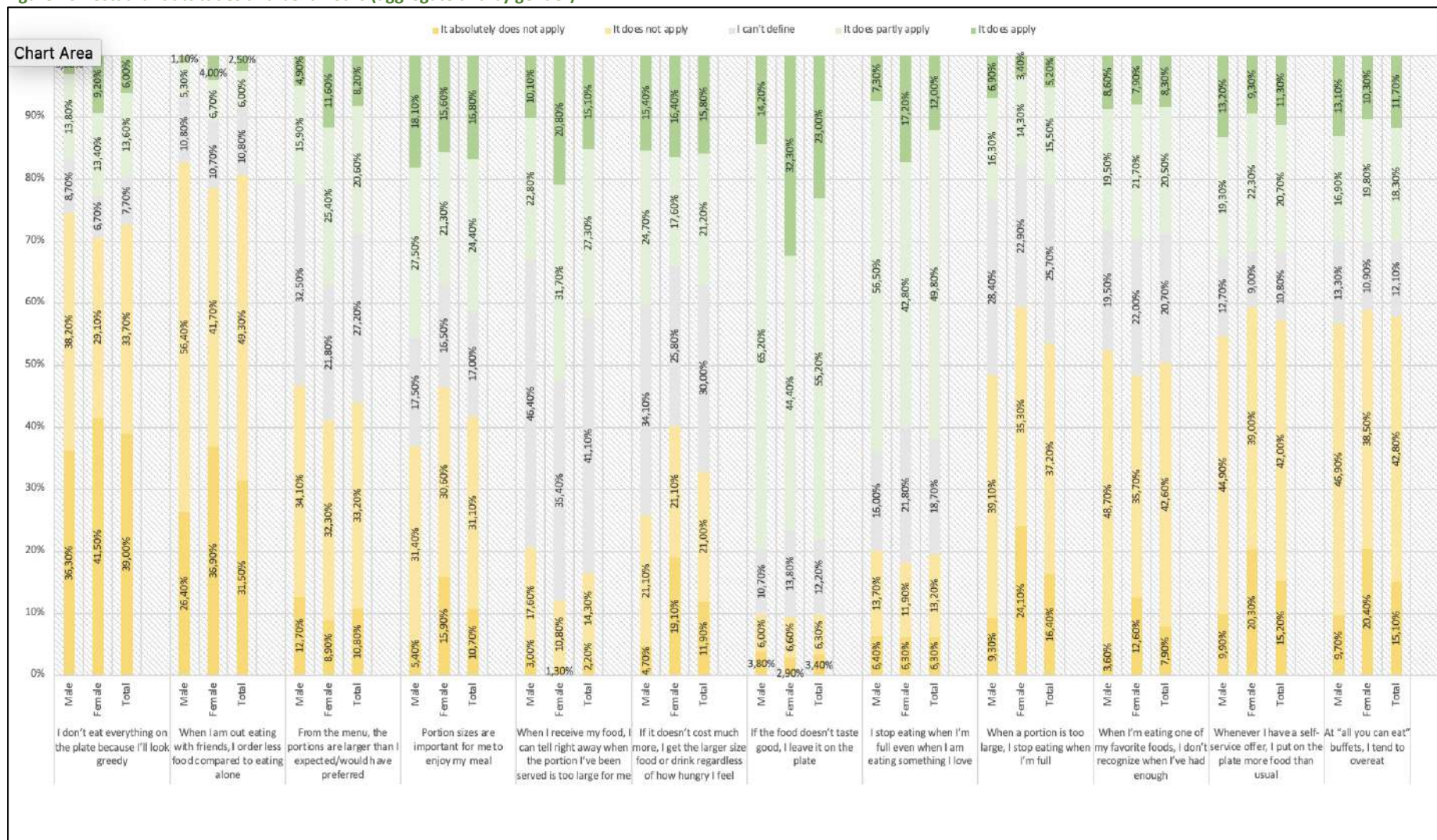
4.4   Case Study 6: Date marking and sustainable, smart food packaging – focus on Spain

The following points offer a concise **summary of the main findings** first for the pilot home survey and then for the consumer survey:

Pilot Homes Survey

- Seven (7) out of the 13 households surveyed **do not plan** weekly meals.

- Three (3) of the pilot homes **do not throw away food**.

- Households admit that they throw food away because they **do not plan meals and portion sizes well**.

- In most cases, leftovers are **disposed** while sometimes the respondents **use the leftover food as lunch/dinner for the next day**, especially in households where there are no children, or the children are older.

- In the case of the vegan and vegetarian households, the **leftovers are used to feed the animals**.

- Most households throw food away because **they forget it in the fridge, and it gets spoiled**.

- Households that **eat all the food** are mainly those without children at home.

- With this first analysis, **no correlation between waste and household typologies** could be found.

Consumer survey

- European consumers believe that they **throw away a small amount of food**, especially in Spain, while Estonians believe that they throw away more frequently.

- Around Europe, it is not believed that throwing food away is a matter of high social status (**this social norm does not influence food waste**). The main reasons why consumers buy more food than they need/planned, hence generating food waste, are a) sales and discounts and b) willingness to store food in case of unforeseen events.

- Respondents check marking dates mainly **for fresh products** such as meat and fish. Apart from Greece, in the rest of the countries evaluated, the main reason/motivation for throwing away food is inadequate appearance and smell.

- Consumers believe that they check marking dates attentively, especially in Hungary (**this social norm influences food waste**). Nevertheless, at Europe as a whole, consumers are not clear about the difference between "best before" and "safe until" (especially depending on the product). Spanish consumers are the most likely to recognize that they are not clear about these dates.

- Reponses to question items representing **social status** such as "Lower social status" and "In society throwing food away represents social abundance and good economic level", indicate that **this social norm does not influence food waste.**

- The most common **reasons** for not throwing food away are demonstration of **solidarity**, **ethical stance** against food waste, **economic** utilization, personal **responsibility and guilt**, **value in not wasting food** (the last one is more profound in Spain).

- Regarding **leftovers after cooking,** most European countries exhibit a general indifference, except for Spain, where there's a preference for having leftovers after cooking.

- For European consumers, a high expiration date indicates a product with **many additives.**

- More than 50% of consumers do not consistently retain food in its **original packaging**, their decision **influenced by the specific types of food involved**. Consumers also **do not believe that smart packaging increases the life** of food after opening, with the exception of Spanish respondents.

4.4.1 Methodological framework and overview of data demographics

Methodological framework

The quantitative analysis for CS6 is split in two parts: A) **a consumer survey** addressed to a large sample of European respondents and B) **the pilot homes survey** addressed to a small number of selected households.

The **methodology** used to carry out the consumer survey is quantitative, and it has been established into three blocks:

1. **Habits and Food Waste:** Determining the **frequency and reasons** for food being thrown away in households.
2. **Date Marking:** Evaluate how consumers interpret and **expiration dates**, decide whether or not to consume the products.
3. **Smart Packaging:** Evaluate the consumer perception of **smart packaging, storage** and **durability.**

On the other hand, the **methodology** for the pilot homes survey has been established in answering four blocks of questions:

1. Plan and Organize: Have you **planned and organized** week's lunch/dinner?
2. Leftovers: This week did you have **any leftovers**? Why?
3. Throw Food Away: Apart from leftovers, did you throw food away this week? Why?
4. Amount of food: How much food (excluding the non-edible parts, such as cores, peels, or bones) does your household throw away every week?

The data obtained have been statistically treated using the statistical software *XLSTAT-Sensory* version 2023.1.3.

Demographics of the consumer survey

To address the research objectives, **5 online surveys** were launched and **1,170 consumers** have been interacted with throughout the **EU (Spain, Greece, Netherlands, Hungary and Estonia)**. In this subsection, the **demographics** of these consumers are presented.

As it can be seen in **Figures 77-81,** in **Spain** the 237 consumers surveyed were mostly **women** (71.0%), aged between **35 and 54 years old** (59%). In **Greece** the 201 consumers surveyed were equally distributed (51% women and 49%), aged between **35 and 54 years old** (72%). The same applied for the **Netherlands** where 45% of the 201 consumers surveyed were women and 55% were

male, while half of them belonged to the **35 to 54 years** age band. In **Hungary**, the 204 consumers surveyed were also equally distributed (49% women and 51% male), and the **35 to 54 years** age band represented 53% of the sample. Finally, in **Estonia**, 53% of the 246 consumers surveyed were women, 46% were men, while 1% preferred not to state their gender. 49% of the Estonian respondents were aged between **35 and 54 years old**, and 45% between **18 and 34 years old.**

Figure 77 Consumer profiles in Spain (ES) (gender and age)
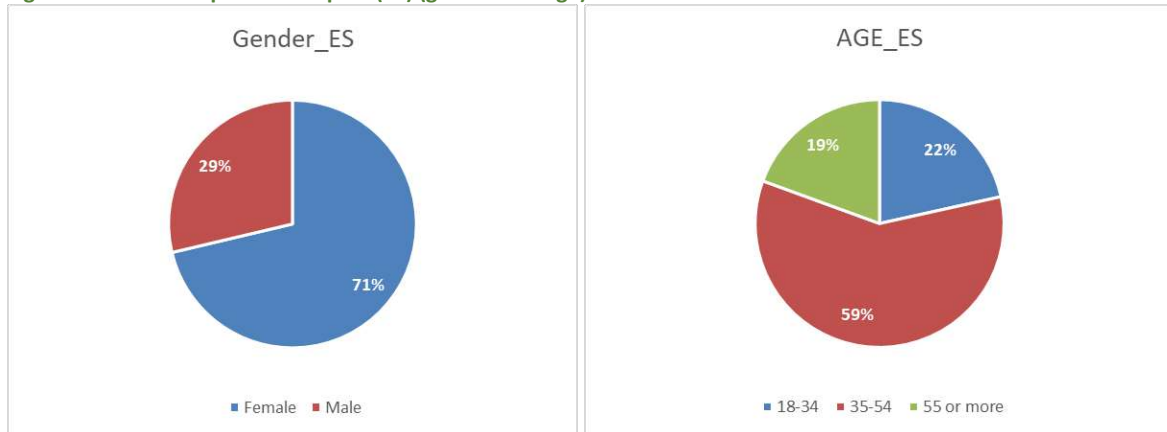
Figure 78 Consumer profiles in Greece (GR) (gender and age)
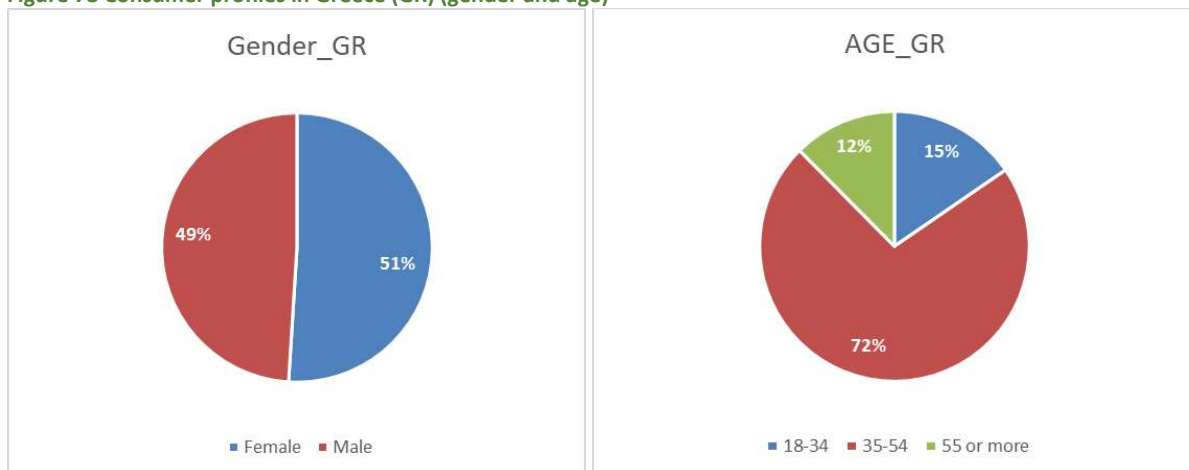
Figure 79 Consumer profiles in Netherlands (NL) (gender and age)
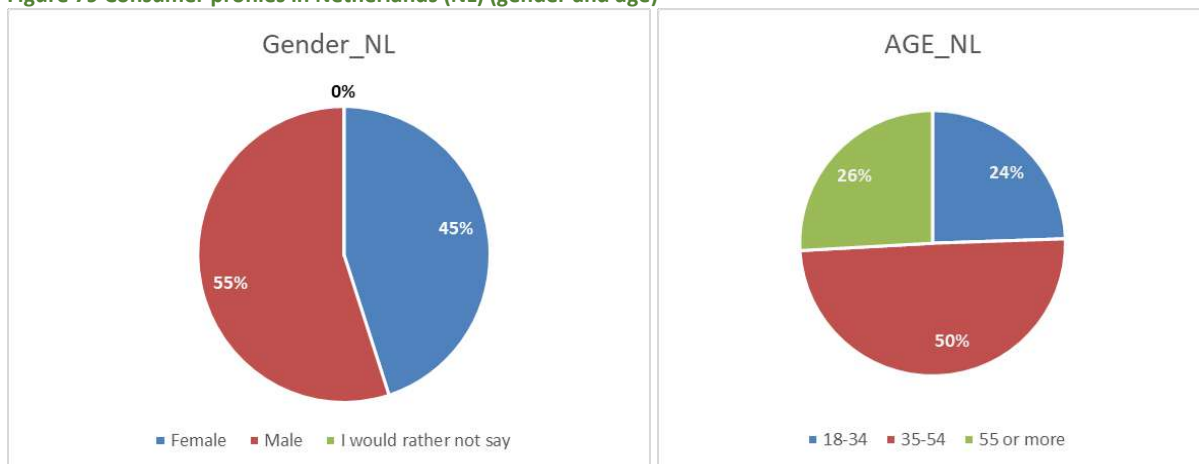
Figure 80 Consumer profiles in Hungary (HU) (gender and age)
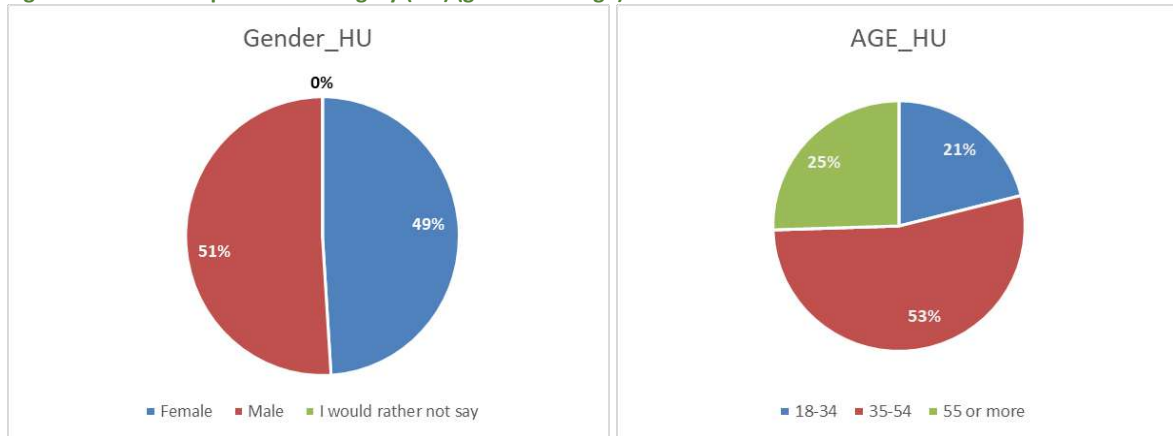
Figure 81 Consumer profiles in Estonia (EE) (gender and age)
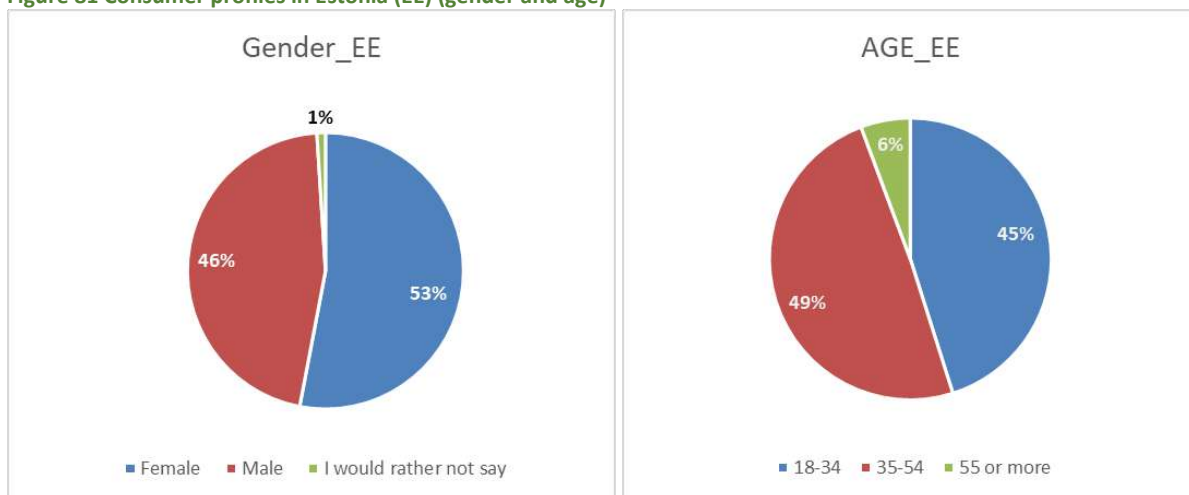
In Spain, most of the consumers resided in **a big city/metropolis** (34%) or in a **town or a small city** (32%). All respondents had school graduates and the majority of them (68%) had **university studies** (**Figure 82**).

Figure 82 Consumer profiles ES (place of residence and level of completed studies)
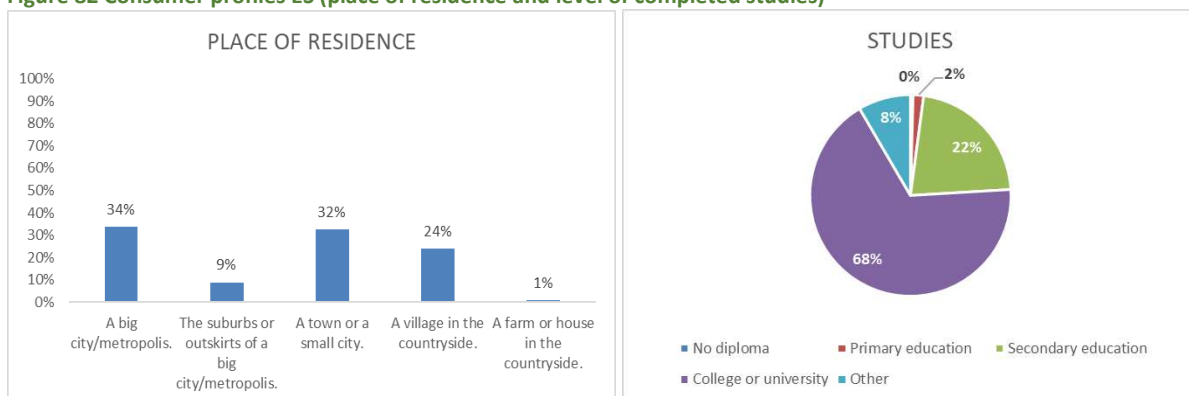
In Greece, most of the consumers resided in **a big city/metropolis** (70%). All respondents had school graduates and the majority of them (68%) had **university studies** (**Figure 83**).

Figure 83 Consumer profiles GR (place of residence and level of completed studies)
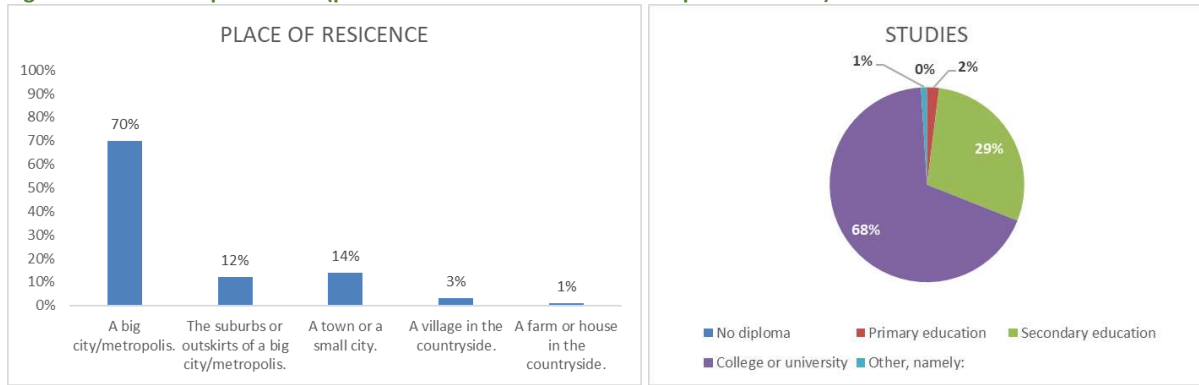
Figure 84 Consumer profiles NL (place of residence and level of completed studies)
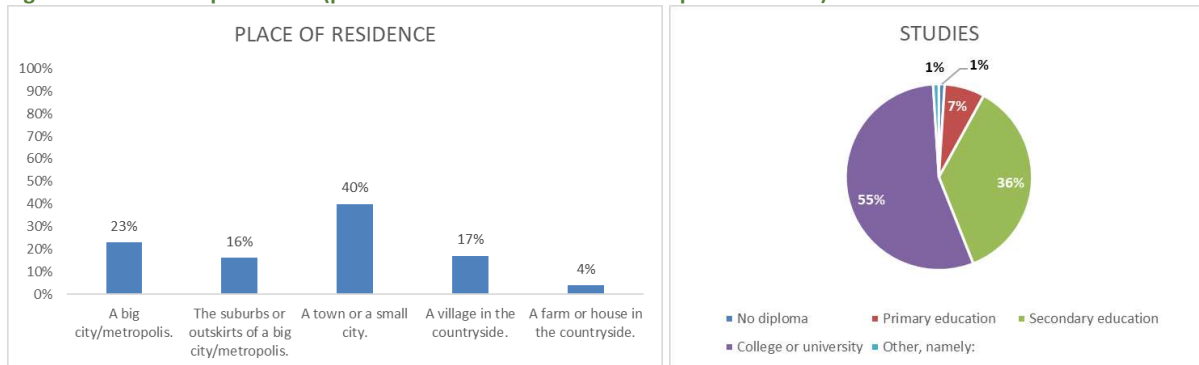
In Hungary, most of consumers resided in **a town or a small city** (40%) and the majority of them (58%) had **secondary education** (**Figure 85**).

Figure 85 Consumer profiles HU (place of residence and level of completed studies)
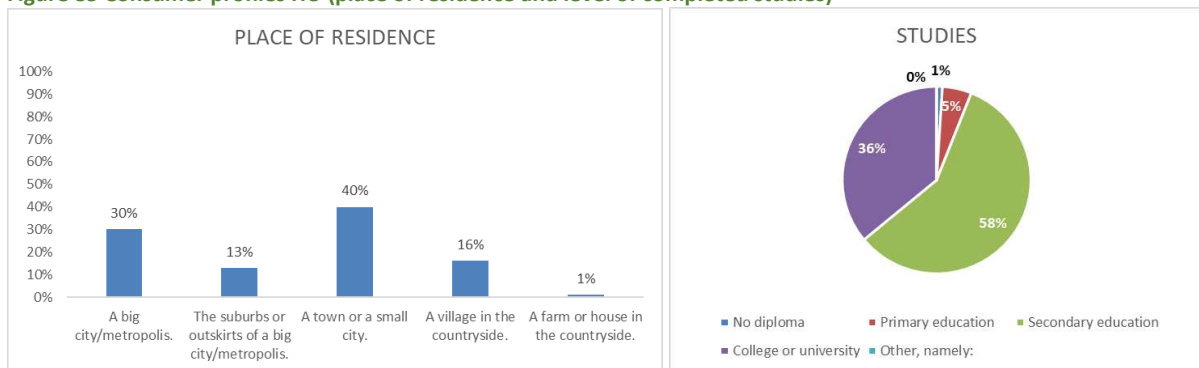
In Estonia, most of the consumers resided in **a town or a small city** (45%) and the majority of them (61%) had **university studies** (**Figure 86**).

Figure 86 Consumer profiles EE (place of residence and level of completed studies)
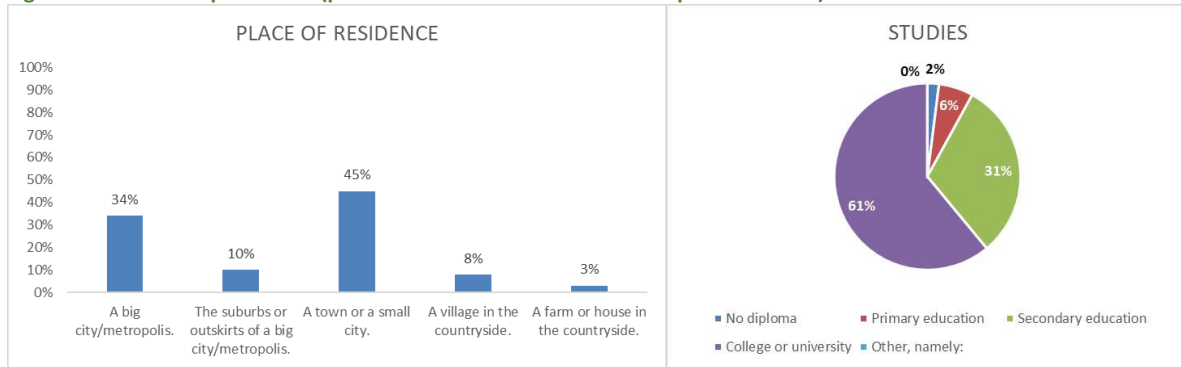
Taking into account the intrinsic situations for each of the countries:

- In Spain the majority of consumers **share a home with one** (27%), **two** (27%) **or three** (29%) **people.**
- In Greece the majority of consumers **share a home with two** (31%) **or three** (33%) **people.**
- In the Netherlands the majority of consumers **share a home with one person** (27%), but many people live **alone** (25%).
- In Hungary the majority of consumers **share a home with one** (32%), or **two** (25%) **people.**
- In Estonia the majority of consumers **share a home with one** (26%), or **two** (24%) **people** (**Figure 88**).

Regarding the **socioeconomic level** of the respondents:

- In Spain was in its majority "getting by well" (77%) and in most of the cases the financial situation of their households has not changed over the past 3 years (40%).
- In Greece 53% of the respondents were "just getting by" and in most of the cases the financial situation of their households has changed over the past 3 years (32% considerably deteriorated and 30% slightly deteriorated).
- In the Netherlands 42% of the sample was "getting by well", while 43% were "just getting by" and in most of the cases the financial situation of their households has slightly deteriorated in the last 3 years (32%).
- In Hungary almost half of the consumers (44%) were "just getting by" and in most of the cases the financial situation of their households has changed over the past 3 years (33% considerably deteriorated and 36% slightly deteriorated).
- In Estonia 41% of the respondents were "getting by well" another 41% were "just getting by", while in most of the cases the financial situation of their households has slightly deteriorated in the last 3 years (32%) (**Figure 89**).

Demographics of pilot homes survey

As can be seen below, **13 households of different typologies** were selected, in order to evaluate their behaviour, knowing the characteristics of each household.

Figure 87 Household profiles

HOUSEHOLD PROFILES

- House with **2 ELDERLY** without dependent children → BIG CITY / SMALL TOWN
- House with **2 ADULTS** without dependent children → BIG CITY / SMALL TOWN
- House with **2 ADULTS** with **2 CHILDREN between 18-10 YEARS** OLD in a BIG CITY
- House with **2 ADULTS** with **2 CHILDREN between 9-0 YEARS** OLD → BIG CITY / SMALL TOWN
- House with **1 ADULT with 1 DEPENDENT CHILDREN** in a SMALL TOWN
- House with **1 ADULT** without children → BIG CITY / SMALL TOWN
- House with 1 **CELIAC**
- House with a **VEGAN**
- House with a **VEGETARIAN**

Figure 88 Consumer profiles (number of people living in the household)
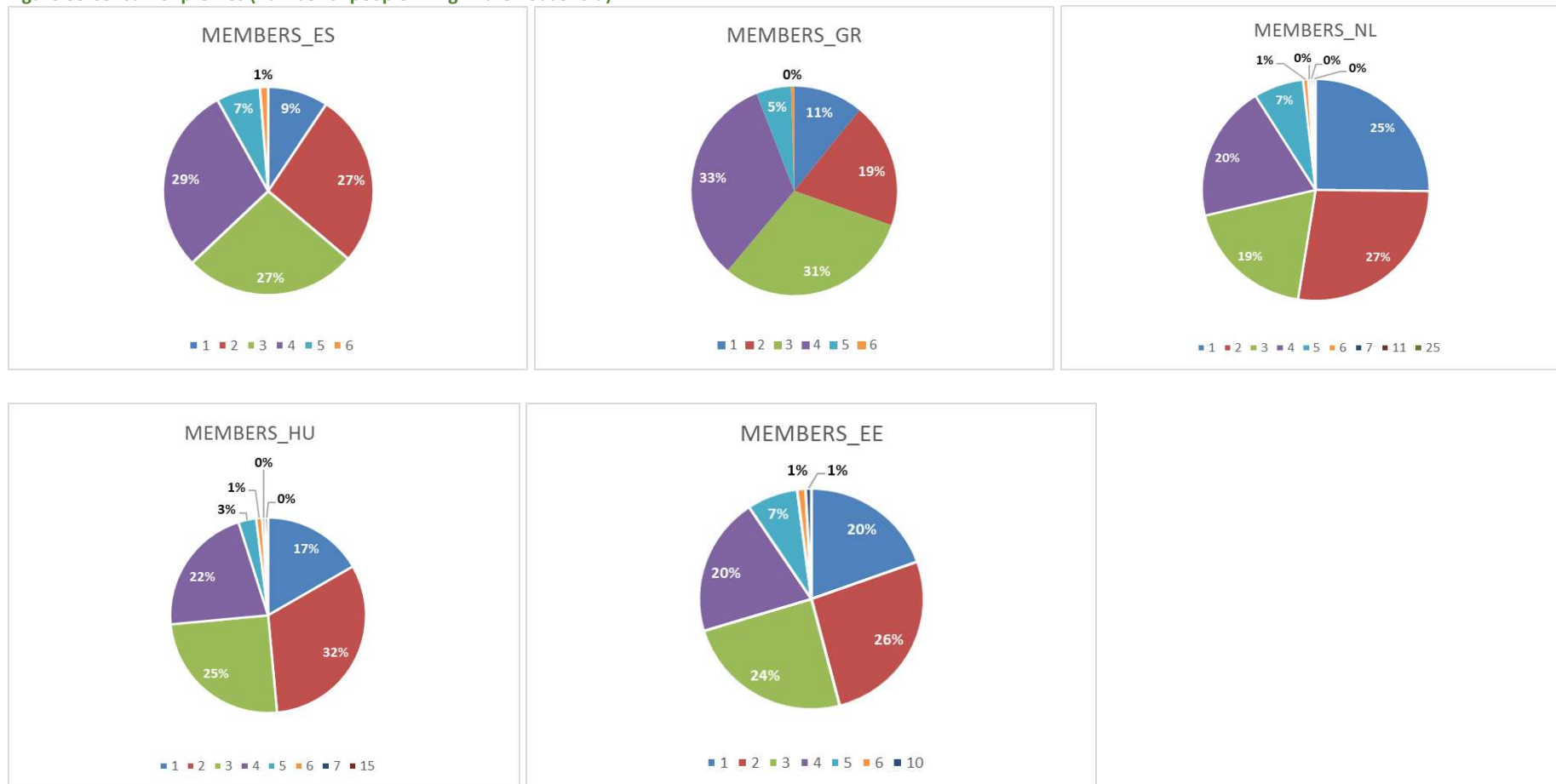
Figure 89 Consumer profiles (socioeconomic level and change over the last 3 years)
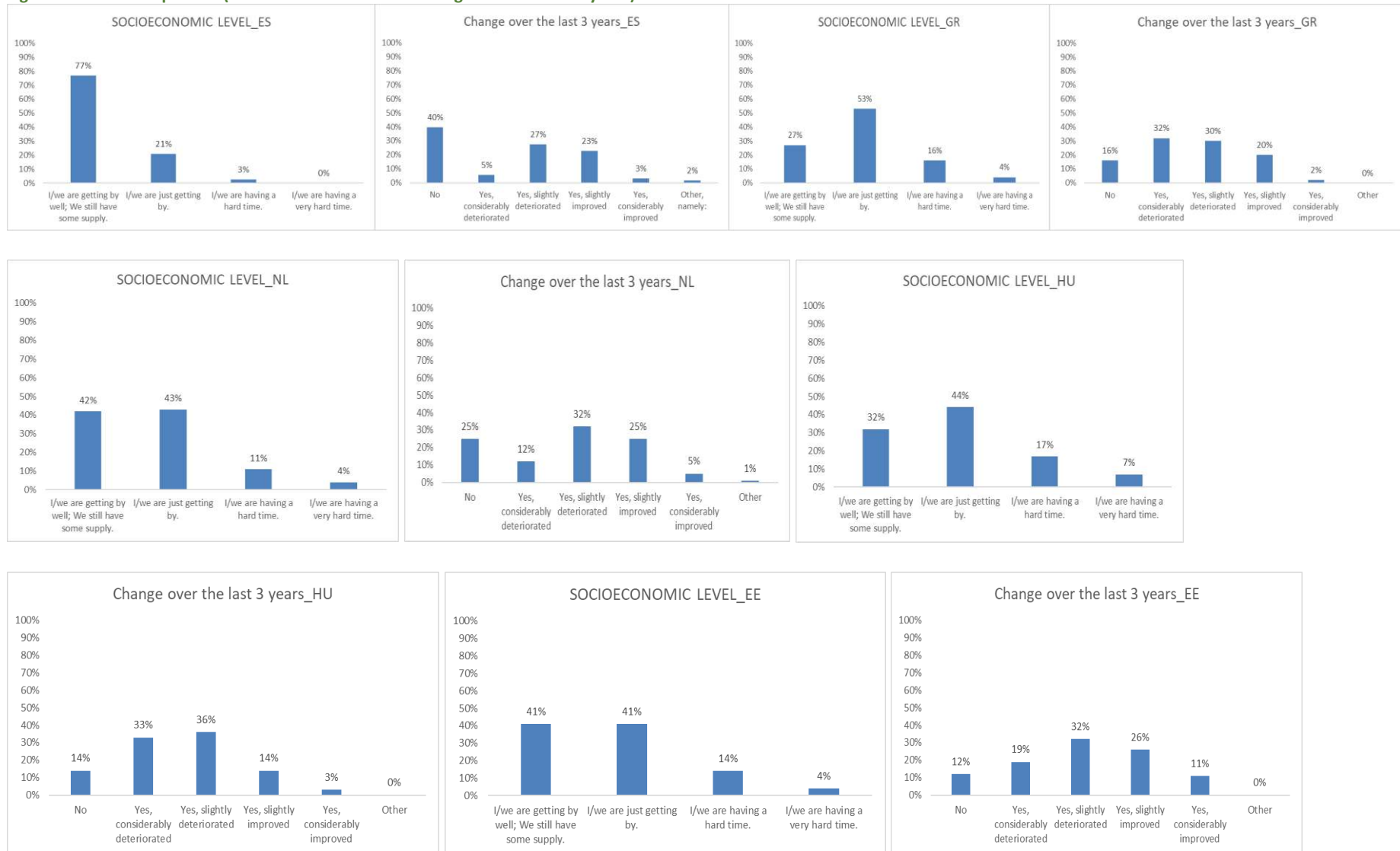
4.4.2   Food waste measurement

Descriptive Statistics and Correlation Analysis

Consumer survey

To understand how social norms **influence behaviour** and food loss and waste (FLW), we have quantified how often households buy so much food that some of **it expires** without being consumed (**Figure 90**).

European consumers believe that they buy **infrequently** so much food that some of it expires without being eaten, especially in Spain (63%), but in Estonia, they believe that they do that more frequently (54% sometimes).

Figure 90 Frequency of food waste (expired and thrown away) by European country
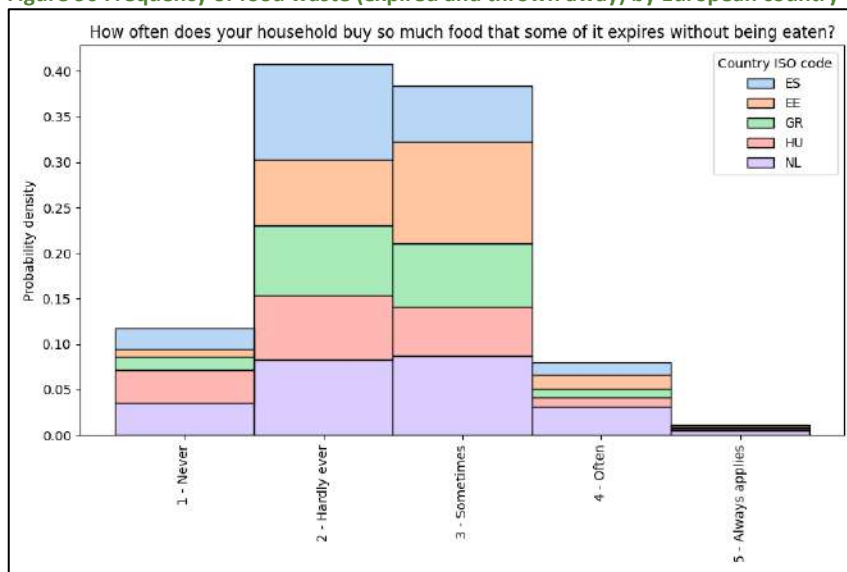
When investigating the weekly food wastage within households, specifically focusing on edible portions and excluding cores, peels, and bones, intriguing patterns emerge (**Figure 91**). The prevailing trend across these findings indicates that a significant majority believe **they throw away a small amount of food**. However, this outcome likely mirrors a self-reporting bias, a tendency also observed in other case studies of the CHORIZO project. Such bias might arise from respondents potentially underestimating their actual food waste due to social desirability or a desire to appear more careful in their consumption habits.

Pilot Home survey

The amount of food the respondents in the pilot homes have thrown away (food waste) in the 5 weeks of the study by household type are depicted in more detail in Appendix F.

Figure 91 Food waste per category for consumer

BREAD

ES: 78% 2 slices or less
GR: 76% 2 slices or less
NL: 73% 2 slices or less
HU: 81% 2 slices or less
EE: 79% 2 slices or less

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

ES: 95% <200g
GR: 84% <200g
NL: 77% <200g
HU: 86% <200g
EE: 78% <200g

MEAT (including charcuterie)

ES: 88% 0 – 50g
GR: 73% 0 – 50g
NL: 70% 0 – 50g
HU: 83% 0 – 50g
EE: 70% 0 – 50g

FRUITS AND VEGETABLES

ES: 88% <500g
GR: 76% <500g
NL: 73% <500g
HU: 87% <500g
EE: 79% <500g

DAIRY (milk, yogurt, cheese)

ES: 90% <200ml
GR: 80% <200ml
NL: 74% <200ml
HU: 91% <200ml
EE: 80% <200ml

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

ES: 92% 1 glass or less
GR: 79% 1 glass or less
NL: 71% 1 glass or less
HU: 89% 1 glass or less
EE: 81% 1 glass or less

OTHER (chips, cookies, chocolate, etc.)

ES: 92% <200g
GR: 84% <200g
NL: 80% <200g
HU: 93% <200g
EE: 88% <200g

4.4.3   FW-related behaviour

<u>Qualitative Analysis</u>

Consumers

Case study 6 included 15 in-depth interviews (IDIs) with consumers in Spain. The objective was to obtain consumers' insights on date-marking ('use-by' expiry date and 'best-by'), smart packaging, and ultimately determining if and how they relate to food waste. Of the 15 interviews, 10 took place with females and 5 with males. All interviewees participated in buying food and preparing meals in the household. The average age of the interviewee was 40.4 years old. Most were living in a household where they were married or with a partner, but most often, there were no children or other family members.

When asked how much food had been wasted over the past week, nearly all (11) answered that the amount of food waste was negligible, with answers such as "little," "very little," "not a lot," or "not much," while one interviewee noted that nothing was wasted, and only two respondents said that they wasted "a lot" of food. Overall, most interviewees believed that they wasted minimal amounts of food. Only one person acknowledged that perhaps households are unaware of the amount of food they throw away.

Motivation (consumers)

When asked whether it was **essential to avoid food waste**, all interviewees replied in the affirmative. The issue was essential for them to vary due to their **awareness** of the different impacts of food waste generation in society. Interviewees mentioned a mixture of **societal, environmental, and economic impacts**. More than half of those interviewed (60-70%) stated that food waste is associated with different impacts, from economic to environmental and social. Among the societal impacts, the interviewees most often highlighted awareness due to media campaigns and first-hand experience regarding those in society struggling with food insecurity (i.e., not enough to eat daily). All those interviewed agreed that the main social impact was the injustice that occurs by wasting food when there is so much hunger in the world. Among those who noted environmental concerns, there was not only awareness but also evident knowledge about the food supply chain system and what resources are generally needed to produce food commodities. This awareness also highlighted the economic cost of such production and that if the commodity is not eaten, then the money invested in it, is essentially lost. The importance of household expenses was raised, noting a clear link between **family finances** and food waste generation. The importance of not wasting food was further evident when respondents were asked how they felt when throwing away food. The predominant feelings expressed were guilt, annoyance at oneself, feeling sorry, and generally feeling bad about it. The reasons for the bad feelings related to the negative impacts of food waste.

Date-marking (consumers)

Regarding date-marking, a critical topic that emerged was the expiration date. Several interviewees noted that as soon as a product was beyond its indicated expiration date, they were more inclined to throw it away. The overwhelming reasoning for this action was a concern about the **product's safety**, as it was evident with one interviewee when stating, *"If you don't know…well, I'll throw it away just in case",* or with another interviewee when stating *"…because it is cooking, and cooked food sometimes has dairy products or creams, and you don't have to risk having that because it immediately creates bacteria".* However, most respondents (12) also noted that before they threw out the food that had expired, they evaluated it based on sight, smell, and/or taste. So, in this respect, it depended on the product itself, and most interviewees were not automatically throwing

out food due to an expiration date. For example, one interviewee noted, *"…if it is a meat and we see that the expiration date has passed, we throw it away. In other words, it depends more on the type of product"*. However, the other variable in terms of expired food being thrown away or not was **who the food was meant for** – oneself, other family members, or friends. There was a mixture of responses, with 5 respondents stating that if the food was for other family members or friends, they would instead use food that was not expired, three respondents believed that if the expired food were safe enough for themselves, then it would also be for anyone else, and one respondent replied that it depended on the type of food (i.e. fresh product, dairy, meat, fish versus packaged food).

Meanwhile, products near the expiration date but not yet expired were not seen as a health risk. Ten respondents stated that they did not believe products near expiration posed a health risk for consumers. For example, one interviewee stated, *"No, if it hasn't expired yet and you put the date for safety, if it's about to expire it's safe, even if it expires today, you're on the borderline".* Most respondents (8) trusted that the regulation behind the date-marking was there to ensure that the product was safe to eat. One respondent noted, *"I think that with regard to food and more something that is sold to the public, there are tremendous security measures. If not, the company takes a lot of risks and I think that the last thing those companies want are troubles of the kind that there has been an intoxication. I don't think so, it's all pretty much under control".* Only one respondent thought that companies modified dates to encourage more sales – i.e. shorten the expiration date so that the product had to be bought more often. Other respondents (2) were unsure, indicating that they had not given much thought to the topic of company influence on date-marking.

Interviewees were asked if they checked date-marking of food products (i.e. "use-by" (expiration date) and "best-by") when shopping and when preparing food at home. For **shopping,** 11 respondents said they **checked for the date marking**, while 10 interviewees said they also checked the dates when **preparing food**. There was only one respondent who said that the dates indicated on products was not checked when buying food, and three respondents who did not check dates when cooking. There were two caveats, however, for both situations (i.e., buying and preparing food). The first is that while dates were checked, it also **depended on the type of food** being bought or prepared. Dates were mainly checked regarding **fresh products**, including fruits, vegetables, dairy products, meat, fish, and generally anything that was not packaged. One interviewee said, *"It's not the same that meat has expired then that some chickpeas or macaroni have expired. The truth is that in legumes or packaged things that are not fresh I don't usually look so much at the expiration date; I look more at fresh products, dairy products, and preserves".* Another interviewee stated, *"What I usually check less is maybe the pasta, rice, everything that doesn't go in the fridge."*

The other caveat was the **type of date being checked** – i.e., "use-by" / expiration date or "best-by date." This related directly to awareness about the dates and understanding what they meant and consequently, if and how they were utilized. While all respondents knew that a date existed, there was evidence that there was not always an understanding of the difference between the two dates. For 8 of the respondents, it was clear what the distinction was between the two dates, but 6 of the respondents thought that the dates meant the same thing or were not aware that there was more than one date.

Abilities (consumers)

When asked about the ease of use of date-marking, 8 interviewees responded that it was not easy but **somewhat confusing to interpret**. A good example is the response from one interviewee who said, *"I think that consuming preferentially is confusing because if you consume it before that date, fine, but what if you exceed that date, what harm does it bring? Does the product lose properties, does the product lose nutritional value, or can you get poisoned?"* The difficulty was primarily with

the "best-by" date in terms of what that entailed for the quality and safety of the product. One respondent highlighted the need for consumers to **receive more information** and **education** about different expiration dates. Other interviewees noted the physical challenge of locating and seeing the dates, depending on the product, suggesting that this issue also needs to be addressed. While the majority of respondents (8) highlighted that date-marking was not easily understood by themselves, these respondents also felt that this was the case for the population at large. For example, one noted, *"People don't care if they put an expiration date or a preferential consumption date, they don't know how to distinguish it"*.

Ensuring knowledge about date-marking and preservation methods for opened and used food emerged as necessary abilities to invest in. However, other abilities about date-marking and packaging also emerged during analysis of the interviews.

- **Testing food** – "Look, Smell, Taste"- Utilized when determining if the food was of good quality and safe to it when it was close to or after the expiration date.
- **Freezing** – Method employed for left-over food from meals or surplus food due to large quantity purchases.
- **Visible stocking for meal preparation** – About half of the respondents (7) utilized a stocking system, which allowed them to utilize soon-to-be expired products before other products.
- **"Smart" Shopping** – These included efforts to do regular (weekly) shopping trips and make a grocery list in advance of shopping by meal planning.
- **Use of left-over food** ranged from giving left-over food to livestock and domestic animals to incorporating the food into new recipes and meals.

One of the most widespread behaviours among respondents was trying to have habits that helped them to reduce food waste. These included **organizing meals** for the week, making **small purchases**, making a **shopping list** or **rotating products** in the pantry.

Opportunities (consumers)

When interviewees were asked if the size and material of the **current packaging** met their family needs, 11 responded that it did not. However, within that set of responses, three people indicated that the current **size** and **material** met their needs, but only because they adapted to it (by freezing, for example, what was excessive). Those who said that they could not find packaging adapted to the quantities they needed, were mainly small households, as they stressed that the packaging is usually designed for large families. In addition, they pointed out that sales and special offers are always focused on buying large quantities of product. A bigger size was though welcomed in regards to its lower cost to purchase. There was one person within this group who thought that while generally the size and material sufficed, there were products for which packaging material was inadequate in addressing family needs. The interviewee stated, *"…in fruits and vegetables, I think a lot of plastic is used, and we should try to reduce that expense; for example, take them with a reusable cloth bag. So in those containers, they are inadequate to what I would like or what I think in my house and in general we need"*. Plastic was also explicitly mentioned by one other respondent. *"I don't like plastic at all…what is in purely plastic, such as slices or wedges of cheese, I don't like to have it in plastic; I transfer it to film or paper"*. There was only one respondent who said that the quantity was often too large.

About half of the interviewees (7) noted that they kept food in its original packaging for **practicality and convenience**. For example, one respondent said, *"For convenience and because I think it's silly, what's the point, it doesn't make sense"*. This may also point to either apathy towards preserving food, or simply need for knowledge among these respondents regarding food preservation techniques. The thought process was also that the food had already come in a particular package, so

changing it was unnecessary. *"Yes, because it already has come prepared to be there. The food company has developed something for you to keep in the container".* Three respondents said that it depended on the product, with some products, such as meat, fish, and cheese products requiring another container. *"For example, a piece of white cheese that was bought in the little store downstairs, which they give me in a plastic bag, I put it in a taper and put it in the fridge".* Four interviewees said they generally changed the packaging to preserve the food better. The other half of the respondents (53%) stated that they take the food out of its original packaging and store it in a new one (e.g. Tupperware, foil or cling film), either to save space when storing it ("I keep it in the original container normally unless I've done something with it, like if I buy Parmesan cheese and only use half of it, then maybe I don't put it back in the plastic, I put it in a lunch box.") or because the original packaging does not close well ("Not all, some can't be in their packaging because it's too open.").

When asked if the **size and material of packaging** affects the amount of food waste, only one interviewee answered a definite "yes". The majority of respondents (8) responded that **it did not affect food waste,** or that it was dependent on the product, with a variety of different sizes and package materials available across most product ranges. One interviewee, even noted that the amount of food waste generated was their own fault and that it rather depended on the possibility and ability to preserve excess food, by either freezing it or putting it in another container. Most interviewees did not see the larger packaging in a negative light, because it is often less expensive than a smaller-sized product. However, what is key in terms of food waste generation is the **extent to which the interviewees possess knowledge and the ability to preserve food, regardless of packaging material and size**. This merits more attention in subsequent research, follow-up interviews, and analysis.

During interviews, respondents were given a broad explanation of what **smart packaging** entailed and thereafter were asked if they supported the introduction of smart packaging options onto the market. All 15 interviewees gave their **support to the general idea** and related initiatives. The respondents supported it because they thought it would be beneficial in addressing food waste, but also because it could possibly help consumers understand if a product is still safe to eat. *"Yes, of course, I think it's really useful at the level of daily life because if it tells you when a product is bad or when you have to throw it away, you're not going to consume it anymore; you're not going to put your health at risk".* However, they also indicated that when it came to such tools, they were looking for something that was **convenient**, **easy to understand** with **clear instructions,** and that would help to **facilitate optimal preservation of the product.** The **cost of smart packaging** was also raised as an issue to address, concerning the extent to which it might increase the product's price. Ultimately, while respondents were supportive of smart packaging, its cost, appearance, utilization method, and the need for potential consumer training merit more attention in future research.

Industry

In-depth interviews were carried out by FIAB with 25 Spanish companies about the possible impact of social norms in food waste in relation to date marking and smart packaging. In order to obtain a sample representing the different actors in the industry, an in-depth interview was completed by small, medium and large companies of the Spanish Food Industry with a total of 30 questions asked. Those questions were divided into:

- General questions about the Food Industry.
- Question related to production.
- Questions related to storage/packaging.
- Question related to Distribution.
- Questions related to Social Norms in all the stages.

- Final questions.

Since some of the data was considered by companies to be highly sensitive information and in order to increase the trust of the companies during the interview, all participants were anonymised.

The methodology used to develop the analysis started with identifying the social norms and then to explain them with examples from the interviews. The interviews demonstrated a clear division of opinions in some of the questions depending on the type of product produced by the company. The groups identified with similar answers were classified as follows:

- **Fresh products or low processed products**: fruits, vegetables, meat, dairy products, eggs, ingredients, juices, bakery.
- **Canned food/ frozen/ non-perishables**: Olives, olive, coffee, additives and flavours.
- **Alcoholic drinks/ Soft drinks**: Vermouth, wine, beer, bubble tea.
- **Waste management**: Two companies dedicated to management of by-products that gave a different and interesting point of view.

Figure 92 Distribution of the companies interviewed
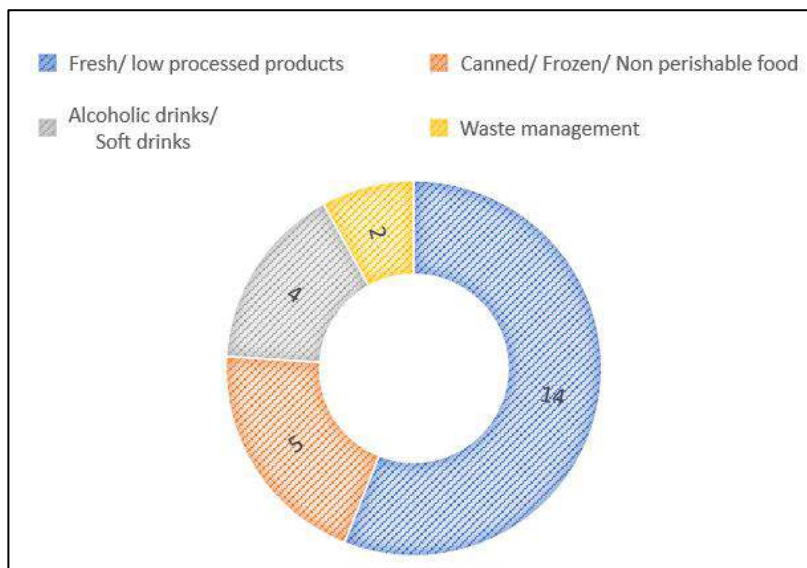
Motivation (industry)

All industries work under **strict rules and laws about food safety**, they apply the **FIC Regulation** with respect to date marks. Microbiological analysis must be done for the establishment of expiration dates, while organoleptic and physicochemical ones are used for best-before dates establishment. The criteria are then directly related to the real shelf-life of the product, nevertheless, many companies recalled being influenced by external factors, for example consumer preferences and storage behaviour or the requirements from retail to shorten or extend those dates.

During the interviews it became apparent that industries were **aware of the importance that consumers give to date marking** in some products, even though they thought that consumers do not usually understand the difference. Of course, there are products where date marking was not relevant for consumers, such as alcoholic drinks, non-perishable products like rice, flour, coffee or frozen food. The answers obtained from different industries differed regarding some questions related to date marking due to the difference in properties of each product.

Another interesting discussion was about **differences in behaviour depending on the context**. All participants agreed that people act differently in relation to **best-before dates** or **expiration** dates **depending on who is the final consumer**. Extra care is used for children and old people, or if the product is expensive. Also, when the product is served in a **social setting,** industry representatives interviewed believed that consumers gave more importance to the expiration date, as they wouldn't want to take the risk with a product close to expiration; probably related to social acceptance.

Abilities (industry)

The main industry client (distribution) highlighted certain techniques utilized for products close to expiration, such as **putting them on sale**, or **exhibiting them in the front row** of the shelfs. But in some rare occasions distribution would return the products to the factory to avoid money wastage. Some questions about returns from clients (distribution, retail, HORECA) due to date marking were formulated, but most of the companies (64%) agreed that they **don't accept returns** for those reasons. According to the discussions, the percentage or amount (in kilograms) of food waste due to date marking reasons was very low (around 2-5%) or was not event calculated or registered.

Within the supply chain discussions highlighted that it was important to note that management of warehouses and the length of remaining shelf-life of a product delivered to the retailer are key factors in avoiding food waste and directly dependant on stock control. Many companies (small companies) interviewed work under **"zero stock",** in that they produced what they sold. They saw it as a good way to avoid food waste, but it also gave them less margin to act under any external problems. All of them made sure to leave enough margin of time to retail for the sale of their products. Many of the participants agreed that the main methodology for stock management was FIFO **("First In First Out").**

Opportunities (industry)

The industry representatives all agreed that packaging was a key aspect within the determination of the shelf-life of a product, and very relevant to avoid loss of organoleptic characteristics. Indeed, many of the respondents (40%) were already making innovations in their packaging systems or doing research about it.

An important **consumer habit** that could be influenced by industries is the change of packaging once the product is opened at home. Most interviewees (60%) agreed that there was no need to change containers, but they didn't communicate it to the consumer. Others thought it was better to change it. The uncertainty about the conditions in which the product might be stored after opening led industry to use formulations such as "consume immediately" as a prevention measure.

One way of **communication** between the industry and the final consumer is via packaging, although it was the general consensus among interviewees that introducing new smart packaging is not appreciated as valuable by consumers in many cases, or even accepted at all, due to higher prices. General agreement among interviewees was to have better information given to consumers to increase their awareness. The acceptance of products is important for a company's financial results, and many of them agreed that any innovation should be analysed - it should provide a longer shelf-life, be sustainable, not harm the utility of the packaging, and of course not cause economic loss for the company. Achieving such a balance is complicated, but most of the interviewees agreed it was necessary to invest in research in the matter. Participants shared the current initiatives that they were involved in, with a number of companies investing in packaging research and improvement, but also other relevant initiatives related to increasing shelf-life of their products, improvement of production processes, participation in research projects, or join initiatives to educate consumers (e.g., Including messages like #LookSmellTest on their packaging).

Main conclusions from consumer and industry interviews

- **Motivation:** The belief that food waste is important and, both as individuals and as a society, we should be addressing it, was evident in the overwhelming affirmative responses given by consumer and industry respondents. Other evidence of the importance given to food waste was found in the indications by interviewees that they were aware of the detrimental social, environmental, and economic impacts of food waste, as well as in the negative feelings that emerged when they generated food waste. In terms of social norms, based on consumer interview data, food waste generation was seen by the majority of respondents as something that should not be done (disapproved by society) and, in this respect, was indicative of an injunctive social norm with a proscriptive character.

- **Date-marking:** Date-marking affected food waste generation, but how this took place was not straightforward. There were various factors at play - expiry date, the type of product, for whom the food was intended, food safety concerns, and the understanding of what "best-by" and "use-by" meant.

- **"Best-by" and "use-by":** Data from the interviews demonstrated that more attention (training) should be given to consumers on the difference between the two dates and/or to invest in more precise methods of indicating the lifespan of a product.

- **Importance of food safety:** When asked about the importance of food safety, consumer and industry respondents overwhelmingly noted that it was indeed important and should never be compromised. A direct link was made by consumers interviewed between food safety and the expiration date when discussing why food was thrown away.

- **Trust in companies:** The majority of respondents believed in the regulation that determined the date markings, noting that companies would not risk reputational damage by compromising the safety of a product.

- **Packaging**: Regarding packaging (size and material), what proved key in food waste generation was the knowledge of, and the capacity to utilize one's ability to preserve food, regardless of packaging material and size. It is a topic that merits more attention in any subsequent research, follow-up interviews, and analysis.

- **Smart packaging:** There is an opportunity for smart packaging to help consumers utilize food for as long as possible. However, more research is needed to better determine its appearance and functionality, while attention should be given to where along the value chain any additional costs due to this packaging will be covered, and what training can be given to consumers.

Descriptive Statistics and Correlation Analysis

In this subsection we discuss the various aspects of consumer FW behaviours and attitudes, focusing on three key themes: habits and food waste, marking dates and smart packaging.

Consumer survey - habits and food waste

Regarding **leftovers after cooking** (**Figure 93**) most European countries exhibit a general indifference (GR 44%; NL 49%; HU 59%; EE 53%), except for Spain, where there's a preference for having leftovers after cooking (28%). The stacked bars **Figure 93** show simultaneously the total share of the various answers and the break down per country. **Figure 94** reflects that more than 50% of the

respondents don't consistently **retain food in its original packaging**, their decision influenced by the specific types of food involved (ES 64%; GR 68%; NL 51%; HU 64%; EE 54%).

Figure 93 Cooking and Leftovers Preferences
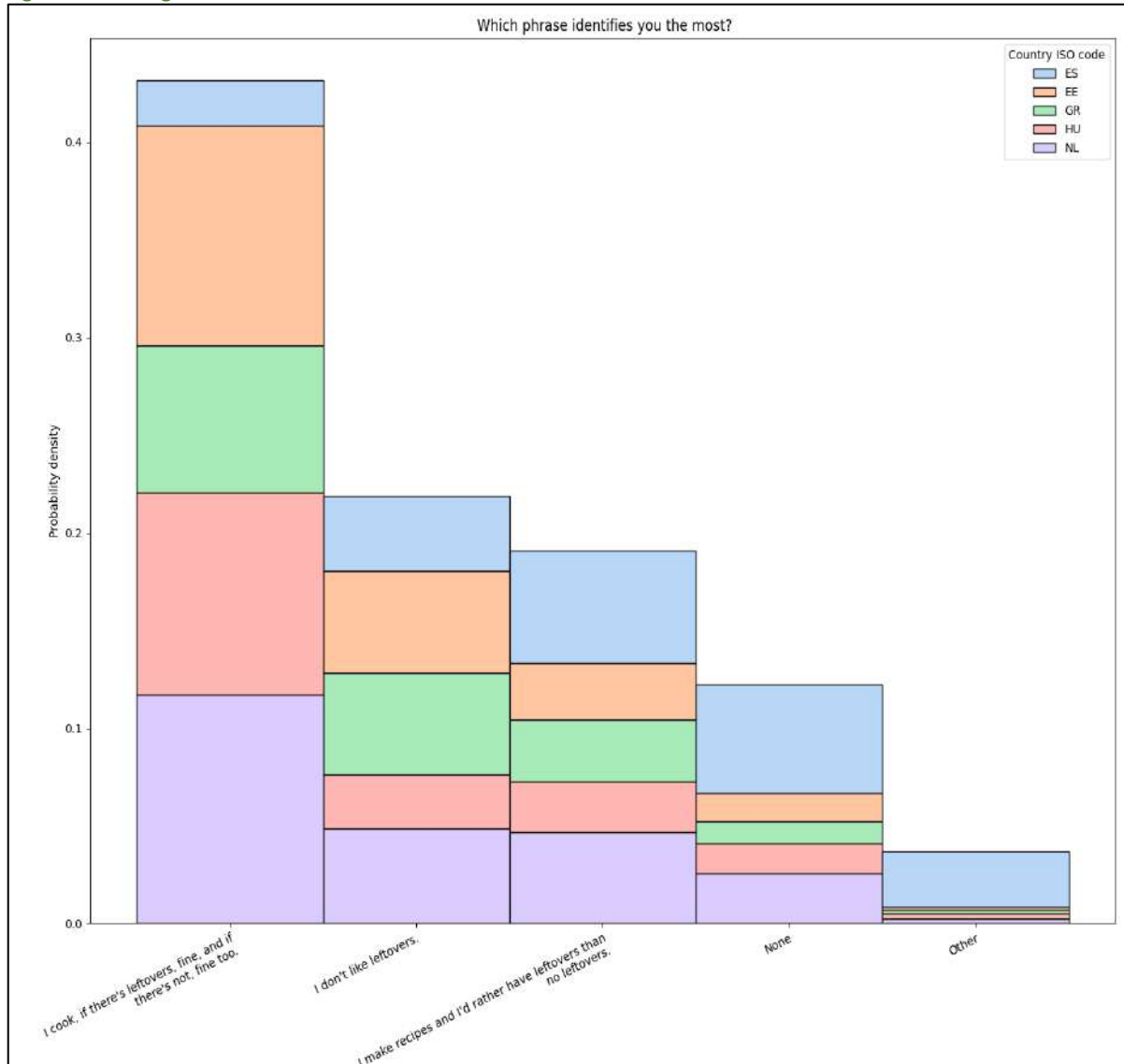
Figure 94 Keeping original packaging after opening
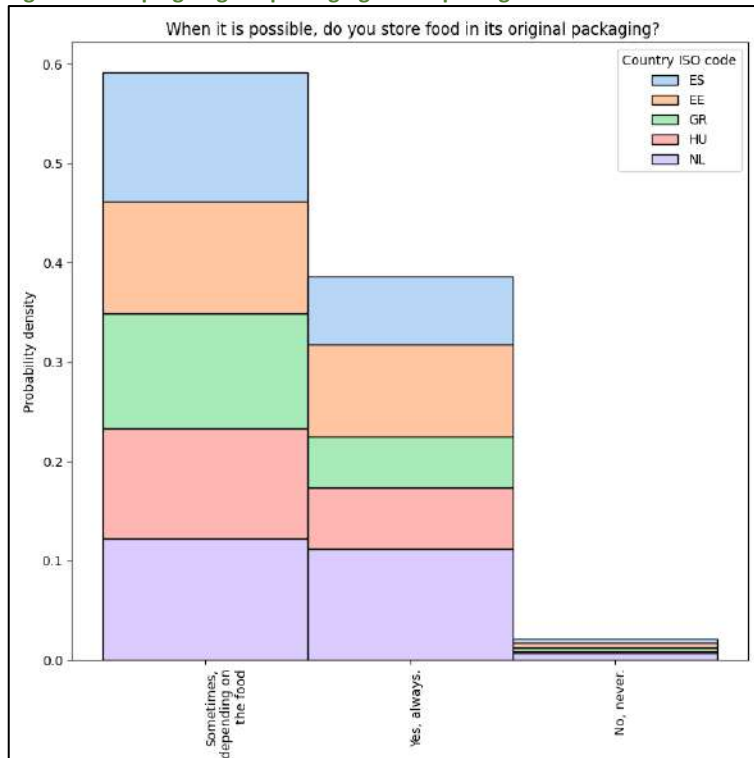
Consumer survey – Marking dates

To understand how social norms **influence behaviour** and food loss and waste (FLW), this study explores how often households check expiration dates or signs of spoilage/freshness for the food they buy **(Figure 95)**. The bars show the average responses for each food type and country, so on an aggregate level, European consumers often check the marking dates for the food they buy.

Figure 95 Frequency of checking expiration dates and food quality
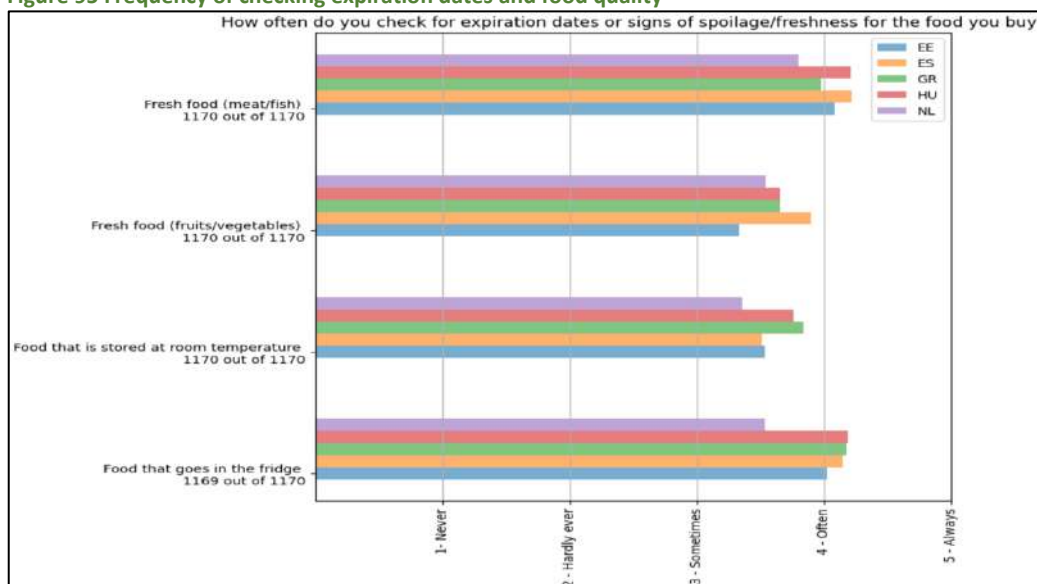
The **marking dates are looked at more in fresh products** such as meat and fish as well as for food that goes in the fridge. In most households, consumers "always" check expiration dates, especially in Hungary (53% for fresh food and 46% for food that goes in the fridge) and in Spain (54% for fresh food, 37% for food that goes in the fridge). In Greece, 45% of respondents always check the marking

dates for fresh food, and 46% check them for food that goes in the fridge. In the Netherlands 39% of the respondents always check for fresh food, while in Estonia 49% of the respondents always check for fresh food, and 41% always check for food that goes in the fridge.

As can be seen in **Figure 96,** when European consumers **decide** whether **to eat or throw food away that is outside of the consumption dates**, their **main habit** is to "eat it if it looks good and smells good" (ES 28% - 38% depending on the type of product; NL 17% - 24%; HU 20%- 24%; EE 21% - 30%), apart from Greece where they "never consume it and they throw it away" (33%). In the case of fruits/vegetables many consumers "eat if it looks good" (ES 29%; NL 23%; HU 25%; EE 29%).

Figure 96 Behaviour on eating or throwing away food of consumption dates
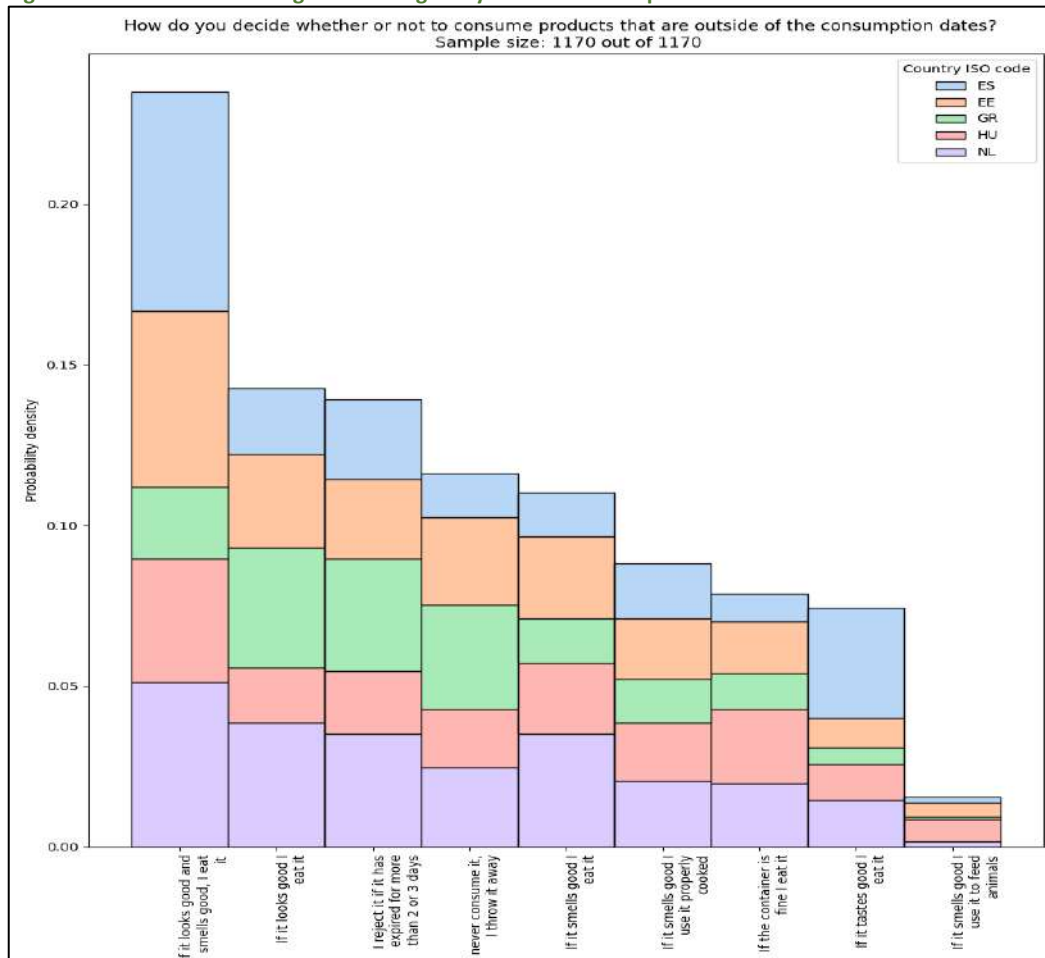
Therefore, apart from Greece, in the rest of the countries that were surveyed, the main **reason/motivation** for throwing away food is **inadequate appearance and smell**.

In **Figure 97**, it is interesting that over half of consumers across Europe believe they are **sufficiently attentive when checking expiration dates** (GR 53%, NL 55%, EE 55%), with a notably higher proportion in **Hungary** (71%) and a lower in Spain (46%).

Regarding the interpretation of date marking, as it can be seen in the following **Figures (98-101), across Europe consumers are not clear about the difference between "best before" and "safe until"** (especially depending on the product). The majority of the respondents think that they can consume the food more or less around those days (marking dates), even after "expiration" (ES 47%; GR 48%; NL 45%; HU 55%; EE 39%) **(Figure 98).** Therefore, **this behaviour influences the reduction of food waste.**

Consumers are **much stricter with meat and fish** than with other food types (ES 40% meat and 49% fish; GR 48% meat and 53% fish; NL 41% meat and 43% fish; HU 44% meat and 48% fish; EE 48% meat and 57% fish) (**Figure 99**).

As it can be seen in **Figures 100 and 101**, the meaning of the marking dates is not well understood by the consumer (both 'safe until' and 'best before'). Among the 1,170 respondents, a **majority perceive the clarity of these dates as contingent upon the type of food,** especially in Spain and Estonia (ES 54%; GR 47%; NL 50%; HU 47%; EE 62), while a minority, predominantly Spanish respondents, find the markings entirely unclear (**Figure 102**). Those struggling with clarity often confuse the distinctions between "best before" and "safe until" labels, highlighting a knowledge gap that is important to address through targeted awareness campaigns.

The reasons why consumers believe that they are unclear are because they are confused between "safe until" and "best before", while especially in Hungary the main reason is that the marking dates are "Not big enough on the packaging".

In evaluating the **behaviour** of European consumers, it can be seen that in most cases, they discarded fine-looking food because it was past marking date, both for "safe until" and "best before" markings (**Figure 104**).

Consumer survey – Smart packaging

Generally, the majority of consumers believed that should the industry develop a packaging that ensures the durability of the product, **the quality of the product would be the same** (ES 54%; GR 50%; NL 46%; HU 53%; EE 51%) (**Figure 105**). A significant segment of respondents either hold the belief or is certain that smart packaging won't extend the shelf life of food post-opening (NL 37%; HU 38%; EE 38%; GR 38%), with the exception of Spain where the majority thinks that smart packaging will increase the shelf life of food (**Figure 106**). This scepticism suggests varying perceptions about the effectiveness of innovative packaging solutions among surveyed individuals.

Figure 97 Answer to "Do you think other people check expiration dates more attentively than you"

Perception on other people´s checking date marking_ES

- No
- Yes

46% — No
54% — Yes

Perception on other people´s checking date marking_GR

- No
- Yes

53% — No
47% — Yes

Perception on other people´s checking date marking_NL

- No
- Yes

55% — No
45% — Yes

Perception on other people´s checking date marking_HU

- No
- Yes

71% — No
29% — Yes

Perception on other people´s checking date marking_EE

- No
- Yes

55% — No
45% — Yes

Figure 98 Interpretation of date marking

INTERPRETATION OF DATE MARKING_ES

- I have to "compulsorily" consume the food before the date. — 7%
- I can consume the food more or less around those days, even if it exceeds. — 47%
- Is just a suggestion. — 10%
- Depends on the type of marking dates. — 35%

INTERPRETATION OF DATE MARKING_GR

- I have to "compulsorily" consume the food before the date. — 31%
- I can consume the food more or less around those days, even if it exceeds. — 48%
- Is just a suggestion. — 9%
- Depends on the type of marking dates. — 12%

INTERPRETATION OF DATE MARKING_NL

- I have to "compulsorily" consume the food before the date. — 16%
- I can consume the food more or less around those days, even if it exceeds. — 45%
- Is just a suggestion. — 18%
- Depends on the type of marking dates. — 21%

INTERPRETATION OF DATE MARKING_HU

- I have to "compulsorily" consume the food before the date. — 12%
- I can consume the food more or less around those days, even if it exceeds. — 55%
- Is just a suggestion. — 24%
- Depends on the type of marking dates. — 9%

INTERPRETATION OF DATE MARKING_EE

- I have to "compulsorily" consume the food before the date. — 16%
- I can consume the food more or less around those days, even if it exceeds. — 39%
- Is just a suggestion. — 13%
- Depends on the type of marking dates. — 32%

Figure 99 Interpretation of expiration date by food type

Does your interpretation of "expiration date" change depending on the type of food?

Figure 100 Interpretation of "Safe Until"

SAFE UNTIL_ES

- The food is no longer fit for consumption. — 48%
- Eating the food will cause us a disease. — 11%
- The food will "taste bad". — 6%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 38%
- The quality of the product begins to deteriorate — 57%

SAFE UNTIL_GR

- The food is no longer fit for consumption. — 50%
- Eating the food will cause us a disease. — 16%
- The food will "taste bad". — 15%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 33%
- The quality of the product begins to deteriorate — 42%

SAFE UNTIL_NL

- The food is no longer fit for consumption. — 32%
- Eating the food will cause us a disease. — 20%
- The food will "taste bad". — 23%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 33%
- The quality of the product begins to deteriorate — 42%

SAFE UNTIL_HU

- The food is no longer fit for consumption. — 29%
- Eating the food will cause us a disease. — 18%
- The food will "taste bad". — 7%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 53%
- The quality of the product begins to deteriorate — 38%

SAFE UNTIL_EE

- The food is no longer fit for consumption. — 47%
- Eating the food will cause us a disease. — 31%
- The food will "taste bad". — 27%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 38%
- The quality of the product begins to deteriorate — 43%

Figure 101 Interpretation of "Best Before"

BEST BEFORE_ES

- The food is no longer fit for consumption. — 4%
- Eating the food will cause us a disease. — 3%
- The food will "taste bad". — 5%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 57%
- The quality of the product begins to deteriorate. — 70%

BEST BEFORE_GR

- The food is no longer fit for consumption. — 32%
- Eating the food will cause us a disease. — 9%
- The food will "taste bad". — 14%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 39%
- The quality of the product begins to deteriorate. — 48%

BEST BEFORE_NL

- The food is no longer fit for consumption. — 16%
- Eating the food will cause us a disease. — 13%
- The food will "taste bad". — 17%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 42%
- The quality of the product begins to deteriorate. — 49%

BEST BEFORE_HU

- The food is no longer fit for consumption. — 11%
- Eating the food will cause us a disease. — 12%
- The food will "taste bad". — 10%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 49%
- The quality of the product begins to deteriorate. — 50%

BEST BEFORE_EE

- The food is no longer fit for consumption. — 17%
- Eating the food will cause us a disease. — 12%
- The food will "taste bad". — 17%
- The food can't be sold anymore for regulatory reasons but has no health/quality meaning. — 51%
- The quality of the product begins to deteriorate. — 61%

Figure 102 Answer to "Do you think the marking dates on the food packaging are clear?"

DATE MARKING_CLEAR_ES

- Yes, they are clear
- Depends on the type of food
- No

38%
54%
8%

DATE MARKING_CLEAR_GR

- Yes, they are clear
- Depends on the type of food
- No

49%
47%
4%

DATE MARKING_CLEAR_NL

- Yes, they are clear
- Depends on the type of food
- No

45%
50%
5%

DATE MARKING_CLEAR_HU

- Yes, they are clear
- Depends on the type of food
- No

49%
47%
4%

DATE MARKING_CLEAR_EE

- Yes, they are clear
- Depends on the type of food
- No

36%
62%
2%

Figure 103 Answer to "Why do you think that marking dates on the packaging are NOT clear?"

NO, Why do you think that?_ES

NO, Why do you think that?_GR

NO, Why do you think that?_NL

NO, Why do you think that?_HU

NO, Why do you think that?_EE

Figure 104 Frequency of discarding fine-looking food because of expiration

Discarded food because it was past marking date, even if it looked fine_ES

Discarded food because it was past marking date, even if it looked fine_GR

Discarded food because it was past marking date, even if it looked fine_NL

Discarded food because it was past marking date, even if it looked fine_HU

Discarded food because it was past marking date, even if it looked fine_EE

Figure 105 Consumers' confidence in smart packaging

Figure 106 Beliefs about smart packaging and life of food

Home Pilot survey

The characteristics of the pilot households in terms of their habits relating to leftovers, as well as why and if they throw away food apart from leftovers are presented in detail in Appendix F.

4.4.4   Social norms

Qualitative Analysis

Sub-optimal food/undesirable food quality: According to the opinion of the industries interviewed, loss of organoleptic characteristics (understood as appearance, taste, flavour) is the most probable reason why consumers throw away food close to expiration (with a score of 101 points). **Industries find loss of organoleptic properties (bad appearance, taste, or flavour) as the most probable reason why consumers throw out food close to expiration dates.** Several consumer interviewees also noted that as soon as a product was beyond its indicated expiration date, that they were more

inclined to throw it away. The overwhelming reasoning for this action was a concern about the product's safety.

Portion size and food affluence: Industries adapted to family units (e.g. family packs, small packs etc.). When consumer interviewees were asked if the size and material of current packaging met their family needs, 11 responded that it did meet their needs. However, within that set of responses, 3 people indicated that **the current size and material met their needs**, but only because they **adapted to it** (by freezing for example what was excessive). For these respondents, a bigger size was welcomed largely due its' **lower cost to purchase**.

Food waste behaviour and socio-economic status: Industries recalled differences in consumer behaviour depending on the context. For expensive products there is less food waste, and if the economic situation of the family is better, date marking has lower importance in purchase decisions.

Descriptive Statistics and Correlation Analysis

Habits and food waste

Figure 107 presents a breakdown of the reasons cited by respondents across Europe for **purchasing more food than they need/planned** which generates food waste. The horizonal axis represents the frequency with which each reason was selected, and the bars depict the average (numeric value between 1 and 5) for each country. There's a prevailing belief that buying excessive amounts of food, leading to subsequent waste, isn't indicative of elevated social status, so **this social norm does not influence food waste** (Never; ES 68%, GR 40%, NL 50%, HU 56% and EE 54%). On the other hand, the primary driver for over-purchasing revolves around the attractiveness of sales and discounts particularly in Hungary (36%), in Greece (28%) and in Estonia (26%).

Figure 107 Reasons for over-purchasing
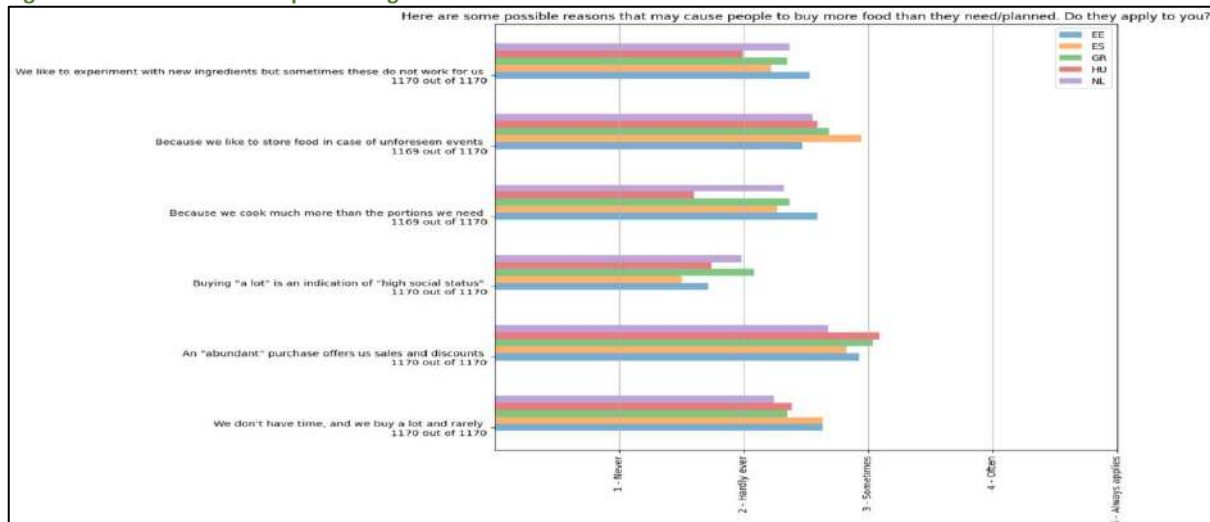
As it can be seen in **Figure 108**, the main reasons and **motives** for keeping food in the packaging are:

- "The packaging gives them confidence and guarantee" in Spain (54%) and Greece (50%).
- "The container is comfortable, and they will use the product immediately" in the Netherlands (46%), Hungary (53%) and Estonia (51%).

Marking dates

Consumers do **not agree** that the reasons that may cause people to throw away expired or out-of-date foods are that "Using them seems to be indicative of having lower social status" (ES 54%; GR 41%, NL 43%; HU 55%), or that "In society throwing them away represents abundance and good economic level" (ES 43%; HU 42%) (figure 5.45), so **these social norms do not influence food waste (Figure 109).**

When exploring the motivations behind not discarding expired or out-of-date food **(Figure 110)**, coupled with general sentiments on food waste **(Figure 111),** respondents expressed several key beliefs and behaviours:

- **Demonstration of solidarity**: A sense of solidarity towards households experiencing food scarcity.
- **Ethical Stance Against Food Waste**: Food should not be needlessly thrown away.
- **Economic Utilization**: Consume expired food to minimize waste and maximize resources.
- **Personal Responsibility and Guilt:** Feelings play a role in decision making.
- **Value in not wasting food:** The importance of minimizing food waste reflects a shared societal value (especially in Spain where this reason is selected by 60% of the respondents).

Regarding consumers' opinions on the influence of the **industry** on marking dates, the answers obtained from the respondents are mostly neutral (**Figure 112**).

European consumers **agree** in their interpretation that a high expiration date indicates a product with **many additives** (ES 45%; GR 48%; NL 39%; HU 42%; EE 53%) **(Figure 113).**

Figure 108 Reasons for keeping food in packaging

Keep it in the original packaging_ES

- I keep it if the packaging gives me confidence and guarantee.: 54%
- I keep it if the container is comfortable and I will use the product immediately.: 35%
- I do not keep it because it seems to me that food is preserved in another type of container.: 5%
- I do not keep it, I always change them to one with airtight and with lid.: 6%

Keep it in the original packaging_GR

- I keep it if the packaging gives me confidence and guarantee.: 50%
- I keep it if the container is comfortable and I will use the product immediately.: 42%
- I do not keep it because it seems to me that food is preserved in another type of container.: 3%
- I do not keep it, I always change them to one with airtight and with lid.: 5%

Keep it in the original packaging_NL

- I keep it if the packaging gives me confidence and guarantee.: 39%
- I keep it if the container is comfortable and I will use the product immediately.: 46%
- I do not keep it because it seems to me that food is preserved in another type of container.: 10%
- I do not keep it, I always change them to one with airtight and with lid.: 5%

Keep it in the original packaging_HU

- I keep it if the packaging gives me confidence and guarantee.: 28%
- I keep it if the container is comfortable and I will use the product immediately.: 53%
- I do not keep it because it seems to me that food is preserved in another type of container.: 12%
- I do not keep it, I always change them to one with airtight and with lid.: 7%

Keep it in the original packaging_EE

- I keep it if the packaging gives me confidence and guarantee.: 37%
- I keep it if the container is comfortable and I will use the product immediately.: 51%
- I do not keep it because it seems to me that food is preserved in another type of container.: 8%
- I do not keep it, I always change them to one with airtight and with lid.: 4%

Figure 109 Reasons for throwing away expired food

Here are some possible reasons that may cause people to throw away expired or out-of-date foods. Do they apply to you?

Figure 110 Reasons for NOT throwing away expired food

Some possible reasons that may cause people to NOT throw away expired or out-of-date foods. Do they apply to you?

Figure 111 General beliefs about food waste

Figure 112 Consumers' perception of companies' intentions to shorten expiration dates

Figure 113 Consumers' interpretation of high expiration date

4.4.5   Gender and intersectional differences

Gender, age, income levels and food waste

The association between demographics and perceived over-purchase is demonstrated. **Figure 114** shows the relationship between over-purchasing (and indirectly generating food waste) and gender. Men believe that they throw away slightly smaller amounts of food than women, but the difference is not significant.

Figure 114 Frequency of food waste (expired and thrown away) by gender
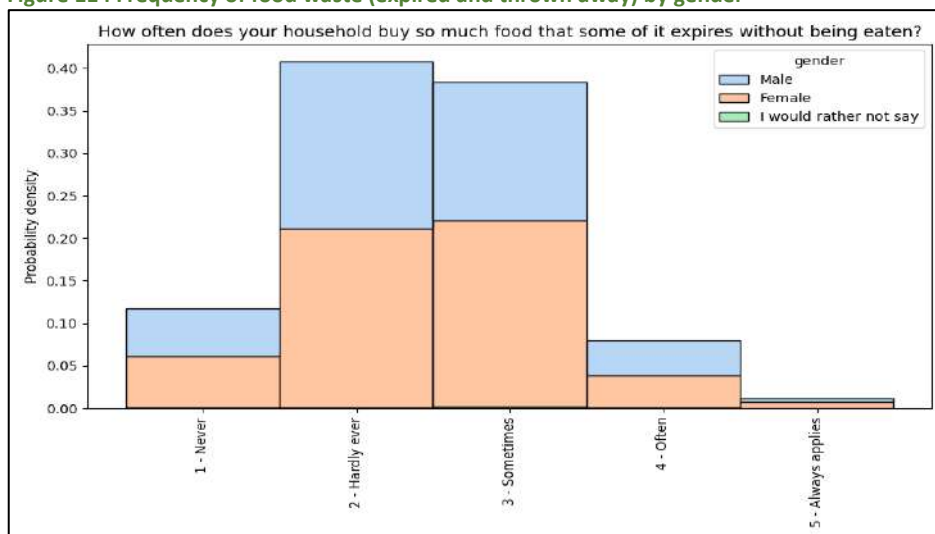
In **Figure 115** it is deducted that there is association between over-purchasing and age. Older individuals (age group of 55+) are reporting a lower food waste amount compared to young and middle-aged individuals.

Figure 115 Frequency of food waste (expired and thrown away) by age
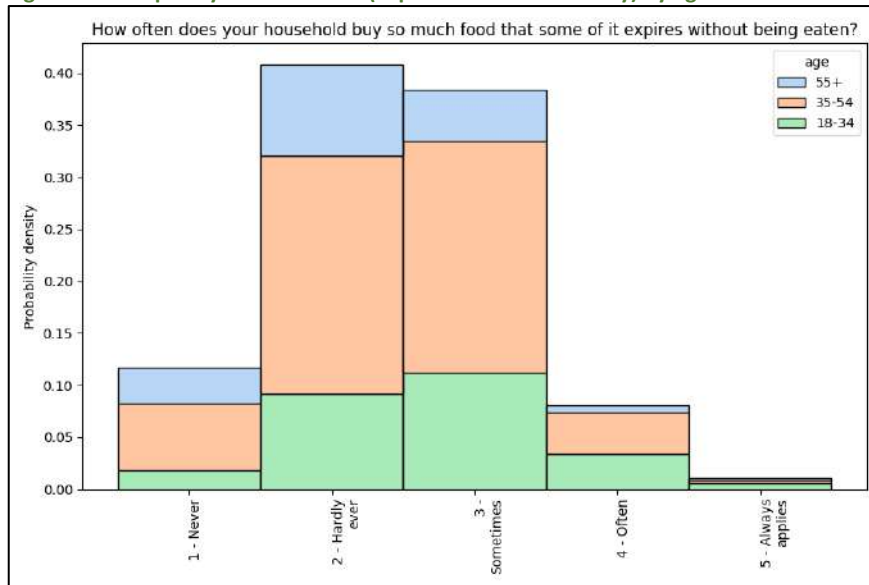
Finally **Figure 116** shows the relationship between over-purchasing and income. Individuals that are having a hard time financially, are less likely to over-purchase, but the difference is not significant.

Figure 116 Frequency of food waste (expired and thrown away) by household income
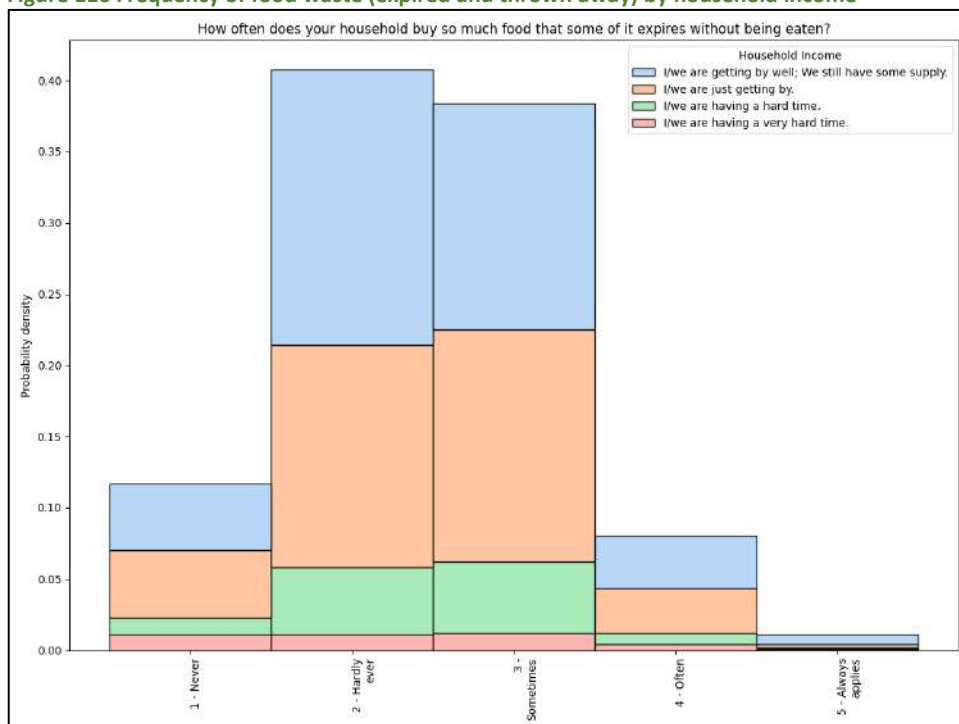
Gender and smart packaging

Overall, distinguishing between the behaviours of male and female respondents doesn't reveal stark contrasts. Yet, an interesting observation surfaces: while the overall percentage of individuals completely **convinced about the efficacy of smart packaging** to extend food shelf life remains below 10%, a notably higher proportion of females fall within this confident group (**Figure 117**). This trend similarly applies to those affirming a definite "Yes" to the idea that smart packaging will prolong food shelf life. Possible explanations might stem from differing levels of exposure to information or marketing strategies targeting these technologies. It could also reflect varying degrees of trust or

receptiveness towards innovative food preservation methods based on personal experiences or cultural influences.

Figure 117 Beliefs about smart packaging and life of food by Gender
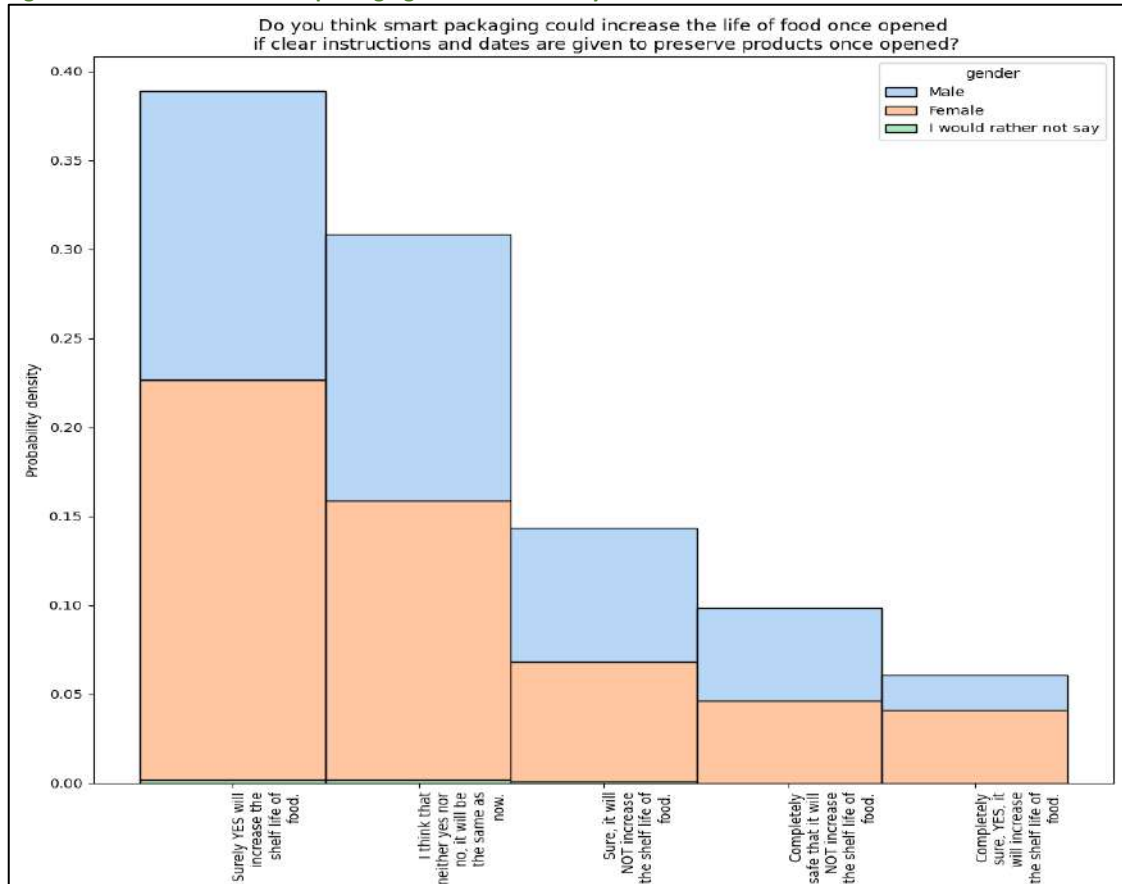
4.5 Case Study 4 (Schools in Denmark – food waste, obesity and malnutrition) and Case Study 5 (Food banks' mediated supply chain in Hungary)

Case studies 4 and 5 did not conduct surveys, but rather for data collection purposes utilized in-depth interviews to obtain the necessary data. For this reason, there is no statistical analysis of either case study in this report. However, both case studies did focus their research on qualitative information in relation to social norms, and the further motivations, as well as opportunities, and abilities that affect food waste related behaviour. Consequently, an overview of solely the qualitative analysis regarding behaviour and social norms for these two case studies, is provided here below.

4.5.1 FW-related behaviour (case study 4)

Quirkos software was used to analyse all the data coming out of interviews (with parents, teachers and headmasters) and focus group interviews (with pupils). Interview transcriptions were coded and grouped into various themes that were decided to explore across the case study. Themes were mainly related to the MOA (Motivation, Opportunities, and Abilities) framework of behaviour change strategy, and communication and educational potential, and potential impacts of food waste.

Motivations

The data demonstrated that there was awareness about food waste in the context of climate and world hunger. There was also a pattern that food waste was terrible and that there should be more consciousness about it and more action than there is now. The parents interviewed expressed a keen understanding of the repercussions of food wastage, articulating concerns over discarding perfect items such as carrots and acknowledging excessive food waste. They recognized food waste as a negative phenomenon, emphasizing its wasteful depletion of resources and detrimental impact on the climate. Moreover, they demonstrated awareness of global food disparities, noting the paradox of food scarcity in some regions juxtaposed with excess waste in others. They expressed their consciousness regarding the consequences of food waste but often refrained from taking concrete measures to address it. Their primary motivation to minimize waste stemmed from economic considerations, although they also endeavoured to educate their children about global hunger issues to instil awareness regarding food waste. Regarding the students, they did exhibit a heightened sensitivity to food wastage, recognizing the disposal of edible or "good" food as a significant issue. They perceived food waste as detrimental, both in terms of resource squandering and its adverse impact on the environment, particularly concerning climate change. Environmental concerns feature prominently in their discussions, emphasizing the detrimental effects of food waste on the climate. Moreover, they demonstrated awareness of the global food landscape, acknowledging disparities where some countries suffer from food scarcity while others dispose of excess food. Their attitudes towards discarding food were primarily influenced by considerations of taste, texture, and freshness, reflecting their standards of quality. All groups interviewed (pupils, parents, teachers, headmasters) generally agreed that awareness should be raised and more initiatives in reducing food waste should be introduced.

Types of food

No significant differences were found between boys and girls regarding the type of wasted food items and choice behaviours. Teachers noticed that younger students tended to follow their parents' advice, ate more of whatever they had brought from home. In contrast, older students sought to assert their independence by making their own choices, often opting for unhealthy options as a form of rebellion against parental expectations. Attitudes towards various food items appeared in the data. Pupils did not like certain food items for various reasons and therefore avoided eating them.

Based on their observations, teachers believed that more than half of the pupils discarded items from their lunch boxes. Evidence suggests that food items with strong odours, regardless of taste, tended to be disposed of - examples of disliked food items included meat sauce, fish items, and sandwiches with liver paste. Additionally, fruits and vegetables frequently appearing in lunch boxes were perceived as boring and consequently thrown out. In some cases, these attitudes were formed due to the belief that none of the other pupils consume such food items and that it was embarrassing thus to do so. However, chocolate biscuits or similar items were more popular choices, indicating a preference for foods high in carbohydrates and sugars while other options were often overlooked by pupils. The resulting behaviour among pupils was overwhelmingly that they **threw out food if they didn't like it or had too much of it**. While the primary motivational factors seem to be associated with attitudes toward specific food items and eating norms, the long-term formation of these attitudes and food choices remains unclear. It was noticed during the interviews (focus groups) with pupils, that some of them were leading the discussion, while others appear to be simply following the opinion of the others.

4.5.2   Social norms (case study 4)

Most of the social norm evidence in the data pertained to descriptive characteristics. This dominance of descriptive social norms is due to the age of the sample group, as they are not yet in the stage of strongly forming injunctive social norms. The most evident social norm was "suboptimal food/undesirable food quality". Given its strong association with quality, parental concern and pupils' attitudes heavily depended on this social norm.

The most prevalent and important social norm in the case study was **suboptimal food/undesirable food quality**. In this respect, the following characteristics were key: appearance and consistency, texture, taste and quality, and social acceptance. The individuals' perception of how food should be or what is "right", was paramount in this respect and directly affected if the food would be thrown out or not by the pupil. There were examples of foods that were mentioned as being "broken" or "wrong" such as brown bananas, apples with dots or bread that is torn. Teachers observed some pupils who were very selective and picky in terms of what they did and did not want to eat based on appearance, texture, taste of the food. Some pupils threw out surplus food in a garbage bin to avoid letting their parents know in case the parent(s) might become angry. Fruit and vegetable snacks, such as bananas and tomatoes, become inedible and are often thrown out mainly due to their changed appearance and texture. Fruits and vegetables were the most wasted food items due to perceived inferior quality. Meanwhile, there was a tendency for processed foods to be perceived as more satisfying in taste. Pupils tended to stick with familiar foods they knew and were hesitant to try new ones. Ultimately, the social acceptance of the food among peers also played a significant role. It was mentioned that foods that an individual was prone to like could be perceived as gross among his/her peers, leading the individual to throw it out, as well as changing their own taste preferences for these food items. Social context played a significant role in these decisions, with some foods deemed more "popular" than others.

The data also demonstrated that it was important to the parents to be **good food providers**. There were examples of parents who knew that the lunch was being thrown out but continued to provide the food because it was seen as the societal expectation of what a parent should do. Also, the lunchbox is very embedded in Danish culture and it felt unnatural for parents to not provide it. The parents also emphasised that even though they focused on health, they sometimes included less healthy options to ensure that that their children had something to eat, as they may not eat the fruits and vegetables. And while the social norm of **portion size** did not come up specifically in the data, there were examples of parents trying to convince their children to eat dishes or food, but the children refused, and the food ended up being thrown away.

4.5.3 FW-related behaviour (case study 5)

The data required for this case study was collected via in-depth interviews. The target population consisted of retailers, workers in the RECA sector, food processors, and charity organizations involved in Hungary's food bank network. A convenience sampling approach was followed from the HFBA network, and the synthesis of the 30 interviewees was the following: 5 retailers, 5 RECA sector workers, 10 food processors, 10 charities. Three questionnaires were developed to adjust to the specificities of each sector, while keeping the backbone the same for all of them in the fundamental questions. Interviews were conducted between March and July 2023 in Hungarian, and the transcripts were then translated into English.

Types of food and frequency

From the interviews, **food products that are either donated by companies and/or received by NGOs are characterized by a high degree of heterogeneity.** They can go from all sorts of canned, preserved, and frozen products to fresh food (fruit, vegetables, bakery meat, and dairy products). Also, the **frequency of donations presents a high degree of heterogeneity,** going from examples of daily donations (e.g., from supermarkets) to once a year or less (e.g., food processors). The type of products donated and the frequency of donations, both depend on the type of company (a food processor that works with veggies will always donate veggies, while a retailer donates a higher variety of products) and on the different management strategies and/or logistic possibilities associated with each food. For example, canned and preserved food (long-term products) are more prone to good management strategies, so potentially, there might be fewer donations. At the same time, they result in more manageable security and quality, so they often constitute an item suitable for donation. Frozen products are still long-term items, but they require the maintenance of the cool chain, and this can constitute a factor that inhibits donations, especially if the companies do not know or trust NGOs to manage those products. Fresh food is donated with higher frequencies (more daily or weekly donations are associated with this product), but they are perceived as more challenging to manage both for companies and food banks, and they are associated with an increased risk perception in terms of food quality and food safety.

The type of product also influences the reason behind the donations. **Fresh foods are donated because of their short-term shelf life**, while other products are influenced by **seasonality** (e.g., ice creams and specific holiday sweets and candies). Also, other **long-term products are donated because of minor damages in the packaging**. From some interviews with NGOs, it also emerged that sometimes there can occur a mismatch between the needs of their beneficiaries and the offers they receive, but it is something that they are used to managing.

Motivations

The **fear of food safety issues is a significant deterrent for companies when considering food surplus donation initiatives.** Concerns about potential liability, risks of contamination, and adherence to stringent food safety regulations loom large in the corporate decision-making process. The strict regulations (determined at country and European levels) surrounding food safety contribute to these concerns.

Companies prioritize consumer safety (to protect their **reputation and consumer expectations**) and avoid potential **legal repercussions** that could arise, if donated food were to cause illness or any health-related issues. Another concern firms share, is the perceived risk that **long-term products may lose their appeal**, if donated after a substantial period, impacting their palatability characteristics. Consequently, the perceived risk of donating surplus items often outweighs the

goodwill generated through such charitable acts. Companies need help with the conflict between preserving brands and addressing immediate food insecurity.

On the other hand, while NGOs and charitable organizations recognize the crucial importance of food safety, they sometimes perceive existing regulations as overly strict or cumbersome, which could make food donation harder or even impossible. Moreover, NGOs are deeply committed to providing high-quality food to their beneficiaries, so they often put in place strategies to preserve and check the quality of food before donating. This, however, is relatively unknown from the donors' side, as many interviews reveal that once the donation is made, the donor does not want or cannot follow the food in the process. From the interviews with corporations, they have no awareness of the donation practices of other companies in the country. **The decision to donate surplus food is thus less affected by peer pressure,** as peers – in this case, represented by other companies – are not part of the network of influence.

For many corporations, alternative uses of food surplus often revolve around **cost-effective methods of managing excess inventory**. This could involve repurposing surplus items for secondary markets, animal feed, or energy generation through composting or conversion to biofuel. While these methods may address the immediate need to reduce waste and minimize losses, they might **not necessarily align with broader societal goals or address food insecurity.** HORECA businesses appear to be more proactive than retailers and producers in actively implementing various measures to minimize surplus in the first place. The level of awareness about food waste and its implications in the HORECA sector has seen a notable increase in recent years. There is a growing recognition within this sector of the significant impact food waste has on the environment and the bottom line. HORECA actors realize that wasted food represents lost revenue and contributes to more significant environmental issues such as greenhouse gas emissions, land use, and water wastage.

NGOs and Charitable Organizations instead focused on social welfare, often advocating for food surplus to be redirected toward feeding programs, food banks, and shelters. Their primary objective is to **alleviate hunger and ensure surplus food reaches those in need**. While acknowledging the potential for alternative uses, they prioritize ensuring that surplus food serves its primary purpose of nourishing vulnerable populations.

4.5.4   Social norms (case study 5)

Donating food items after their best before date is a topic that sparks discussions on waste, safety, and social responsibility. **The stigma surrounding donating food past its best before date often stems from concerns about safety and liability**. While many organizations gladly accept these donations and distribute them to those in need, some retail or processing companies shy away from this practice due to fear of legal repercussions or negative public perception. In this context, the relevance of social norms arises, as companies' perception about what the public could think influence their actions.

There is a declared principle by retail, food processing, and HORECA actors that people in need should receive the same quality of food as anyone else, but on the other side they often think that people in need should also accept the reduced quality food, if it is still safe for consumption. Many companies, while acknowledging the importance of providing quality food to those in need, often **draw a line where they consider donating products that might not meet the standards, they set for retail sale**. This distinction is based on the understanding that there is a difference between what customers might purchase from a store shelf and **what is still safe and nutritious for consumption.** Two distinct lines of thought often guide these decisions. These different lines of thought are related to the social role the individual has, and can lead to the emergence of a conflict between social roles:

1. The first perspective ("Would I Buy It?") could be described as related to the "customer" social role. From this perspective, the quality of food corresponds to the minimum quality level that customers expect when purchasing products from stores. Companies are often reluctant to donate items that fall below this standard, considering it might negatively impact their brand reputation or consumer trust even if it results in much higher food waste ratio than necessary.

2. The second perspective ("Would I eat it?") could be described as related to the "consumer". From this perspective, the quality of food corresponds to the minimum quality level an individual might accept when consuming food at home. It is a more forgiving criterion, often allowing for the acceptance of products slightly past their prime but still safe and nutritious. When deciding whether to donate or not food surpluses, companies (here intended as individuals responsible for these decisions within companies) confront the conflict arising from these two different social roles, whose behaviour is usually influenced by different social norms.

Organizations that support people in need, such as food banks and shelters, operate on the premise that any food donation is valuable. They understand that their recipients often lack access to necessities, including food, and are grateful for any contributions they receive. Consequently, these organizations are more flexible in their acceptance criteria and are happy to receive donations that might fall below the "Would I buy it?" threshold but remain above the "Would I eat it?" line.

NGOs and charitable organizations play a pivotal role in addressing food insecurity and alleviating hunger within communities. The almost unanimous opinion of interviewees was that NGOs should accept all kind of donated food, but alcohol. It aligns with their mission to provide nutritious and safe meals to those in need while upholding ethical and safety standards. Accepting a wide range of food donations, including perishable and non-perishable items, enables NGOs to diversify their food offerings and cater to varying dietary needs. However, from the interviews, it emerges **the perception that the boundaries of the minimum quality level an individual might accept is related to severity of their socio-economic condition.**

Understanding the dynamics and motivations behind companies' decisions regarding food surplus donation sheds light on the complexities of corporate social responsibility, efficiency concerns, and perceptions about social impact.

Branding and reputation:

In Western Europe the customers' choice of food store is influenced by the store's food donation habits, and because of this, most companies weigh the impact of their donations on their branding and reputation. In this sense, customers represent an important share of companies' network of influence. The consumer attitude is different in Hungary and probably in the whole eastern European region. Related to this, an interesting duality can be observed. Hungarian consumers do not consider companies' social responsibility as a decisive factor in their purchasing decisions, but they strongly react on the negative news in connection with issues happen during donation. Referring to social norms' profiles (see Deliverable 3.2; Vittuari et al. 2023), customers are advocates of the social norm prescribing that companies should avoid any risk that could damage their good. This injunctive social norm is proscriptive. On the other hand, taking into consideration **the social norm according to which helping people in need is the right thing to do** (prescriptive social norm), customers are zero givers. Therefore, the retail and processing companies prioritize maintaining brand image and meeting consumer expectations, which often leads them to hesitate in donating items that do not meet retail standards. On the contrary, **organizations serving the needy prioritize alleviating hunger and ensuring food security, valuing any donation that can contribute to this cause.**

Efficiency and profitability:

A new segment of surplus food redistribution appeared and is growing in Hungary: organizations, like Munch, sell food surplus on discounted price, consequently reducing the amount of food that is donated and distributed by NGOs. The reason is that the cornerstone of many corporate decisions is efficiency and profitability. For companies dealing with surplus food, the bottom line often heavily influences their choices, so discounting surplus products might appear as a more economically viable choice for them compared to donating. This approach aligns with their profit-driven mind set, allowing them to recoup at least a portion of the invested costs. Comparatively, the act of donating surplus food involves logistical complexities and costs. Coordinating with charitable organizations, ensuring proper storage and transportation, and addressing potential legal concerns around food safety and liability require human and economic resources that can impact a company's bottom line. Moreover, the immediate financial impact of discounting is clearer and more quantifiable than the indirect, intangible benefits of donating. The tangible return from discounting surplus items aligns more directly with companies' financial goals and their drive for profitability. **The profitability aspect of selling surplus food rather than donating it, and the risk aversion of companies, both contribute to weakening the social norm according to which donating food is the right thing to do in terms of social impacts.**

Management influence and social thinking

Most of the interviewees agreed that personal attitude of company managers significantly influence company's decisions about food surplus donation. Managers with a heightened social consciousness recognize the impact of food surplus on both environmental sustainability and societal well-being. They perceive surplus not merely as excess inventory but as an opportunity to make a positive difference in addressing hunger and reducing waste. By promoting donation initiatives and emphasizing the importance of giving back to the community, these managers can inspire employees and stakeholders to align with the company's broader social objectives. Their commitment to social causes influences not only immediate decisions but also shapes the company's long-term strategies, contributing to a more socially conscious and impactful approach to surplus management.

5 ECONOMETRIC ASSESSMENT AND SYNTHETIC ANALYSIS

5.1 Relationships between social norms, FW behaviours and FW

In this chapter the focus moves beyond descriptive and correlation analysis, delving deeper into an econometric assessment of the data. Depending on the case study and the research generated, varying analytical techniques are utilized – regression analysis, clustering analysis, factor analysis, and structural equation modelling.

5.1.1 Case Study 1: Households in Flanders, Belgium and Spain in and off crisis period

The following points encapsulate the **main findings**:

- Both weighted and unweighted data indicate a prevalent perception among households of wasting less food than the average. This inclination could reflect a bias toward socially desirable responses, potentially leading to **underreported food waste.**

- Diversity characterizes food waste patterns across demographics. **Larger households** tend to report increased food waste, while **older demographics in Belgium** exhibit lower waste tendencies. Additionally, **higher household income** correlates with elevated levels of food waste. These results are supported both by regression and clustering analyses.

- **In Belgium** there is a significant relationship between higher **food ordering frequency** and increased food waste. This could imply a potential association with planning skills in food purchase and utilization. Individuals who tend to order food more frequently might face challenges in effective meal planning, leading to a surplus of food, overestimation of quantities, or inadequate utilization of perishable items. Alternatively, it could be possible that portion sizes are on average larger when ordering. A similar effect is observed for **Spain** but for the **frequency of having guests.**

- Individuals that **perceive their eating quantities to be high**, also perceive their food waste higher compared to other individuals. The underlying effect of this relationship can be what was identified in the qualitative analysis as "hunger anxiety". People experiencing this kind of anxiety tend to buy more than they need.

- The regression models spotlighting **waste in fish, and meat** exhibit better model fit than other food types, potentially offering **deeper insights into the waste dynamics within these specific categories**. A theory for this occurrence, that is also supported by evidence in the IDIs, is that food waste from other food types like fruits, bread and potato is more common, hence it is likely that the whole effect can be attributed to poor planning skills. Nevertheless, when we study social norms, motivation or people's reflections about food waste, products like meat and fish can offer more complex relationships.

- Clustering analysis highlighted five distinct "**types of wasters**" with **diverse profiles** in their social norms and planning, cooking, and hosting habits. While food waste levels differ across these clusters, **waste behaviour is homogeneous across food types** (e.g. bread, fruits, perishable, non-perishable etc.) within clusters.

- The **MOA structure is validated** with Structural Equation Modeling. Individuals with concerns for the environment and the needy as well as guilts associated with food wastage (**Motivation**), and individuals that can estimate food quantities (**Ability**) are associated with lower food waste.

Opportunity is not statistically significant, but there was only one question in the survey attributed to that factor.

The remainder of this section combines regression analysis, cluster analysis, factor analysis, and structural equation modelling with the aim to uncover insights on the interrelationships between social norms and food waste levels.

Data Preprocessing

Before proceeding with the analysis, here are some basic data preprocessing steps that were followed for the demographics and the items related with food waste behaviours and habits:

- The missing cases for the number of children that live in the household were replaced with 0.
- Individuals that did not disclose their income and selected 'Don't know' or 'Rather not say' were removed from the dataset. These people are in total 31 for Belgium and 8 for Spain (approximately 4% in both cases) so it was a reasonable trade off in order to keep the income variable as a cofounder of food waste.
- An extra individual was removed for the Belgian subsample because he/she did not provide an answer to the 'frequency of household grocery shopping' question.
- The cooking role question was recoded so that the values have an ordinal nature, i.e. an increasing number from 1 to 5 is inversely related to the participation of the respondent to the cooking process.

After following these steps, the final sample size is 768 individuals for Belgium and 197 individuals for Spain.

Visual Comparison and Correlations

From a visual inspection of the total food waste compared with all the other variables that were selected for the regression, as well as the other food waste amounts and frequencies described above , we can see that there is potentially a relationship with the following parameters: a) all the individual food waste levels per food type, b) the food waste frequencies per food category, c) household size, d) Students and Retired status, e) Age, f) Cooking role, g) Perception of portion sizes, h) Number of meals at school/work, i) Frequency of ordering and j) Frequency of grocery shopping. The bivariate relationships of food waste with the parameters above are presented in Appendix A (Figure A1 for Belgium and Figure A2 for Spain). The statistical significance of the relationships highlighted here will be explored in the models later in this section.

As a final step before conducting the regression analysis, we create a correlation table with the regressors. Understanding the various correlations aids in identifying potential multicollinearity issues, impacting the reliability of regression results. This can help in making informed decisions on variable selection. The two correlation tables are presented in Appendix A (Figure A3 for Belgium and Figure A4 for Spain) after filtering out correlations that are below 0.4 (in absolute terms) and hiding the upper triangular values because they are symmetric. We can summarize the following:

- The strongest negative correlation for Belgium is between "Full time work" and "Retired" (-0.57) and for Spain is between "Full time work" and "Part time work", both of which are expected.
- The second strongest negative correlation is between "Age" and "Student" (-0.43 for Belgium and -0.46 for Spain), which is also expected. The same exact value is observed between "Age" and "Frequency of ordering" for Belgium, meaning that **as people get older, they tend to order food less**.

- The strongest positive correlation is between "Age" and "Retired" for Belgium (0.75). This high correlation value is a potential source of multicollinearity, but we will keep both values for the analysis as we expect "Age" to reflect some additional characteristics apart from the employment status.

Regression Analysis

The model that was selected for the analysis is ordinal logistic regression or ordered logit (OL). The baseline models include the factors that are depicted in Figures A1 and A2 in Appendix A, that are a combination of demographics and food waste related behaviours and habits that are not measured on a Likert scale. The latter include mainly frequency variables (e.g. frequency of ordering, frequency of eating at home etc.) and other ordinal variables like portion size perception and the recoded cooking role. In total we have 15 models (1 for total food waste, 7 for food waste by food types and 7 for food waste frequencies by food category). The baseline models for total food waste are presented in Appendix A (Table A1).

For the results to be more comprehensive, we ran the total food waste model, but with an extended number of regressors. The new regressors consist of the Likert scale items of the questionnaire, i.e., the -3 to +3 agreement statements (strongly disagree to strongly agree) and the -3 to +3 importance (Not at all important to extremely important). Directly including ordinal regressors, such as Likert scale items, to the model has some caveats (see Box 1 for more details). Even for the extended model, we had to exclude some behavioural items, because only a small amount of the respondents provided answers. The reason for the missing data was that filters were applied based on previous questions, so the respondents were presented with these questions only if they fulfilled certain criteria. Nevertheless, we had to make a trade-off and not exclude all the items, thus the sample size of the extended models is significantly reduced compared to the baseline ones. While this analysis was possible for Belgium, it was not performed for Spain due to the considerably smaller sample size which made it impossible to identify the ordinal logistic regression for the expanded specification.

BOX 1. ORDINAL LOGISTIC REGRESSION (OL) IN A NUTSHELL

Ordinal Logistic regression estimates the odds of an outcome being in a higher category versus a lower one, while taking into account the ordered nature of the categories.

Reason for selecting OL: The reason for this choice is that unlike linear regression, which assumes a continuous and normally distributed outcome, OL accommodates the ordered and discrete nature of the response categories. This method acknowledges the inherent structure and hierarchy within the response options and does not assume equal intervals between categories (-3 to +3 for food waste, 1 to 5 for food waste by food types, and 1=Never to 8=Every day for food waste frequencies).

Caveats with directly including ordinal items as regressors:

- Analysing Likert scale items as continuous variables can produce misleading coefficients

Modelling assumptions: In the interest of keeping a parsimonious structure, the ordinal cofounders in the baseline models (and subsequently in the extended models) were treated as linear. By adopting this linear treatment, we avoid the inclusion of numerous separate categorical variables, and the regression models aim to strike a balance between complexity and practicality.

Log-odds ratio interpretation: Here we provide some basic information on the interpretation of the dependent variable coefficients and the evaluation metrics that are consistent across the different models (see results in Appendix A). The values -3|2, -2|-1, -1|0, 0|1, 1|2 and 2|3 represent the estimated coefficients associated with the transitions between adjacent categories on the ordinal response scale. They quantify the log-odds ratio of being in a certain category or lower versus being in a higher category. For

and standard errors, because of the assumption of linear relationship between the values.

- Also, there is an excessive number of Likert scale variables, and this can lead to overfitting, less interpretable models and multicollinearity.

To address the issues above, one of the common strategies is dimensionality reduction. In that direction we have performed factor analysis and integrated the latent constructs in a structural equation model, presented later in this section.

instance, the -3|-2 coefficient indicates the log-odds ratio of stating -3 compared to stating -2 or higher. Likewise, the -2|-1 coefficient indicates the log-odds ratio of stating a value of -2 or below (i.e. -3 or -2) compared to stating a value of -1 or higher (i.e. -1, 0, 1, 2 or 3).

Evaluation metrics: AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) are measures of model fit and complexity. Lower values of AIC and BIC indicate better model fit while penalizing for model complexity. They are mainly used as a relative metric to compare models. Finally, RMSE (Root Mean Square Error) is a measure of the model's predictive accuracy.

Below are the main findings from the baseline models:

- The most statistically significant parameter ($p < 0.001$) for Belgium is this of **household size**. The same variable is also significant for Spain but at the $p < 0.05$ level. In both countries, households with more members are more likely to report higher food waste.
- The most statistically significant parameter ($p<0.001$) for Spain is the frequency of **having guests**. The more often the respondents host guests at their place the more likely it is that their food waste increases. This effect is not statistically significant in Belgium.
- Another parameter that is significant at the $p < 0.001$ level for Belgium is the **frequency of ordering food.** The more people order food, the more food waste they report to generate. This effect is not statistically significant in Spain.
- **Age** has a negative relationship with food waste ($p<0.01$) in Belgium with older people wasting less.
- Individuals that **perceive their eating quantities to be high**, also perceive their food waste higher compared to other individuals ($p < 0.01$ for Belgium and $p < 0.05$ for Spain).
- If there are **people in the household with a special case** in Belgium**,** it is more likely that the food waste increases at the $p < 0.05$ significance level. This result potentially indicates specific dietary needs.
- Higher **household income** is associated with higher food waste ($p < 0.05$ for both countries).
- People that **go for grocery shopping** frequently tend to generate less food waste ($p<0.01$ for Spain and $p<0.05$ for Belgium).
- Individuals in Belgium that are less **involved with cooking activities** themselves, tend to report higher waste amounts ($p<0.05$).

The results of the expanded analysis for Belgium is also presented in Appendix A (Table A2). This analysis resulted in a sample size of 469 respondents and notable improvements in model fit metrics such as AIC and BIC. It is important to note that the observed improvements in model fit could be an artefact of including too many variables in the model. Compared to the baseline models, the results are affected in the following way:

- All the coefficients described above apart from the household size, become less significant.

- **The strongest relationship is associated with the following social norm: "A good head of household ensures no food is wasted"**. People that agree with this statement **tend to report lower food wastes** ($p < 0.001$).
- **Behavioural tendencies** such as forgetting about leftovers in the fridge or discarding food after its expiration **relate to higher reported waste** ($p<0.01$).
- Surprisingly, the affirmation that '**serving large portions equals caring for those who eat' correlates with lower waste** ($p<0.01$), showcasing a less intuitive outcome.
- People that **agree to the following statement: "In my daily life, I try very actively to avoid food waste", are also reporting lower food waste compared to other individuals** ($p < 0.05$).

Tables A3 and A4 in Appendix A demonstrate the results for each food type separately, yet the main difference with the previous model is that the ordinal dependent variables have value in the 1-5 range that correspond to units of the respective categories. Here are the most interesting findings, when we compare the coefficients across the models as well as with the previous model for the total food waste:

- For Belgium, the number of people in the household **with special case is only statistically significant** ($p<0.01$) **for waste associated with potatoes, fish, and meat.** For Spain, it is interesting that the same variable is only significant for waste associated with **potatoes**, but it has the opposite sign, i.e. if there are individuals with special in the HH the food waste is reduced.
- The **household income coefficient is related with waste from all food types apart from fruits** in Belgium**,** while it is only related with **egg waste** in Spain.
- **Age** is now not **statistically significant across all food types**.
- The **frequency of grocery shopping** retains its negative relationship with food waste for **bread** ($p<0.01$ in both countries), **potatoes** ($p < 0.05$ in Spain), **fish and meat** ($p<0.001$ in Spain), **fruits** ($p<0.05$ in Belgium) and **eggs** ($p<0.01$ in Spain).
- The **cooking role** is now not **statistically significant across all food types**.
- **Eating quantity perception** retains its **positive relationship with food waste**, for all food types in Spain, but only for **fruits** ($p<0.01$) and **eggs** ($p<0.05$) in Belgium.
- The frequency of cooking that was not statistically significant for the total food waste, has a **negative relationship with bread** ($p<0.001$), **eggs** ($p<0.001$) and **potatoes** ($p<0.05$) waste in Belgium and a **positive relationship** with **fruit** ($p<0.05$) and **potatoes** ($p<0.05$) in Spain.
- Strikingly, certain lifestyle choices exhibit contrasting effects on different food types of waste: **food rescue apps usage relates to reduced bread waste** in Belgium **but to increased waste for several food categories** in Spain. Meanwhile, **frequent eating out correlates with higher waste in breads for both countries and fruit** only in Belgium. Lastly, the **frequency of ordering food boxes** (e.g. Hello Fresh) corresponds to **increased egg waste** in Belgium **and to decreased waste in several food categories** in Spain.
- The hometown coefficient becomes significant for **fish and meat waste** ($p<0.01$) in Belgium. In particular, **the more rural the area that the individual lives the higher the waste in these products**. Gender differences also manifest uniquely across food types, with **females associated with higher potato waste** in Belgium **and males with elevated waste in fish and meat** ($p<0.05$) in Belgium and increased bread waste in Spain. However, since we don't have any information on the dietary preferences of the respondents and the heterogeneity in the sample, this could be an artefact effect of Belgian men in rural areas having more meat and fish in their diet.

Remarkably, **models focusing on fish and meat** waste demonstrate notably superior model fit compared to other food types, **indicating potentially more explanatory power in understanding waste dynamics for these specific categories**. A possible explanation is that food waste from other food types like fruits, bread and potato is more common, hence it is likely that the whole effect can

be attributed to poor planning skills. Nevertheless, when we study social norms, motivation or people's reflections about food waste, products like meat, fish and eggs can offer more complex relationships.

Finally, Tables A5 and A6 in Appendix A demonstrate the results for each food category separately, but now the dependent variables are frequencies and the categories range between 1=Never and 8=Every Day. Here are the most interesting findings, when we compare the coefficients across the models as well as with the previous model for the total food waste:

- The **household size** does **not have a statistically significant effect** for **unused long shelf-life food** in Belgium and is **ONLY statistically significant for meal leftovers on plates** in Spain.
- The presence of **individuals with special cases** in Belgian households **correlates with meal leftovers after storage** (p<0.05), potentially resonating with previous findings linking this factor to increased meat and fish waste. The results are less clear for Spain where the same factor correlates more with **partly used long shelf-life food and leftover ingredients**.
- The **household income coefficient** is now **not related with all food categories**.
- Being a **full-time worker** has now become **a statistically significant cofounder for leftover ingredients** (p < 0.001 in Belgium and p<0.05 in Spain) and **meal leftover on plates** (p<0.05 for both countries).
- Gender differences emerge prominently in Belgium, with **males associated with higher waste frequencies across several categories like meal leftovers after storage** (p<0.001), **leftover ingredients** (p<0.05), **partly used perishable** (p<0.05) and **completely unused perishable** (p<0.05), delineating gender-specific waste tendencies. In Spain, there is no apparent gender differentiation.
- In Belgium, **age is not statistically significant** for meal **leftovers on plates** and **after storage**. On the other hand, **age is ONLY statistically significant for partly used perishable** in Spain.
- In Belgium, **the frequency of grocery shopping is not statistically significant** for meal **leftovers on plates** and **after storage**. For Spain, while the effect was very strong for total food waste, now it's not statistically significant for any of the subcategories.
- In Belgium, being **less involved with cooking activities is associated with higher food waste frequency for leftover ingredients** (p<0.001), **meal leftover on plates** (p<0.05) and **after storage** (p<0.01). The effect is opposite for Spain where being more involved with cooking activities is associated with higher food waste frequency for **completely unused perishables** (p<0.05), **partly used perishable** (p<0.05) and **meal leftover on plates** (p<0.05).
- **Eating quantity perceptions** has a **positive relationship with food waste frequency** for completely **unused perishable** (p<0.001 in Belgium and p<0.05 in Spain), **partly used perishable** (p<0.01 in Belgium and p<0.05 in Spain), **leftover ingredients** (p<0.01 and p<0.05 in Spain), **meal leftovers on plates** (p<0.05 in Belgium) and **meal leftovers after storage** (p<0.01 in Spain).
- **Of particular interest are lifestyle choices** and **external factors influencing waste frequencies**. Greater frequencies of having **guests** (p<0.05) and **eating out** (p<0.05) relate to higher waste frequencies in Belgium, signifying potential implications of social engagements on waste generation. The same effects are not statistically significant in Spain.
- **Higher frequency of eating home is associated with higher frequency of wasting meal leftovers on plates** in Belgium (p<0.05) but it doesn't have a statistically significant effect in Spain.
- Belgian respondents that **cook more tend to waste less frequently** when it comes to **leftover ingredients** (p<0.01), **meal leftovers on plates** (p<0.05) and **meal leftovers after storage** (p<0.05).
- Belgian respondents that use **food rescue apps** more are **less likely to throw away meal leftovers on plates** (p<0.01) and **after storage** (p<0.05).

From all the food categories, **models focusing on unused and partly used long shelf-life food** demonstrate a better model fit, indicating **potentially more explanatory power in understanding waste dynamics for these specific categories.**

While the models above provide useful insights on the demographics, social norms and behaviours/habits that affect food waste levels, it is also observed that the **respondents in general underestimate their FW levels** and **overestimate their performance in avoiding food waste**. For this reason, the next step of the analysis was to divide the sample in clusters based on their wasting behaviour and explore if there are distinct "**types of wasters**". Following this approach, we can ensure that even if the dependent variables of reported food waste levels and frequencies prove to be unreliable in absolute terms, the relative food waste performance of the various clusters still provides valuable insights towards our research objectives.

<u>Clustering Analysis</u>

The dependent variables used in the regression models, collectively offer a comprehensive view of different dimensions and patterns of food waste behaviours within the dataset. By employing these variables for clustering, the aim is to **identify distinct groups** and **characterize diverse waste behaviour profiles within the sample population**. Subsequently, the identified clusters will be examined concerning the total food waste variable, as well as the regressors that we used for the models and even the behavioural items that were excluded earlier to avoid reducing the sample size.

The clustering methodology that was implemented was this of K-modes, which led to the identification of 5 distinct clusters (see more details in Box 2).

BOX 2. KMODES IN A NUTSHELL

Unlike many traditional clustering algorithms designed for numerical data, K-modes is specifically tailored to handle categorical and nominal data, making it an ideal fit for this problem where the variables are categorical proxies for food waste levels and frequencies. K-modes measures similarity or dissimilarity between categorical data by computing the mode (most frequent category) within each cluster. Additionally, it offers flexibility because it does not rely on assumptions of cluster shape or distribution.

In K-modes, the **number of clusters** is a parameter that needs to be selected by the analyst/researcher. Unless there is prior information on the expected number of clusters, this is a challenging task and a typical technique to tackle the uncertainty, is to use the **elbow method** to visually select the optimal number of clusters. This method involved plotting the variance against different numbers of clusters and identifying the point where the rate of change significantly slows down, resembling an "elbow" in the plot. The rationale behind employing this method lies in its ability to discern the point at which the addition of more clusters provides diminishing returns in reducing within cluster variance.

The critical point for our data, lies somewhere between 4 and 7 for both countries (see Figures B1 and B2 in Appendix B). We have selected 5 clusters, because apart from optimality, this point signifies a **trade-off** between maximizing the distinctiveness of clusters while avoiding excessive complexity or overfitting. Therefore, as the number of clusters increase it becomes more challenging to identify very distinctive characteristics.

The detailed profiles of the individuals that belong to the 5 clusters are presented in Appendix B (Figures B1 and B2) **Table 8** summarizes the main characteristics of the clusters for each subsample ordered by lowest to highest food waste. As it can be seen in the distribution of the respondents

across different clusters, the two clusters with the lowest food waste correspond to a higher share of individuals for both countries, as it is demonstrated in **Figure 118.**

Comparing the clustering results with the regression results, one noticeable common effect of this is household size, as we can see that **moving from the low waste to the high waste clusters**, **the household size tends to be larger**. Likewise, the **negative relationship of food waste with age for Belgium is visible** as Clusters 0 and Clusters 1 have the highest proportion of retired individuals. Finally, the **relationship with income levels** is also visible in the cluster structure for both countries.

What is interesting is that while we used 12 food waste related variables to cluster our sample, there is no obvious differentiation of food waste type within clusters. In other words, **individuals that report high food waste are likely to waste across all food types** (e.g. bread, fruits, perishable, non-perishable etc.). However, **the groups are definitely distinct in their social norms and planning, cooking and hosting habits.**

Table 8 Descriptions of food waste clusters

	BELGIUM	SPAIN
Lowest food waste group	**Thoughtful Planner Couples (Cluster 0):** Efficient retired or elder couples who plan meals meticulously. They shop wisely, use resources efficiently, avoid waste by using leftovers, and prioritize planning and organization in meal preparation. They believe in serving appropriate portions, minimizing waste and being responsible hosts and parents. They consider themselves adept at estimating food needs and safety, while being conscious of their impact on the environment and budget.	**Resourceful Waste Minimizers (Cluster 2):** Characterized by small household sizes, predominantly comprising students or retirees with lower incomes, they demonstrate a conscious effort to minimize food waste. They rarely eat out, preferring to dine at home with company, and are diligent in checking their stock and managing grocery lists. They are actively trying to reduce food waste, planning meals efficiently and utilizing leftover ingredients. They don't believe in serving large portions or catering to individual preferences excessively, focusing instead on practicality and efficiency. They don't feel pressure from peers regarding food waste and want to be perceived as responsible heads of household. It is interesting that this group combines older and younger people with similar behaviour, something that was not observed in the Belgian subsample.
Second lowest food waste group	**Welcoming Homemakers (Cluster 1):** Hospitable couples, often retired, who value variety when hosting guests but maintain a conservative approach to food. They prefer guests to manage portions and avoid wasting leftovers. While being attentive hosts, they are less concerned about being perceived as exceptional cooks or guests.	**Thoughtful Planners (Cluster 1):** This group exhibits meticulous planning and consideration in their approach to consumption. With small household sizes and a higher proportion of stay-at-home parents, they prioritize meal planning and diligently manage their grocery lists. They tend to use products with longer shelf lives and repurpose leftover ingredients effectively. They actively seek to minimize waste, feeling guilty when it occurs, and want to be seen as responsible hosts. Finally, they believe that their peers perceive them as stingy when they try to reduce food waste. They are very similar to the Thoughtful Planner Couples in Belgium.
Average food	**Insecure Urban Professionals (Cluster 4):** Lower-income urban professionals who plan	**Family Oriented Cooks (Cluster 4):** This cluster comprises individuals with a higher rate of unemployment and part-time work. They are actively

	BELGIUM	SPAIN
waste group	meals, make shopping lists and are attentive hosts. They are conscious of societal expectations and strive to be seen as responsible hosts and parents and they are open to using expired products or leftovers.	involved in cooking, often preparing meals in advance, but struggle with estimating cooking amounts. They emphasize politeness in finishing meals for household members and believe in serving larger portions. They feel pressure from peers to minimize food waste. However, they don't feel guilty when wasting food and rarely consider environmental or financial implications. Overall, they prioritize family norms in their approach to food consumption.
Second highest food waste group	**Relaxed Urban Consumers** (Cluster 3): Urban households with an inclination towards dining out and ordering in. They exhibit less interest in reducing waste, they are more relaxed towards responsible hosting or parenting practices, and do not prioritize food safety or estimating food needs. They perceive less pressure from their social circle to reduce food waste.	**Spontaneous Urban Consumers** (Cluster 0): This group stands out for its high income, urban lifestyle, and chaotic nature. They exhibit a lack of pre-planning, often preparing meals spontaneously and without consideration for leftovers. Unlike other clusters, they prioritize serving large portions and don't feel societal pressure to minimize waste. They lack a sense of responsibility towards reducing food waste and find it difficult to estimate cooking amounts. They combine elements of the Carefree Consumers and Relaxed Urban Consumers that were observed in Belgium.
Highest food waste group	**Carefree Consumers** (Cluster 2): Larger households with members from diverse backgrounds typically younger with high income. They exhibit impulsive buying behaviours, lack planning and generate significant waste. Prioritizing convenience and not overly concerned about waste reduction or responsible hosting, they may struggle with estimating food needs and safety.	**Carefree Full Timers** (Cluster 3): this cluster consists of individuals with relatively high incomes and predominantly full-time employment, primarily males living in less urban areas. They exhibit a carefree attitude towards food consumption, frequently dining out and ordering in, and rarely checking stock or planning meals in advance. They prefer serving large portions and catering to individual preferences, often leading to excessive waste. They lack a sense of responsibility towards reducing waste and want to be seen as good hosts. They also combine elements of the Carefree Consumers and Relaxed Urban Consumers that were observed in Belgium.

Figure 118 Cluster Sizes for Belgium (up) and Spain (down)
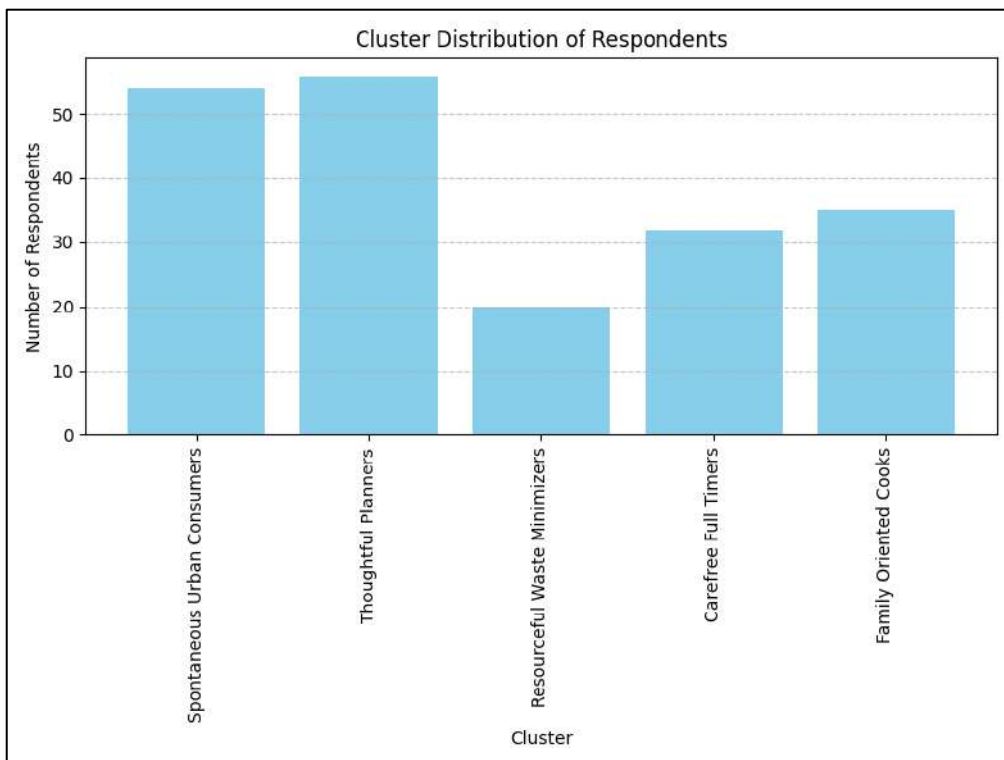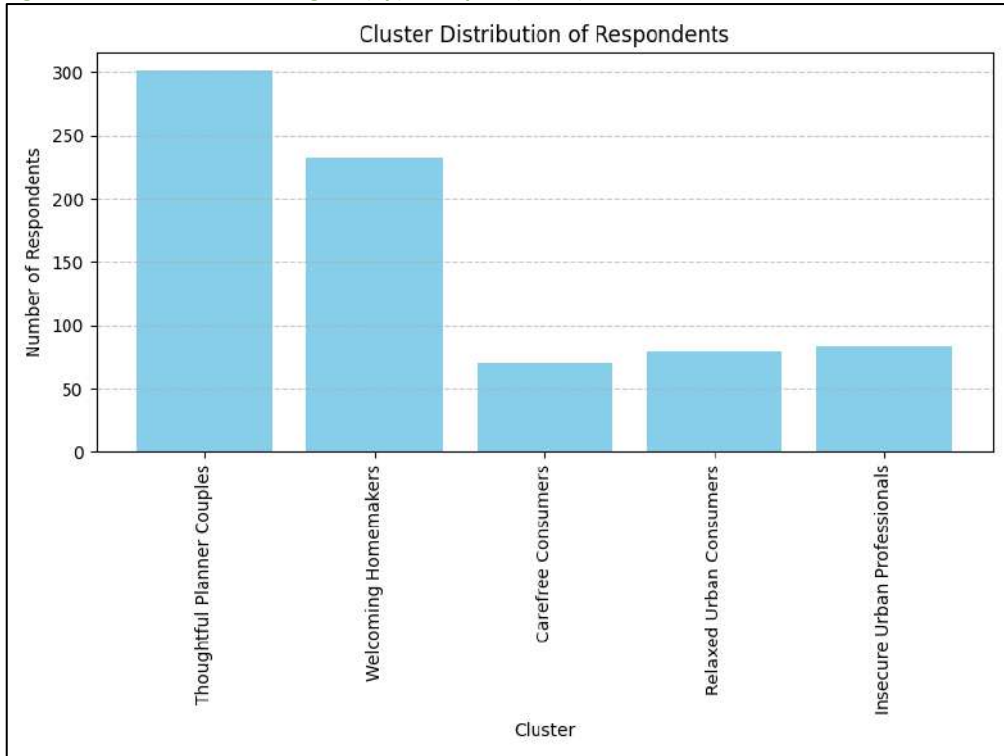
As a final test, it was important to confirm if the difference-in-means between the demographics of the various clusters was statistically significant. The statistical validation process that we followed (see Appendix B for more details) ensured the robustness and reliability of the clustering outcomes, by highlighting statistically significant differences between their demographics.

Factor Analysis

There are three main reasons for using factor analysis in this study:

1. To examine the underlying structure or the existence of latent factors in our data. For this purpose, we will employ Explanatory Factor Analysis (EFA), or in other words we will try to identify patterns or associations between the MOA statements and the social norms without predefining the number of factors. This way we also "ignore" the theoretical background that was used for the design of the questions, and we explore if there are relationships that we did not anticipate.

2. To validate the constructs that will enter the structural equation model later. For this purpose, we will employ Confirmatory Factor Analysis (CFA), i.e. we will apply the factors that were identified with EFA and test their internal validity and their composite reliability.

3. To reduce the dimensionality of our data. Since we have multiple statements that we can include in our models, its preferrable to simplify their interpretation and make the data more manageable. After running EFA and CFA, we will be able to decide what factors to include in our final models, and this smaller number of factors will explain the covariation among the individual items.

Explanatory Factor Analysis (EFA)

The results of EFA (see details on the technique in Box 3) are presented in Appendix C (Table C1 for Belgium and Table C2 for Spain). In order to increase the clarity of the tables, we first encode the items of the questionnaire in the question groups (dimensions) that were presented to the respondents (**Table 9**). The item names correspond to the respective variable names in the dataset.

BOX 3. EXPLANATORY FACTOR ANALYSIS (EFA) IN A NUTSHELL

EFA aims to identify a smaller number of underlying factors that explain the covariance among the observed variables. Various methods can be used for **factor extraction**, but in our analysis we have used the minimum residual (MINRES) solution.

Once the factors are extracted, they may be rotated to achieve simpler and more interpretable solutions. Varimax was selected among the various **rotation techniques**.

The **factor loadings** represent the correlations between the observed variables and the underlying factors. Higher loadings indicate a stronger relationship

between a variable and a factor, suggesting that the variable is more strongly influenced by that factor.

Number of factors: When conducting factor analysis, we face the same challenge that we discussed earlier for k-mode clustering, i.e. we do not know in advance the number of factors. To find the optimal number of factors we are using the **eigenvalues**, which indicate the variance explained by each factor extracted from the dataset. A significant drop in eigenvalues after a certain number of factors indicates diminishing returns in explaining additional variance. The optimal number of factors to include is around 10 for both countries (see Figure C1 in Appendix C).

Table 9 Behavioural Items and Questionnaire Categories (CS 1)

Dimensions	Items	Item Names
Shopping Preparation	SP1: Before we go to the store, meals are always planned ahead for several days	MealPrepping
	SP2: Before going to the store, we/I always check the foodstock at home (e.g. in the refrigerator, pantry)	CheckStock
	SP3: Before we go to the store, we always make ashopping list	GroceryList
	SP4: At checkout it always turns out that we bought moreproducts than planned	ImpulseBuying
	SP5: We buy products that have a longer shelf life, even ifit means reaching for a package at the back of the rack	LongerShelfLife
Cooking Behaviour	CB1: I always think carefully about exactly how much toprepare so that everything gets eaten	Cooking_EstimateAmounts
	CB2: I often use tools (e.g. scale, measuring cup) to prepare just the right amount/ portion size per person	Cooking_UseTools
	CB3: I always make sure to use the food that is in dangerof expiring/about to expire first	Cooking_ShorterShelfLifeFirst
	CB4: I always make sure that leftover ingredients from a previous meal (e.g. previously cut vegetables, half a packet of minced meat) are still used for a later meal	Cooking_ReusedIngredientsLeftovers
	CB5: I never serve dishes that a member of the householddoesn't like	Cooking_Pleasing
	CB6: I always tend to serve larger portions than my familymembers are likely to eat during the meal	Cooking_ServeLargePortions
	CB7: I regularly allow household members toscoop/determine their own portions	Cooking_DecidePortionSize
Family Role Norms	FR1: A good *family head* ensures that all family memberscan eat what they like	HeadofFamily_Pleaser
	FR2: A good *head of household* makes sure there isalways enough food in the house	HeadofFamily_FoodAffluence
	FR3: A good *head of household* ensures no food is wasted	HeadofFamily_0FW
	FR4: A good *head of household* does not waste money onfood that is thrown away	HeadofFamily_MonetaryM
	FR5: As a member of the household, emptying your plateis polite and respectful to the family member who cooked	FamilyMember_FinishPlate
	FR6: Boys/men should eat larger portions thangirls/women	Males_LargerPortion
	FR7: Girls/women must be skinny to be beautiful	Females_Skinny

Dimensions	Items	Item Names
	FR8: A good parent ensures that his/her children haveenough food available to them	Parent_FoodAffluence
	FR9: A good parent respects it if his/her child cannotfinish his/her plate	Parent_FinishPlate_A
	FR10: A good parent respects it if his/her child does notwant to finish his/her plate	Parent_FinishPlate_O
	FR11: Parents should require their children to eat all thefood on their plates	Parent_FinishPlate_injSN
	FR12: Mothers are supposed to eat the children's leftovers	Mothers_EatLeftovers
	FR13: Fathers are supposed to eat the children's leftovers	Fathers_EatLeftovers
Hosts and Guests Norms	HG1: As a guest, it is polite and respectful to the cook toleave your plate empty	Guest_FinishPlate1
	HG2: A good host/hostess serves more food than is strictlynecessary for the number of guests	Host_FoodAffluence
	HG3: A good cook uses only the freshest ingredients	Cook_FreshIngr
	HG4: A good cook serves a varied meal so that everyoneat the table can eat what they like	Cook_VariedMeal
	HG5: A good cook does not use products that are expired	Cook_DateMarking
	HG6: Serving large portions equals taking good care ofthose who eat	PortionSize
	HG7: As a guest, it is better to overeat than to leave foodon your plate	Guest_FinishPlate2
	HG8: Freshly prepared meals are healthier than leftovers	FreshMealvsLeftovers
	HG9: One should leave one's plate empty at all times	FinishPlate
Social Norms	SN1: I think people close to me think I'm stingy when I tryto reduce my food waste	injSN_Stingy
	SN2: I feel that people close to me expect me not to wastefood	injSN_0FW
	SN3: I notice that people close to me make an effort towaste less food	descrSN_M_0FW
	SN4: I think people in my close circle throw away a lot offood	descrSN_FW
Public Picture	PP1: How important is it to you to be seen as a good parent	Good_parent_importance
	PP2: How important is it to you to be seen as a good cook	Good_cook_importance
	PP3: How important is it to you to be seen as a good guest	Good_guest_importance
	PP4: How important is it to you to be seen as a good host/hostess	Good_host_importance

Dimensions	Items	Item Names
	PP5: How important is it to you to be seen as a good family head	Good_head_of_house_importance
Attitudes and Abilities	AA1: In my daily life, I try very actively to avoid food waste	FWAttitude1
	AA2: I think throwing away food is very irresponsible	FWAttitude2
	AA3: I always find it difficult to estimate how much foodto buy	AbilityGroceries Amount
	AA4: I always find it difficult to estimate how much food Ineed to cook for a main meal	AbilityCookingAmount
	AA5: I always find it easy to judge whether a food productis still safe to eat	AbilityCookingFoodSafety
Host Behaviour	HB1: We always know in advance how many guests willjoin us for the meal	Guests_knowledge_in_advance
	HB2: We always prepare/order more food than is strictlynecessary for the expected number of guests	Guests_strict_food
	HB3: We always prepare/order many different types offood to please everyone	Guests_different_food_types
	HB4: We always serve large portions	Guests_large_portions
	HB5: We sometimes let guests determine/scoop theirdesired portion themselves	Guests_desired_portions
	HB6: When we have leftovers, we often give them toguests	Guests_give_leftovers
	HB7: After we host guests, we always throw away theleftovers	Guests_throw_leftovers
Motives	M1: I feel bad (e.g., guilty) when I throw away food	FWAttitude3
	M2: I rarely think about money when I throw away food	Motivation_Monetary
	M3: I rarely think about the environment when I throwaway food	Motivation_Environmental
	M4: I rarely think of the needy when I throw away food	Motivation_Needy
	M5: I am someone who likes to plan things in advance	Motivation_Planning
Eating Behaviour	EB1: How many people will join for the meal is alwayssubject to last-minute changes	LastMinuteChanges
	EB2: We always have leftovers after a meal	AlwaysLeftovers
	EB3: Food often gets past date or spoiled (for example,because we forgot or bought too much)	FoodSpoiled
	EB4: We often store leftovers in the refrigerator with theintention of eating them later, only to find out sometime later that we have to throw them away	ForgetLeftovers

Horizon Europe

Dimensions	Items	Item Names
	EB5: If the expiration date has passed, we always throwaway the product anyway	FollowDateMarking
	EB6: We often freeze food that is not consumed quicklyenough	FreezeFood

The total explained variance from the 10 factors that were identified for both countries is 39.27% for Belgium and 44.77% for Spain. This means that there is still room to increase the number of factors to capture the additional variance but for the purpose of maintaining a parsimonious specification, we did not proceed with a larger number than ten.

The majority of the variables that could not be grouped within any of the factors (see more details in Appendix C) are identical between the two subsamples. One potential explanation is that these variables are not relevant for the specific research question or theoretical framework under investigation, hence they may not capture meaningful variance. The remaining items were regrouped compared to their initial allocation in the questionnaire, but the themes that emerge are always intuitive and, in their majority, they align with the designed MOA groups and social norms before the data collection. Moreover, the factor loadings vary with some of the factors (e.g. Good Eating Behaviour for Belgium or Food Waste Motives for Spain) having very high values and some others (e.g. Good Family Provider for Belgium or Cooking Behaviour for Spain) having values closer to the threshold (i.e. 0.4).

There are some factors that are identical between the two countries, i.e. Ability in Shopping and Cooking and Eating, Planning and Organization, Public Picture, Food Waste Motives and Finishing Plate. However notable differenced emerged. Belgian respondents emphasized the role of being a good provider, whereas Spanish respondents focused more on being a skilled cook and managing portion sizes. Additionally, a factor related to good eating behaviour was prominent in Belgium, while a similar factor for cooking behaviour was observed in Spain. Further distinctions included the presence of a factor for Good Family Provider in Belgium, whereas in Spain, expectations from both the Head of Family and Parents were captured by separate factors. Lastly, gender-related social norms were highlighted by a group of variables unique to the Spanish context.

Confirmatory Factor Analysis (CFA)

To align the identified factors from EFA with the hypothesized MOA structure we employ the qualitative coding tree from section 4 (**Figures 119 and 120**). The elements of the tree are depicted with the blue orthogonal boxes. The individual behavioural items are then linked to the closest constructs and the item codes are presented with red in picture. This corresponds to the 'a priori' categorization of the questions. However, after conducting the EFA in the previous subsection, the 10 factors that replace the individual items are depicted as ellipses that join the respective elements of the MOA tree.

It can be seen in **Figures 119 and 120**, that some behavioural items remain in the hypothesized groupings but at the same there are several re-adjustments and some items that are not included in the factors. For example, there is no factor associated with suboptimal food for Belgium, because many of the original items were allocated to the Good Provider factor. However, the Cooking Behaviour factor is directly associated with suboptimal food for Spain. Likewise, while there is factor associated with Gender Norms for Spain, this is not the case for Belgium (the mother and father questions fit better with the Good Eating Behaviour factor and the male/ female prejudices have low loadings).

A first-order CFA model (see more details in Box 4) was designed to verify the relationship among the MOA constructs and their observed indicators. The results of the CFA models for the two countries are presented in Appendix C (Table C4 for Belgium and Table C5 for Spain). Along with the standardized loadings, there is a brief explanation on the process that was followed to improve model fit, as well as a presentation of the final values of the evaluation metrics.

Figure 119 MOA Structure with "a priori" allocation of items and final factors for Belgium
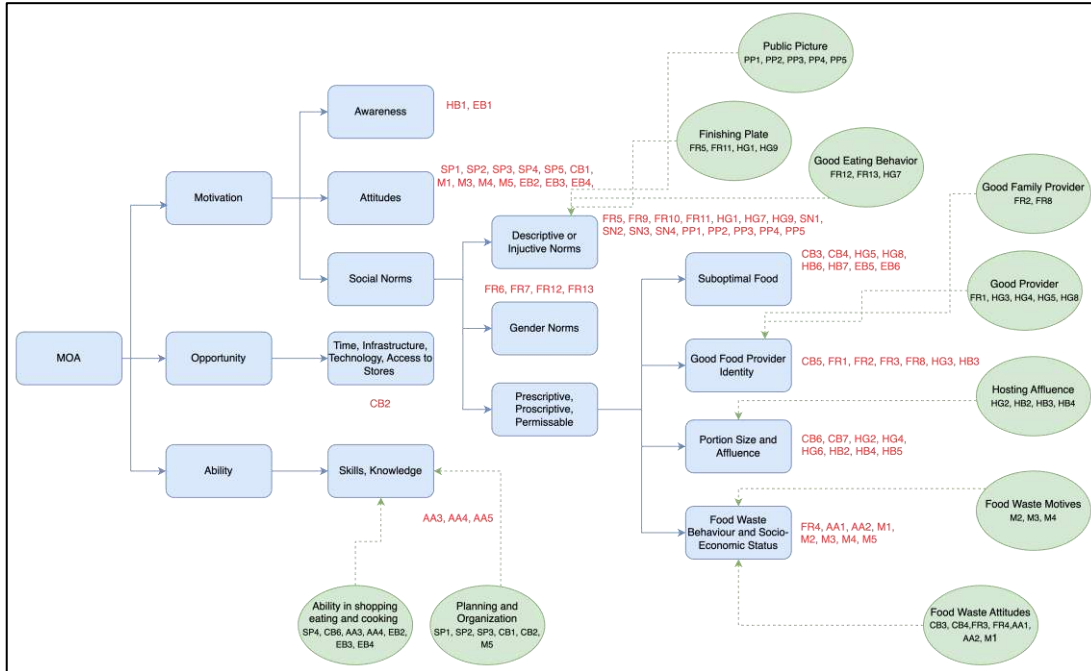
Figure 120 MOA Structure with "a priori" allocation of items and final factors for Spain
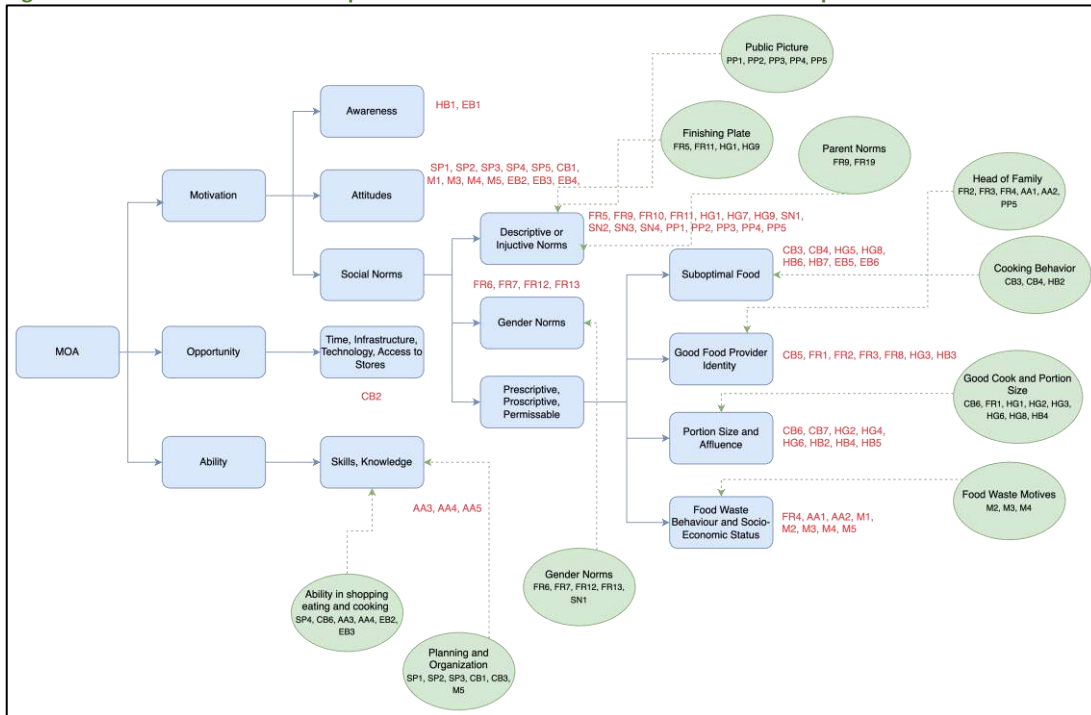
BOX 4. CONFIRMATORY FACTOR ANALYSIS (CFA) IN A NUTSHELL

CFA starts with a hypothesized model that specifies how observed variables are related to latent factors. This model is based on theoretical considerations or prior research and defines the expected pattern of relationships among variables and factors (in our analysis it based on the EFA results).

CFA estimates the standardized loadings of the model, using **maximum likelihood** estimation.

Once the parameters are estimated, CFA evaluates the fit of the model to the observed data using various fit indices, i.e. the Root Mean Square Error Approximation (RMSEA), the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) (Kline, 2015). In particular, an adequate model fit is reflected from RMSEA values that are below 0.06, and from CFI and TLI values that are between 0.90 and 0.95.

If the initial CFA model does not fit the data well, **modifications** may be made to improve model fit. Two steps that are typically followed to improve the model are:

- Review the Modification Indices (MI), and allow variables with high values to correlate
- Remove items with the lowest factor loadings

Both a **first-order CFA** and a second-order CFA aim to model the relationships between observed variables and latent factors. However, **second-order CFA** adds an additional level of complexity by incorporating higher-order factors that capture broader constructs (e.g. a Social Norms construct that is explained by some of the first-level factors)

Structural Equation Modelling (SEM)

The CFA serves as a crucial preliminary step in Structural Equation Modeling (SEM), primarily aimed at validating the constructs that were identified earlier and understanding the relationships between observed and latent variables. We have proved that the measurement model fits the observed data, by confirming the factor structure and measuring the reliability of the latent variables.

SEM will extend the results of CFA by examining the structural relationship between the higher-level MOA constructs and the observed food waste variable. For this we will first need a two-level structure where, if possible, MOA elements are first measured via the latent constructs. Then they are used in the structural equation to explain the total food waste levels.

BOX 5. STRUCTURAL EQUATION MODEL (SEM) IN A NUTSHELL

Structural Equation Modelling (SEM) is a statistical technique used to test and estimate complex relationships among variables. SEM incorporates both measurement and structural components.

The **measurement model** specifies how observed variables are related to underlying latent constructs. This involves estimating factor loadings, which represent the relationships between observed variables and latent factors, and error variances, which capture the unique variance of each observed variable not accounted for by the latent factors. For example, this corresponds to the relationship between behavioural questions in the survey and the factors like Public Picture or Gender Norms.

The **structural model** specifies the relationships among latent constructs and any direct effects between observed variables. This involves estimating path coefficients, which represent the strength and direction of the relationships between variables, as well as error terms for endogenous variables. For example, this corresponds to the relationship of the higher construct Social Norms with the measured or reported variable for Food Waste.

The technique used for SEM estimation was **Diagonally Weighted Least Squares (DWLS)**, which is typical when the observed variables include ordered or categorical data. With DWLS, categories with greater variance or distance from adjacent categories may receive higher weights.

The results are visually presented in **Figure 121** but for a more detailed presentation of the model estimates please refer to Appendix C (Table C6 for Belgium and Table C7 for Spain). In the two tables, we present the standardized coefficients of the latent variables along with their standard errors. The two-level structure allows the factors that were validated from CFA to be first expressed through the behavioural statements of the questionnaire, and then the latent factors are subsequently used to measure higher-level concepts. To follow the qualitative coding tree more closely we would need an extra level where descriptive, injunctive, prescriptive, proscriptive, and permissive social norms are captured by separate factors. However, this increases the complexity of the model specification, and the sample sizes are not adequate to achieve a robust estimation.

As a result, 6 out of 10 factors for Belgium and 8 out of 10 factors for Spain are used as indicators for the Motivation latent variable. For Belgium all these factors are statistically significant and have a positive sign, apart from Food Waste Motives that has a negative sign. High values of Food Waste motives are associated with people thinking less about the environment or the society, so it makes sense that the sign is opposite from Food Waste Attitudes that is associated with people being guilty about food waste. For Spain, the factors are also statistically significant with a positive sign, while the only factor that has an opposite sign is Gender Norms.

In **Figure 121**, the direct 'causal' links between two variables are represented with blue colour. Such an example is the relationships between a latent construct (Motivation) and Food Waste or one of the factors (Planning and Organization) and Food Waste. On the other hand, the links between the latent constructs and the corresponding factors (second level) are represented with green colour.

In theory, social norms, attitudes, and awareness collectively shape motivation. Here all the identified factors belong to the Social Norms category, and they are differentiated between "Descriptive and Injunctive Norms", "Prescriptive, Proscriptive and Permissible Norms" as well as "Gender Norms". The main difference between Belgium and Spain is that a Gender Norms latent variable was identified for the Spanish subsample and not for the Belgian one. **Strong social norms** (β_1 = -0.491 for Belgium and β_1 = -0.478 for Spain) **align with concerns for the environment and the needy** (Food Waste Motives), as well as **feelings of guilt associated with food wastage** (Food Waste

Attitudes), showcasing their influential role in shaping one's **Motivation** and leading towards lower food waste.

Ability is expressed through two indicators that enter the model separately for identification purposes**: Ability in Eating, Shopping and Cooking** and **Planning and Organization.** While the latter is not statistically significant for both countries, the first factor is **positively and in a statistically significant way related to food waste** (β_3 = 0.389 for Belgium and β_3 = 0.232 for Spain). While this seems contradictory to theoretical expectations, ability here is reflected by negative statements (e.g. 'I always find it difficult to estimate how much food to buy') so in practice it expresses lack of ability that leads to higher food waste.

Finally, the only available variable for **Opportunities** was the question to those that cook, with regards to using special tools at the kitchen. This was not found to be statistically significant (β_2 = -0.087 for Belgium and β_2 = -0.098 for Spain).

It is noteworthy that the results are identical for both countries in terms of statistical significance and parameter signs. Despite the difficulties and the differences in identification, as well as the final factors that are used in the SEM, the consistency in the results underscores the universal influence of social norms on food waste behaviour.

Limitations

Overall, the results indicate the **complex interplay of factors influencing food waste**. Although Opportunities did not exhibit statistical significance, SEM provides valuable insights into the MOA constructs' impact on food waste behaviour. Additional statements that would reflect Opportunities (e.g., time availability, infrastructure, and access to stores) could provide additional value to the model. The main limitation is the reduction of the sample size (335 individuals or 44% of the original sample for Belgium and 88 individuals or 45% of the original sample for Spain) to include behavioural statements that had several missing cases.

Based on the filters applied in the questionnaire, the reduced sample contains only:

- People that do grocery shopping more than once a month.
- People that cook more than once a month.
- People that, even rarely, receive guests at home to eat.
- People that, even rarely, are guests to another home to eat.
- People that have some role in the food purchases in the household.
- People that are parents.

Apart from the sample size, this assumption means that we are targeting a very specific subpopulation group and we do not explore for example the effect of social norms on food waste for young people. The second limitation, that is a consequence of the first one, is that CFA and SEM are applied to the unweighted sample. The reason is that the reduced sample does not maintain the representativeness and distribution of the original sample, so the weights are not appropriate anymore and they need to be recalculated.

However, the profiling of the clusters earlier in the analysis, even though it does not strictly follow the MOA theoretical framework, gives some useful insights on how various social norms affect food waste levels for distinctive demographic groups, that all together are representative of the population in Belgium.

Figure 121 Visualization of the SEM model with MOA framework for Belgium (left) and Spain (right)
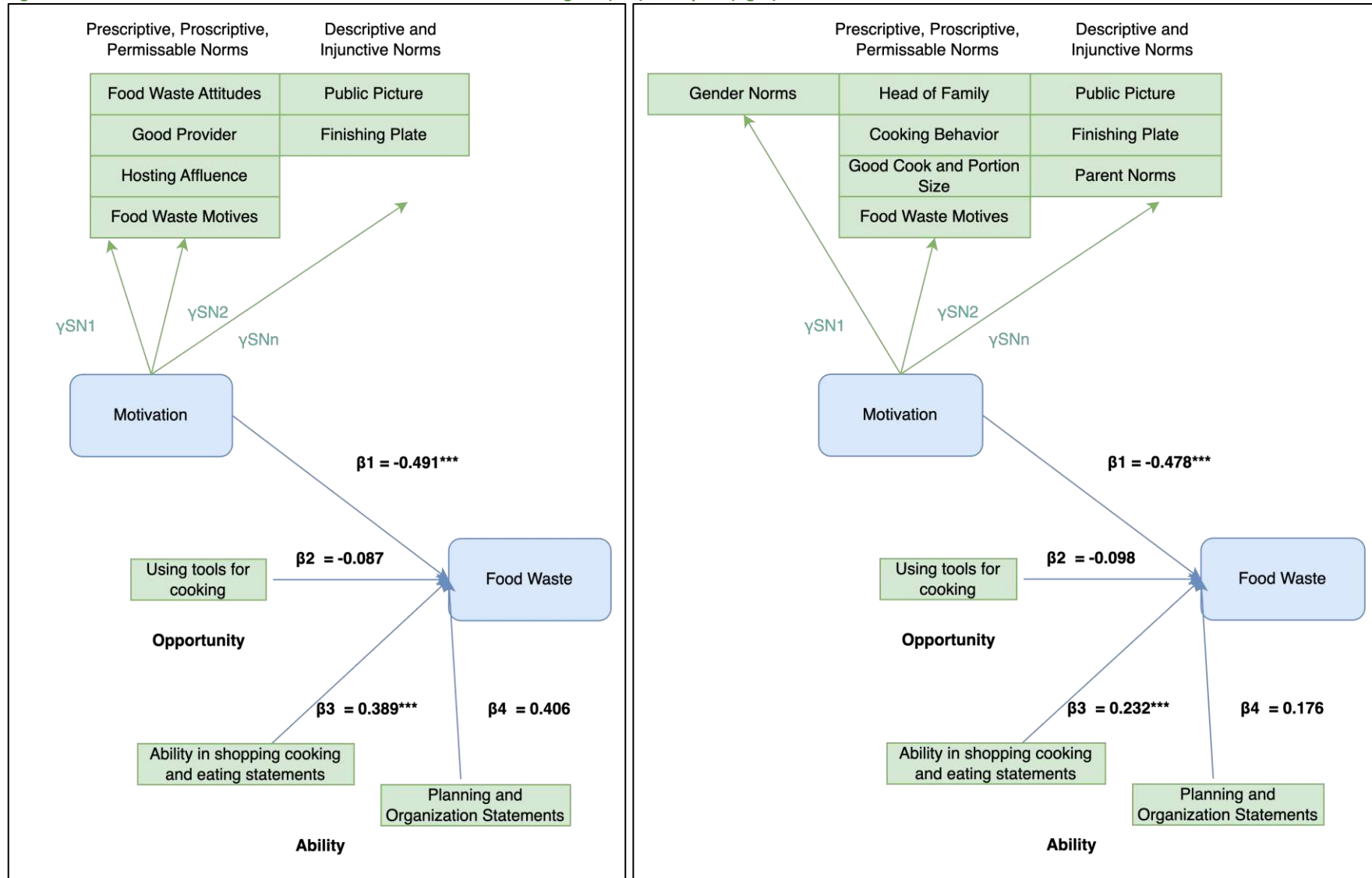
5.1.2   Case Study 2: Hospitality sector in Norway – hotels

In this section, the focus moves beyond descriptive analysis, delving deeper into the breakfast buffet experiment in an effort to understand the message effects on food waste, which were hypothesized in the previous chapter. In contrast to the surveys administered for the other case studies, the experiment's focus was to evaluate food waste levels, rather than directly targeting social norms and food waste related habits and attitudes. However, further discussion about the FW behaviour related to type of messaging is put forth at the end of section 5.1.1. The unique quantitative analysis approach utilized in this case study facilitates a direct examination of actual food waste, leveraging realistic measurements and mitigating potential self-selection biases often encountered with self-reported data.

The following points encapsulate the **main findings**:

- **Provocative messaging** interestingly seems to increase waste. This seemingly paradoxical outcome resonates with established theories and underscores the complex interplay between communication strategies and individual autonomy.

- **Positive messaging** leads to a reduction of food waste but the statistical significance of this effect becomes unstable when controlling for various cofounders, particularly the ratio of business guests. Through interaction analysis and alternative causal inference techniques, we elucidate the reasons for this instability and validate the statistical significance of the effect.

The remainder of this section combines regression analysis and propensity score matching with the aim to identify causal links between messaging interventions and behavioural changes in food waste.

<u>Regression Analysis</u>

The baseline linear regression model is the following:

$$Total\ Waste = \ \beta_0 + \ \beta_1 Guests + \ \beta_2 Message + \beta_3 Hotel + \ \beta_4 Weekend + \ \beta_5 Month$$

The results of the estimation are presented in Appendix A (left part of Table A7), and they are summarized below:

- The 'Positive' message **decreases waste** by approximately 11%. This effect is statistically significant.
- On the contrary, the 'Provocative' message has the opposite outcome: it **increases waste** by 20% and the effect is also statistically significant.
- **Weekends** are associated with a sharp increase in waste (about 23%) even after controlling for the number of guests.
- Among other **hotels**, 'The Thief' has the highest waste production, while 'Hotel Quality Riverstation' stands out for its minimal waste.
- The **months** of May, July, and August record higher waste levels compared to April, March, and June. But after controlling for the number of guests, the statistical significance of these parameters drops.

The baseline specification was enriched by adding the percentage of customers that are estimated to be business travellers. This was an observation that was made during the staff survey **(Figure 122).**

Figure 122 Demographics and characteristics of hotel guests as perceived by hotel staff
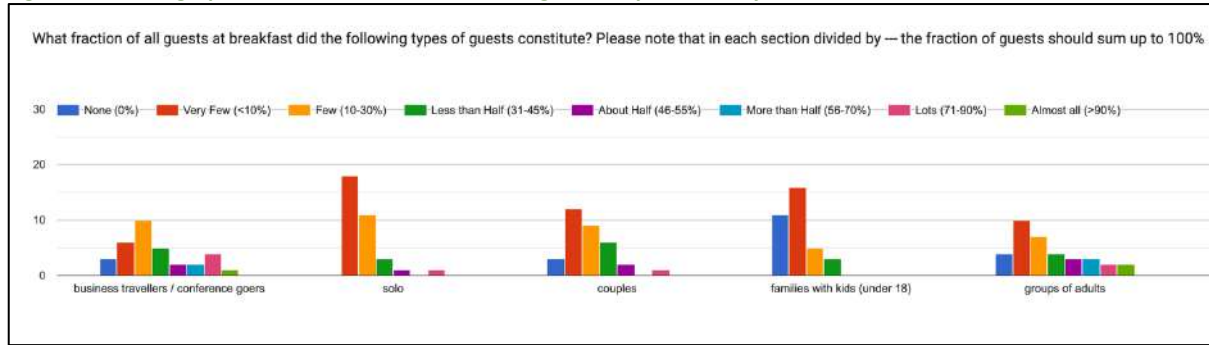
When controlling for the proportion of business guests (right part of Table A7 in Appendix A), the positive messaging is not statistically significant anymore. Moreover:

- 'Provocative' messaging appears to **amplify waste** by 24%, which is statistically significant.
- The composition of guests, specifically the **ratio of tourists to business travellers**, has a pronounced impact: transitioning from a scenario with no business travellers to one with 100% business travellers' results in a staggering waste reduction of 43%.
- **Weekends** continue to be a period of higher waste, with an increase of 26%.

An R^2 of 0.580 and 0.590 for the baseline model and the model with the proportion of business guests respectively, indicates a moderate level of explanatory power. The unexplained variability may be attributed to factors not considered in the model or the data collection, such as individual guest behaviours or specific menu items. For example, there is no easy way to measure how many guests noticed the message, when one was displayed. **Figure 123** shows what the hotel staff believes regarding the portion of guests that pay attention to the message. More than half of the staff who took part in the survey (67.3%) think that very few, few, or in the best-case half of the guests noticed the message.

Moreover, demographics that were not available for analysis in the experiment could play a significant role on both the perception of messages and the subsequent reaction of individuals. Hotel staff provided comments regarding subgroups of guests who exhibited stronger reaction than others. Those comments included observations such as: "Old people reacted in a good way, by smiling", "Older people were positive", "Men in mid 30s, commented that it was a bit over the line but maybe also necessary", "Women mid 30s, thought it was triggering for people with eating disorders".

Figure 123 Perception of hotel staff about the effectiveness of the displayed messages
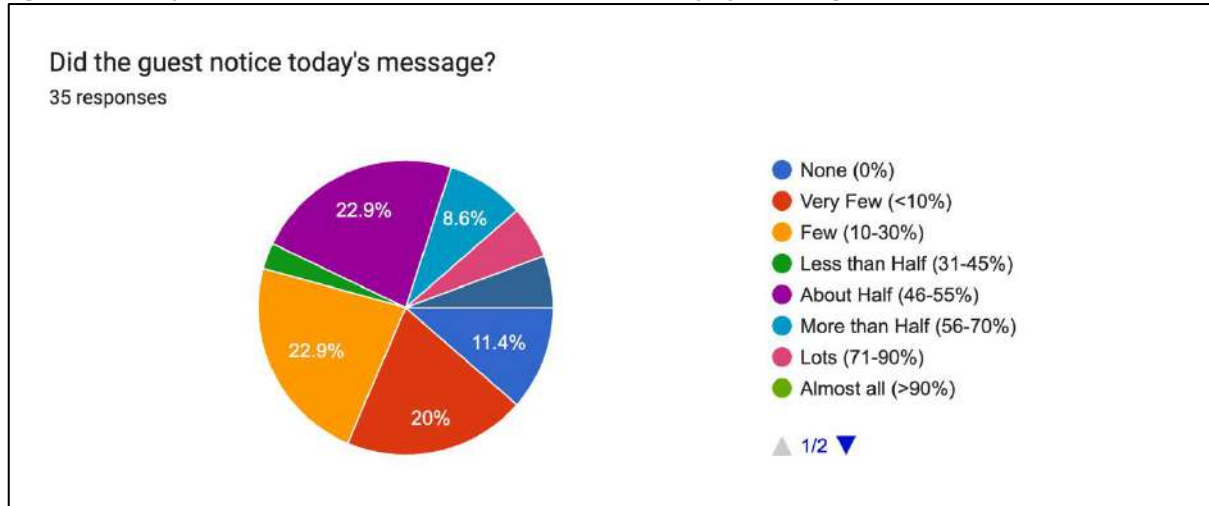
From the results above, provocative messaging has a significant effect, yet positive messaging is only significant when we do not control for the percentage of guests that are business travellers. One might be inclined to **examine whether messaging yields disparate outcomes for business and tourist travellers**. This inquiry could be achieved with a regression analysis. Nevertheless, it is crucial to acknowledge the constraint imposed by the measurement of only aggregate waste and the uniform presentation of messages to both guest groups. Therefore, the only rigorous way to measure effects separately would be:

- The independent and random presentation of messages to each guest group
- Measure food waste for both business and tourist traveler groups.

To achieve this with a regression, we attempt the following:

1. Compute the variables $Business\ Guests = Guests\ x\ Business\ Ratio$ and $Other\ Guests = Guests - Business\ Guests$
2. Add an interaction term in the baseline model, as follows:

$$Total\ Waste = \ \beta_0 + \ \beta_1 BusinessGuests + \ \beta_2 OtherGuests$$
$$+ \beta_3 BusinessGuests\ x\ Message + \ \beta_4 OtherGuests\ x\ Message + \cdots$$

With this regression structure, provocative message is still the only significant effect, but this time only for non-business travellers. In their case displaying provocative messaging increases per capita waste by 11g (an increase of 39%). The results are presented in more detail on the left side of Table A8 in Appendix A. It is crucial to note that this regression functions as an extrapolation and is not a real substitute of finer experimentation.

The marginal effects of this two-way-interaction are presented in Figure A5 in Appendix A. According to the plot, provocative messaging results in an increased FW that is stronger for non-business travellers.

In the middle of Table A8 in Appendix A, an extended model is presented, after the addition of two more interaction terms:

- Weekend with business ratio (the purpose of this term is to disentangle weekend effects from business ratio effects).

- Weekend with type of messaging (to examine if the messages have different effects on weekends).

While the confidence intervals are wide, it is clear that 'positive messaging' and 'weekend' interact:

- Weekend increases waste by 28%.
- After interacting weekend with positive messaging, its total effect on waste is decreased by 16% (i.e. 12% increase in waste).
- There is no significant effect of provocative messaging on waste.

The marginal effects of the two-way-interaction between messaging type and guest type is presented in Figure A6 in Appendix A.

The final model that was investigated included a three-way interaction between message type, guest type and the weekend Boolean variable. The estimates of the single and interacted coefficients are presented at the right side of Table A8 in Appendix A. Interestingly, all the interactions with the business guest are not statistically significant, while the opposite applies for the interactions with the non-business guests.

The marginal effects of the three-way-interaction are visualized in Figure A7 in Appendix A. As a first observation, the positive messaging is associated with a stronger FW reduction for weekends compared to weekdays, both for business and other guests. The same "weekend effect" applies for the provocative messaging, but now there is on top a differentiation between guest types, with the increase being strongest for "other guests in weekends".

While the three-way interaction examined earlier could have resulted in small subgroups in the dataset, a closer examination through a histogram visualization in **Figure 124** reveals otherwise. The number of guests is always higher in the weekends, but the difference between weekday and weekend is higher for the non-business volumes. Moreover, the average number of guests on days that the positive message was displayed is higher both for weekdays and weekends.

The model fit (R^2) of the models with the interaction terms remains unaffected, indicating that although the new terms offer interesting insights, they do not improve the model's explanatory power.

In evaluating the effect of message displays on breakfast buffet food waste through a randomized control trial (RCT), it's crucial to acknowledge the potential limitations inherent in the study design. While RCTs are generally regarded as the gold standards for assessing causality, the presence of cofounding variables in our study undermines the efficacy of a linear regression approach to reliably measure causality. For example, the variations in the timing of control (no message) and treatment periods across different months, as it is observed in **Figure 124,** as well as discrepancies in message presentation strategies among participating hotels, introduces some bias that jeopardizes the underlying randomness of the experiment.

Figure 124 Average daily number of guests by message type, guest type and weekend
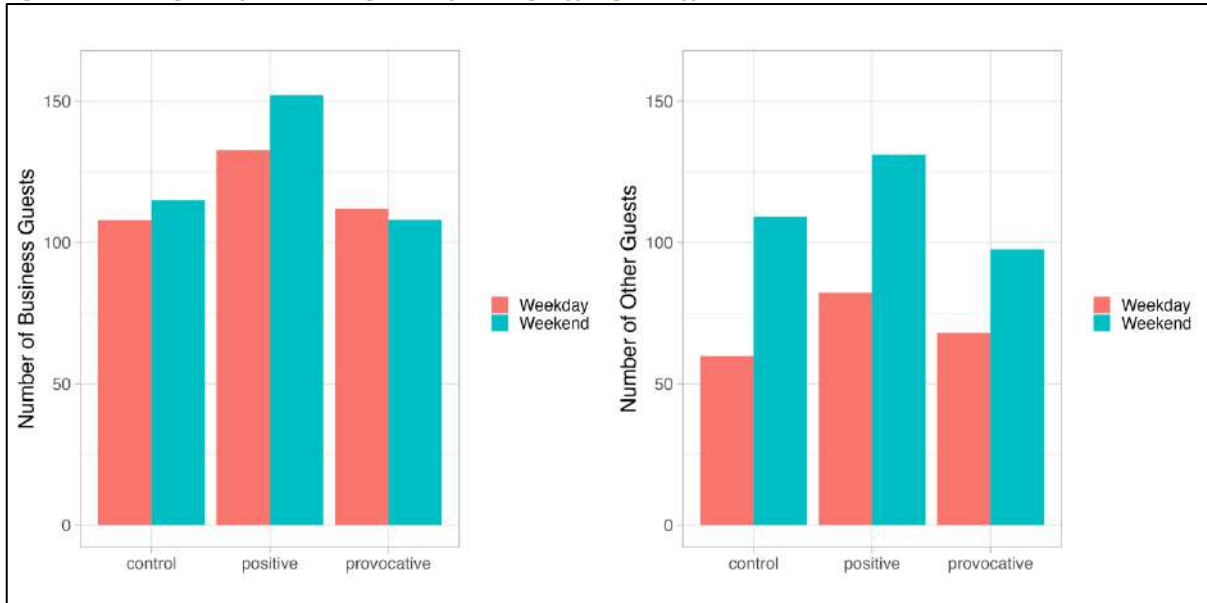
One approach to mitigate the impact of the described phenomenon, is **Propensity Score Matching (PSM)** (For more details in the methodology please refer to Box 6).

BOX 6. PROPENSITY SCORE MATCHING (PSM) IN A NUTSHELL

By matching participants based on their propensity score, which represent the likelihood of receiving a particular treatment (i.e. positive or provocative message) conditional on observed covariates, PSM facilitates the creation of comparable treatment and control groups that are more relatable to those in a randomized experiment. The steps employed in PSM are the following:

• For each day of the experiment that a message was displayed, we try to find a 'match' that has many of the same covariates, but the message was not displayed. This is needed for as many days as possible to create a cohort of control/treatment days.

• A **logistic regression** is fit where the predictor variables are the covariates (business guest ratio, weekend or weekday, hotel etc.) and we are trying to predict the intervention (i.e. if the message was displayed).

• A predicted probability is calculated, and it is used to find the closest match from the opposing group. **K-nearest neighbours (KNN)** is used to find these matches and it can either be 1:1 matching or 1 to many matching, allowing for duplicates. Here, the 1:1 approach was selected.

• The metric that is used to evaluate how well the matching process controlled for all the covariates is the **effect sizes**. The smallest the effect sizes, the most likely that the change in food waste can be attributed to the displayed message, reflecting a potential causal link.

• Finally, a statistical test is performed to compare the waste per guest between the treatment and the control group.

If we compare this methodology with linear regression, the first difference is that instead of one model, now there are two different models. The first model compares control with the positive message and the second compares control with the provocative message. As a result, instead of the 1,074 observations that were used for the estimation of the linear regression models, the first model has 841 observations (493 for control and 348 for positive messaging) and the second 726 observations (493 for control and 233 for provocative).

Additional details on the matching process are presented in Appendix D. After the two groups have been generated, a two-tailed t-test was conducted to assess the differences in food waste per guest between the treatment and control groups. For **positive messaging**, the average waste per guest was reduced by 7.5g that translated to a **19.3% reduction**. This result is very close to the 20% reduction from the previous experiment by Strawberry, which also employed a positive messaging strategy, that was discussed in Chapter 4. The change is statistically significant at the $p < 0.001$ level. On the other hand, for **provocative messaging**, the average waste per guest was increased by 9.8g that translated to a **23.0% increase**, which is very close to the 24% increase that was estimated with the linear regression. The change is also statistically significant at the $p < 0.001$ level.

To summarize, the PSM approach corroborated the findings of the linear regression model, with the following distinction: the FW reduction effect of the positive message had now a statistically significant effect, after the enhanced control for confounding variables achieved through the matching process.

Conclusions

The fundamental aim of this study was to delve into the nuanced effects of different communication framings—specifically, positive/provocative versus neutral—on food waste (FW). The findings shed light on how messaging strategies can either enhance or hinder individuals' tendency for wasting food. Upon analysis, the results unveiled intriguing patterns. It was observed that **while positive messaging exhibited a decrease in FW compared to the control group, provocative messaging elicited a substantial increase in FW**. This seemingly paradoxical outcome underscores the complex interplay between communication strategies and individual autonomy.

From a psychological standpoint, these findings resonate with established theories. Provocative messaging, by its nature, can be construed as a challenge to personal freedom—a phenomenon commonly referred to as reactance or the "boomerang effect" in scholarly discourse. This phenomenon elucidates how attempts to exert influence can backfire, leading to a reinforcement of the targeted behaviour. The crux of reactance lies in individuals' innate desire for autonomy and the perception of their choices being respected. When confronted with provocative messaging, individuals may instinctively rebel against perceived constraints on their freedom, thereby exacerbating the behaviour in question. This reaction stems from individuals wanting to feel their choices are respected and that they have autonomy over their behaviour. When pressured, such as through provocative messaging, people tend to behave contrary to expectations, sometimes even opposing their initial intentions. This paradoxical response is reminiscent of the adage "cutting off one's nose to spite the face."

These findings underscore the importance of crafting communication strategies that align with principles of autonomy and respect for individual choices. Previous research has consistently highlighted the efficacy of social influence techniques that uphold core freedoms. Thus, the observed decrease in FW in response to positive messaging in the breakfast experiment is not surprising.

Practical insights for hotel buffets

For hotel buffets seeking to influence guests' FW effectively, these findings carry profound implications. The experiment underscores the importance of carefully framing messages to avoid triggering reactions. The results suggest that **no message may be better than a poorly constructed one**. In essence, this study offers valuable insights into the intricate dynamics of communication and autonomy. Namely:

- Additional interactional analyses have provided valuable insights into the main results of this study. Surprisingly, when incorporating the business versus other types of guest ratio into the model, the effect of positive messaging became statistically insignificant (for both groups of guests). This unexpected finding challenges the assumption that the variance in the effect of positive messaging could be attributed to one specific type of guest.

- Furthermore, analysis revealed that positive messaging significantly decreased FW on weekends compared to neutral messaging, while no similar effect was observed for provocative messaging. This observation is particularly noteworthy considering the initial findings that guests tend to waste more during weekends. Despite this, guests exposed to positive messaging exhibited lower levels of FW compared to those without any messaging during weekends. This could be attributed to the phenomenon where during weekends, FW is already significantly high, leaving little room for further wastage under certain conditions (sailing effect). Conversely, on weekdays, FW levels are not as high, thereby limiting the potential for decrease via messaging, akin to a floor effect.

- Further analysis indicated that provocative messaging had a significant effect on non-business travellers. This suggests that the impact of messaging strategies on FW may vary depending on the specific characteristics of the guests.

- Business guests appear to be less susceptible to manipulation. This could be attributed to several factors. Business travellers often operate with a different mindset while traveling, focusing on representing their companies rather than responding to external messages. So, the norms within their companies likely influence their behaviour more strongly than external messages tailored towards individuals rather than company representatives.

- Other guests waste more in provocative messaging via boomerang effect.

- Ultimately the findings were validated and reinforced through the application of Propensity Score Matching, offering a distinct methodological framework from that of linear regression. In contrast to the regression analysis which seeks to attribute observed effects to external cofounders, PSM adopts an approach focused on eliminating initial differences and approximating the conditions of a fully randomized control trial.

In conclusion, this study has provided significant insights into the intricate dynamics of communication framings and their impact on food waste (FW). Overall, our findings emphasize the need for **nuanced approaches** in understanding and influencing consumer behaviour, particularly in hospitality settings. By considering the complexities of communication framings and their effects on FW, practitioners can refine their approaches to effectively influence behaviour while respecting individual autonomy.

5.1.3   Case Study 3: Food services sector in Slovenia – restaurants

The following points encapsulate the **main findings**:

- **Males** tend to finish their plates more often than **females** and are also less likely to take leftovers home, albeit with slightly lower statistical significance. This outcome was also identified by cross tabulation in chapter 4.

- There is an emerging **Social Stigma Effect** on food waste from leftovers. More specifically, there are several attitudinal variables that reflect perceptions or concerns about how others might view individuals taking leftovers home from a restaurant. Such variables are the **perception of**

being viewed as poor for taking home leftovers, **the belief that leaving food on plate is acceptable or not**, **concerns about appearing wasteful or greedy by not finishing the food**. These perceptions correlate both with the amount of food left on the plate and the likelihood to take leftovers home, so they are strong indicators of food waste behaviour.

- In the previous section, it was highlighted that the majority of the respondents **do not take leftovers home because restaurants do not allow it**. In this section, this portion of the population is associated with conscientious behaviour regarding food waste. Consequently, only by relaxing external constraints that are imposed by some food service establishments could reduce food waste.

- Two behavioural responses are examined as proxies of food waste in a restaurant setting: the **amount of food that is left on plate** and if the respondents **take leftovers home**. These two behaviours have a rather **hierarchical** relationship instead of a complementary one. Thus, if an individual takes the leftovers home, the quantity of these leftovers is less important because the food will be consumed (or the food waste will be displaced to a household setting). On the other hand, if they don't take leftovers home it is crucial that the uneaten food on the plate is reduced.

- Following the logic above and a calculation of a **naïve composite food waste score**, **clustering analysis** highlighted that individuals who leave food on the table but are the most likely to take leftovers home (**Deal Hunters and Efficient Retirees**) as well as individuals who avoid taking leftovers but are the most likely to finish their plates (**Discerning Customers**) have the best food waste scores compared to clusters that exhibit a more 'balanced' behaviour.

The remainder of this section combines regression analysis, and cluster analysis with the aim to uncover insights on the interrelationships between social norms and food waste levels.

Data Preprocessing

Before proceeding with the analysis, here are some basic data preprocessing steps that were followed for the demographics and the items related with food waste behaviours and habits:

- Two cases were removed because more than 90% of the variables had missing values.
- All the variables were refactored to numeric so that they can be used for quantitative analysis. The majority had an ordinal nature, so they didn't need extra processing. A few of them like eating preference (eat alone, with family or with friends and colleagues), attitudes towards peers taking leftovers at home, motives for not taking leftovers at home, gender, income, and education levels were also recoded as dummy variables.
- After removing a few extra cases that have missing values (5 for family income, 3 for household size, 2 for year of birth and 1 for beliefs about ordering ahead benefits for food waste) the final sample size consists of 792 individuals.

In conducting the regression analysis, a significant number of attitudinal variables were initially considered. However, a substantial portion of these variables contained missing data that exhibited a non-systematic pattern across the dataset. Due to this inconsistency in missing values, a data cleaning process would result in a sample size that would be smaller than 25% of the original. Consequently, removing those variables from the analysis was a necessary step to ensure that we don't sacrifice the majority of our data points.

After this extensive removal, the available data became insufficient to conduct advanced analytical techniques like factor analysis and structural equation modelling, processes that were employed in

Case Study 1 and Case Study 6. The reason was that there was not enough information available to uncover latent constructs that could feed into the MOA structure associated with food waste in the food service industries.

However, the investigation into food waste levels when dining at restaurants involved the estimation of two distinct regression models. These models were separately derived to gauge the **quantity of leftovers left on consumers' plates** and their **tendency towards taking leftovers home**. The combination of those two behavioural aspects – the amount of food left uneaten and the inclination to take this food to consume it later – stands as a key indicator elucidating the dynamics and levels of food waste by consumers.

Figure 125 delineates the survey's primary themes (depicted by green circles). Among these, two themes constitute food waste behaviour while the remaining three (pre-ordering, portion sizes and finishing meals) serve as explanatory factors. These factors are a composition of diverse attitudinal responses that together with demographics and eating preferences impact how much food is left on plates and how often individuals take leftovers home. Items highlighted in blue serve as confounding variables in the regression analysis, while those in red were excluded due to missing data. However, all items are investigated in the clustering analysis to outline behavioural patterns among clusters.

Figure 125 Survey Main Themes and Modelling Framework
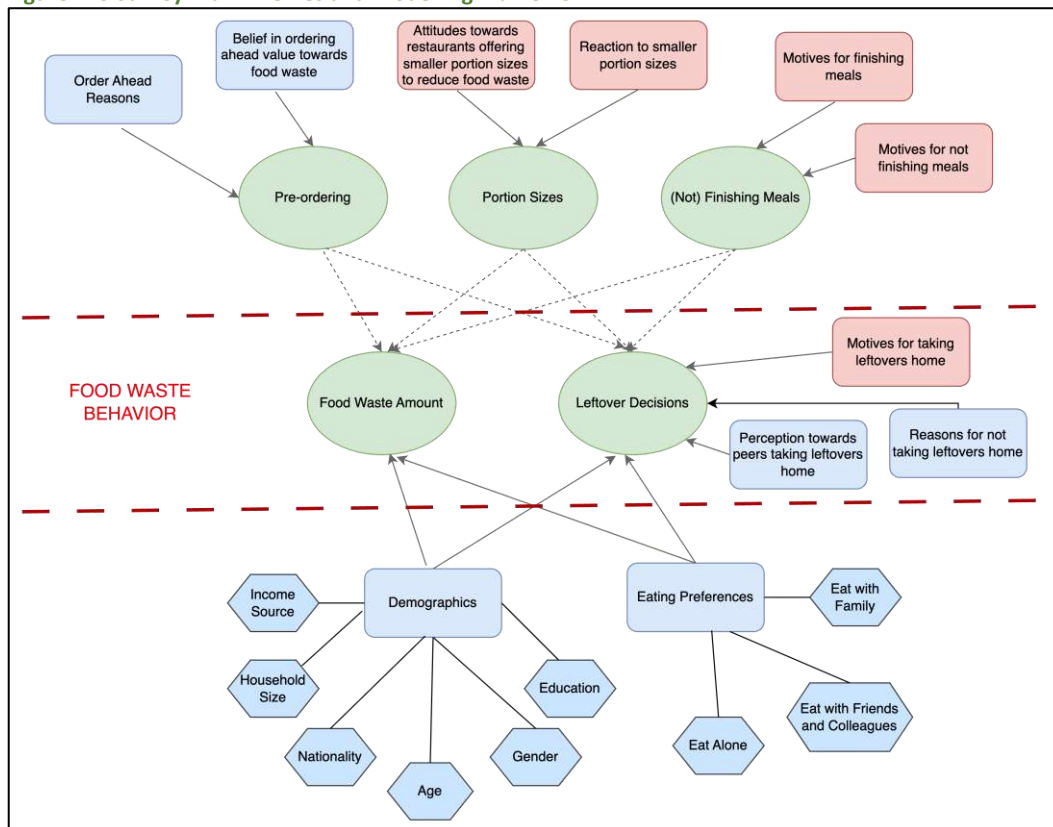
Food Waste Behaviour

The quantity of leftovers left on consumers' plates was depicted in the previous section as a total number and disaggregated by gender. The tendency towards taking leftovers home was also discussed in chapter 4 and the distribution of the responses, which is quite even, can be seen in **Figure 126**. When looking at the results separately for men and women, it can be observed that women were less likely to have answered "No" (21.9%) compared to men (29.7%).

Figure 126 Tendency towards taking leftovers home
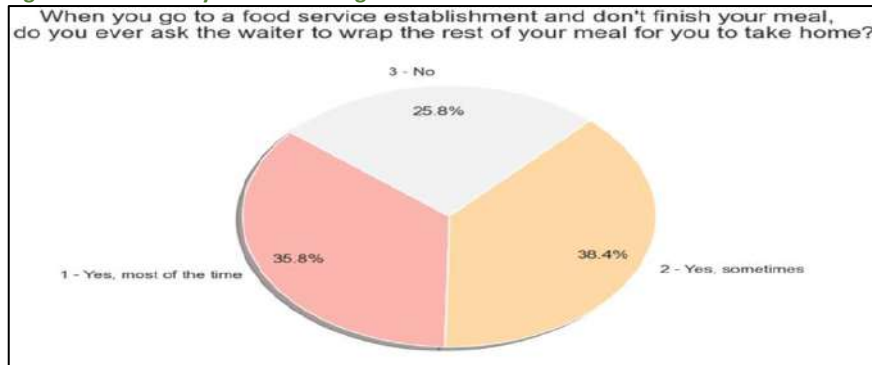
Combining the two variables, individuals that leave more food on their plates and at the same time do not ask the waiter to wrap the leftovers to take home, represent the most significant contributors to food waste within restaurant settings.

Correlations

Before conducting the regression analysis, we create a correlation table with the regressors. Understanding the various correlations aids in identifying potential multicollinearity issues, impacting the reliability of regression results. This can help in making informed decisions on variable selection. The correlation table is presented in Appendix A (Figure A8) after filtering out correlations that are below 0.4 (in absolute terms) and hiding the upper triangular values because they are symmetric. We can summarize the following:

- The strongest negative correlation is between "Male" and "Female", which is expected (-0.99), followed by two reasons for not taking leftovers home: "Because food was not good in the first place" and "because it saves little money" (-0.92).

- Other strong negative correlations are between "eating with family" and "eating with friends or colleagues" (-0.73), between attitudes towards their peers taking home leftovers, i.e. "Do not care" and "Think the person is poor" (-0.7) as well as "Glad that the food did not go to waste" and "Acceptable to leave food on plate" (-0.57), between "income source from pension" and "income source from wages or salaries" (-0.65) and between "Highest level of Education: Secondary" and "Highest level of Education: Undergraduate" (-0.6). **The above correlations are between dummy variables that originate from the same questions, so they are expected.**

- Finally, there is a negative correlation between "year of birth" and "income source from pension" (-0.7). This high correlation value is a potential source of multicollinearity, but we will keep both values for the analysis as we expect age to reflect some additional characteristics apart from the employment status.

- A similar but opposite effect (positive correlation) is observed between "year of birth" and "Income source from wages and salaries" (0.5).

Regression Analysis

The model that was selected for the analysis is ordinal logistic regression or ordered logit (OL) (see Box 1 in Case Study 1 for more details).

For the first model, "Leftovers Amount" is measured from 1 to 5, where 1 corresponds to half a plate and 5 corresponds to no leftovers, indicating decreasing food waste levels with higher values. For

the second model ("Take Home Leftovers"), the tendency to take leftovers home is measured from 1 to 3, where 1 corresponds to "Yes, most of the times", 2 corresponds to "Yes, sometimes" and 3 corresponds to "No", thus higher values are associated with higher food waste because the leftovers are thrown away.

Since the frequency of taking leftovers back home is possibly affected by the reported quantity of leftovers, a third model is estimated ("Take Home Leftovers Controlling for Leftovers Amount"), which is identical to the second one, but it is controlling for this quantity.

All regression models include factors that are a combination of demographics, eating out preferences, attitudes towards ordering ahead, leftovers and finishing plates.

The estimates of the OL models are presented in Appendix A (Table A9). The interpretation of the odds ratio in these tables follows the same logic with Case Study 1.

As a general observation, the results of the models with and without controlling for the amount of leftovers are identical, with the exception of two parameters that become statistically insignificant for the latter: gender and undergraduate education.

Aggregating the model parameters by the themes and factors, the results are summarized below.

Demographics

Households with more members show a higher tendency to take leftovers home ($p<0.01$).

Slovenian respondents tend to leave more leftovers on their plates compared to non-Slovenian respondents ($p<0.001$) and take leftovers home more frequently ($p<0.001$). Here it is crucial to note that the portion of the respondents with non-Slovenian nationality in the sample size is very small (9 out of 792 or 1.1%).

Younger respondents tend to leave less uneaten food on their plate ($p<0.001$) while simultaneously being less inclined to take leftovers home ($p<0.001$).

Males tend to finish their plates more often than **females** ($p<0.001$) and are also less likely to take leftovers home, albeit with slightly lower statistical significance ($p<0.1$). However, the gender effect on taking leftovers back home becomes insignificant when controlling for the leftovers amount. This makes sense because males might have no leftovers to take home to begin with. Interestingly, 2 individuals who prefer **not to state their gender** leave more food on their plates ($p<0.001$) and take leftovers home more frequently ($p<0.001$).

Regarding **income sources**, individuals with "other sources" (11 out of 792) exhibit the highest likelihood of leaving leftovers on their plate ($p<0.001$) and taking these leftovers back home ($p<0.001$).

Focusing on **education**, the highest level of education (i.e. postgraduate) serves as reference to compare with other education levels. Those with no education are more likely to leave leftovers on their plate ($p<0.001$) and less likely to take these leftovers back home ($p<0.001$). Intriguingly, all other educational backgrounds (primary, secondary, undergraduate, other) leave fewer leftovers on their plate and are less likely to take them home compared to highly educated individuals.

Eating preferences

In terms of **eating preferences,** "eating with friends and colleagues" serves as the fixed category. Hence, individuals eating alone are more likely to take leftovers home (p<0.001) compared to those eating with friends or colleagues. A similar trend applies to those eating with their family, albeit with slightly smaller impact (p<0.001).

Pre-ordering

A notable observation stems from **motives driving respondents to order a meal at least 1 day ahead of visiting a restaurant**:

- Individuals sensitive to prices are more likely to leave more leftovers on their plate and are also more prone to take leftovers home (ORDER_AHEAD_REASON_2 exhibits statistical significance at p<0.001 for both models).
- Respondents willing to order ahead if required to reserve a table are less likely to take leftovers home (ORDER_AHEAD_REASON_4 shows statistical significance at p<0.001) but this preference does not affect the amount of leftovers.

Leftover Decisions

The frequency of taking leftovers back home is significantly correlated with the amount of food left on plate (p < 0.001), indicating a positive association. This suggests that individuals are more likely to take leftovers when there is a larger quantity of uneaten food remaining.

A significant set of attitudes towards explaining food waste behaviour is observed concerning **how individuals feel when a peer asks to take the remaining food home**. The fixed response "I am glad that the food will not go to waste", reflects the majority opinion. Here are the findings relative to this answer:

- Indifference is associated with a lower likelihood of taking leftovers home (p<0.001).
- Believing that the person taking leftovers is poor correlates with leaving more uneaten food (p<0.001) and not taking leftovers home (p<0.001). **The combination of these two factors is a strong indicator of higher food waste.**
- **The above effect is even stronger** for individuals believing it's acceptable to leave uneaten food on the plate (p<0.001 for both models).

Another set of attitudes providing insights into food waste behaviour includes the **main motives for NOT taking leftovers back home.** Relative to the response "Bringing food home saves little money", here are the findings:

- Individuals stating that food was not good to begin with, are associated with smaller leftover amounts (p<0.05).
- Believing that leftovers might be unhealthy, correlates with less frequent taking of leftovers (p<0.001) and leaving less food on plates (p<0.001).
- Individuals confident of their cooking abilities leave fewer leftovers on their plate (p<0.001), and also do not take leftovers home (p<0.001).
- Perceiving taking leftovers as indicative of financial constraint is associated with the lowest tendency of taking leftovers back home (p<0.001), but also with a higher tendency to finish meals (p<0.001).
- Respondents stating that restaurants do not allow them to take food home, have a combined behaviour of not leaving many leftovers (p<0.001) and taking what's left back home (p<0.001).

As a result, **this group demonstrates the best behaviour towards food waste**, maybe because they are only limited by external constraints in their decisions.

Clustering Analysis

The attitudinal variables used in the regression models (eating out frequency, ordering ahead, eating preferences and motives for leaving food on plate), collectively offer a comprehensive view of different dimensions and patterns of food waste generation when eating out. By employing these variables for clustering, the aim is to **identify distinct groups** and **characterize diverse waste behaviour profiles within the sample population**. Subsequently, the identified clusters will be examined concerning the leftovers amount, the frequency of taking leftovers home, as well as the regressors that we used for the models and even the behavioural items that were excluded earlier to avoid reducing the sample size.

The clustering methodology that was implemented was this of K-modes (see Box 2 in Case Study 1 for more details). In Figure B5 in Appendix B it can be observed that the critical point for our data, lies somewhere between 5 and 7. We have selected 6 clusters following the same logic as before.

The detailed profiles of the individuals that belong to the 6 clusters are presented in Appendix B (Figure B6). The average value for taking home leftovers was subtracted from the average value of leftovers amount in order to construct a composite index (**food waste score**) to gauge food waste. While this index is arbitrary and the scale of the two variables is not directly comparable, it helps as a comparative indicator of food waste behaviour between the clusters. Summarizing the information demonstrated in the figure, the different clusters can be described as follows:

- **Frequent Diners** (Cluster 0): The lowest amounts of leftovers (+), the least likely to take leftovers home (-), an **overall food waste score of 2.04**. Comprising individuals from lower-income backgrounds, typically living in smaller households, and predominantly male. They eat out more than any other group either alone or with friends and colleagues. They don't care about food variety and they don't want to look greedy to their peers. They like overeating and large portions, and when they take leftovers home it is for social reasons or for convenience.

- **Discerning Customers** (Cluster 1): The second lowest amounts of leftovers (+), not likely to take leftovers home (-), an **overall food waste score of 2.36**. Members of this cluster have a high income, typically live in large households and are generally well-educated. They prioritize food taste over large portions and finish what is on their plate because they were taught to. They are not concerned about smaller portions and they do not care if their peers take leftovers home.

- **Opportunity Takers** (Cluster 2)**:** The second highest amounts of leftovers (-) and more neutral with respect to taking leftovers home (*), an **overall food waste score of 2.20**. This group consists of individuals living in larger households with increased shares of income coming from benefits, investments, properties, unemployment schemes or other sources. They don't believe that ordering ahead could have an impact on food waste, but they are willing to do it with the right incentives. They are not affected by their peers when it comes to finishing their plates, and often take leftovers home, considering it a money-saving strategy. They would be discouraged to return to the restaurant if the food was bad or there was not enough variety.

- **Moderate Eaters** (Cluster 3): The highest amounts of leftovers (-) and more neutral with respect to taking leftovers home (*), **an overall food waste score of 2.07**. They are the youngest group with the highest family income and predominantly female. They do not overeat if the portions are large, and their orders are the same when they eat alone or with others. Moreover, they often leave food due to either large portions, displeasure with taste or because it is polite to do

so. When they take leftovers, it is because the food was tasty, or they don't want it to be wasted and they would so even if it involved paying for containers.

- **Deal Hunters** (Cluster 4) Average amount of leftovers (*) and likely to take leftovers home (+), an **overall food waste score of 2.42**: This cluster mainly comprises of younger individuals that live in small households, are full-time employees and typically eat with friends or colleagues. They tend to overeat if the portions are large or if there is a self-service offer. They typically order more food on purpose, and they would not go back to a restaurant if it did not offer the possibility to take leftovers or if the leftovers had additional charges or fees.

- **Efficient Retirees** (Cluster 5) Average amount of leftovers (*) and the most likely to take leftovers home (+), an **overall food waste score of 2.44**. The oldest group with the lowest income, predominantly male, where all the individuals are of Slovenian nationality and only eat with their family. Many are retired, and this group has the highest proportion with minimal or alternative education. They don't eat frequently out of home, they are mindful of overeating, don't favour large portions, and view taking leftovers as a positive action. They greatly value taking leftovers home, regardless of food appearance, considering it a time-saving practice.

The distribution of the respondents across different clusters is relatively even, as is demonstrated in **Figure 127.**

Upon conducting the clustering, it is notable that no cluster exhibits a simultaneous trend of low leftover amounts and a propensity to take leftovers home. Logically, a cluster exhibiting both traits could imply the lowest food waste. However, the act of taking leftovers minimizes the relevance of the food quantity left on plate. In other words, the relationship appears to be hierarchical: to reduce food waste, if one does not take leftovers home it is ideal if they finish their plates. This hierarchy is partly reflected in the observation that the **clusters frequently taking leftovers home to save money or time (Deal Hunters and Efficient Retirees) demonstrate the highest food waste scores** (where a higher score is indicative of a better behaviour, hence less waste). **Following closely is a cluster characterized for finishing their plates because they were taught to, or they like quality food (Discerning Customers).**

Figure 127 Cluster Sizes
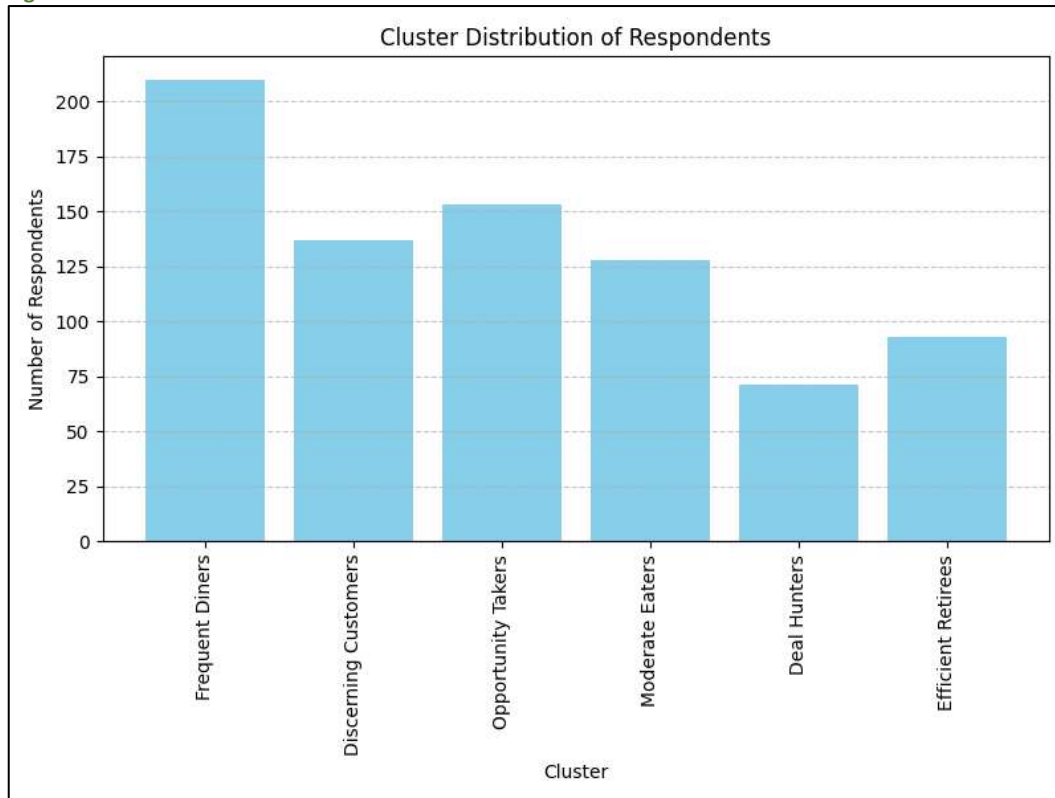
Comparing the clustering results with the regression results as well as with the descriptive analysis in chapter 4, the main common effect is **that men tend to leave fewer quantities of food uneaten**. The frequent diners, that is the group with the highest share of male respondents, is also the group with the lowest amounts of leftovers. Vice versa, moderate eaters, that is the group with the highest share of female respondents, tend to not finish their plates.

As a final test, it was important to confirm if the difference-in-means between the demographics of the various clusters was statistically significant. The statistical validation process that we followed (see Appendix B for more details) ensured the robustness and reliability of the clustering outcomes, by highlighting statistically significant differences between their demographics.

5.1.4   Case study 6: Date marking and sustainable, smart food packaging – focus on Spain

The following points encapsulate the **main findings**:

- Data indicate a prevalent perception among European households of **low over-purchasing** as well as **low levels of food waste across food types**. This inclination could reflect a bias toward socially desirable responses, potentially leading to **underreported food waste.**

- Diversity characterizes food waste patterns across demographics. **Younger demographics** exhibit higher over-purchasing tendencies. Additionally, there are **cross-country** variations with Estonia demonstrating the highest food waste and Hungary the lowest one. These results are supported both by regression and clustering analyses.

- Lower attentiveness in checking **marking dates** and higher sensitivity to marking dates are associated with higher over-purchasing frequencies and higher food waste levels.

- Clustering analysis highlighted five distinct "**types of wasters**" with **diverse profiles** in their demographics, habits as well as perception of marking dates and smart packaging. While food waste levels differ across these clusters, **waste behaviour is quite homogeneous across food types** within clusters.

- The majority of the respondents belong to the **'Eco-Affluent'** group (72%), which is characterised by relatively higher income and education levels as well as an attentive approach to marking dates. This group reports the lowest food waste.

- The **MOA structure is validated** with Structural Equation Modelling. Strong **Social Norms** that indicate embarrassment, guilt, or responsibility for throwing away expired food (Food Waste Feelings) as well as beliefs that food waste should be fined (Food Waste Regulation) have an influential role in shaping one's **Motivation** and leading towards higher food waste. The lack of trust towards food retailers and their motives behind setting expiration dates (**Awareness**) also leads the consumers toward higher food waste. Individuals that purchase more than they need/planned because of time unavailability or because of an abundance in discounts (**Opportunities**) are positively correlated with food waste. Finally, **Ability,** that is expressed through the interpretation of expiration dates by food type is not statistically significant.

The remainder of this section combines regression analysis, cluster analysis, factor analysis, and structural equation modelling with the aim to uncover insights on the interrelationships between social norms and food waste levels.

Data Preprocessing

Before proceeding with the analysis, here are some basic data preprocessing steps that were followed for the demographics and the items related with food waste behaviours and habits:

- The following variables were recoded to dummy variables: gender, country, the interpretation of marking dates on packaging, perceptions of leftovers after cooking and reasons for keeping food in original packaging.
- All the variables were refactored to numeric so that they can be used for quantitative analysis. Some of them had already an ordinal nature, so they didn't need extra processing. However, the following variables were also recoded to an ascending or descending order based on the context: residence location, household income, change of income over the last 3 years, education, food waste by type, clarity of marking dates, storing food with original packaging and perceptions of smart packaging impact on food quality.
- After removing 6 cases that have missing values, the final sample size consists of 1164 individuals.

Food Waste Behaviour

The dependent variable in the regression analysis is food waste. There are two different ways that food waste is stated by the respondents in the questionnaire. In particular:

- Over-purchasing frequency (and subsequently food waste frequency) as a response to the question: "How often does your household buy so much food that some of it expires without being eaten?" (**Figure 90**)
- Weekly Food waste quantities broken down by food types (**Figure 91**).

Visual Comparison and Correlations

From a visual inspection of the over-purchasing frequency, compared with various variables in the dataset, we can see that there is potentially a relationship (positive or negative) with the following parameters: a) all the individual food waste levels per food type, b) the perception of how attentive people are with marking dates compared to other consumers, c) the respondents' belief on what 'safe until' and 'best before' mean, d) the frequency of discarding food past marking date despite its good appearance/smell, e) reasons for keeping the food in its original packaging and f) number of household members. The bivariate relationships of food waste with the parameters above are presented in Appendix A (Figure A9). The statistical significance of the relationships highlighted here will be explored in the models later in this section.

As a final step before conducting the regression analysis, we create a correlation table with the regressors. Understanding the various correlations aids in identifying potential multicollinearity issues, impacting the reliability of regression results. This can help in making informed decisions on variable selection. The correlation table is presented in Appendix A (Figure A10) after filtering out correlations that are below 0.4 (in absolute terms) and hiding the upper triangular values because they are symmetric. We can summarize the following:

- The strongest negative correlation is between "Male" and "Female", which is expected (-0.99)
- Other strong negative correlations are between the reasons for keeping the original packaging and the interpretation of the marking dates on packaging (values between -0.50 and -0.77). **The above correlations are between dummy variables that originate from the same questions, so they are expected.**

<u>Regression Analysis</u>

The model that was selected for the analysis is ordinal logistic regression or ordered logit (OL) (see Box 1 in Case Study 1 for more details).

All regression models include the factors that are depicted in Figure A9 in Appendix A, that are a combination of **demographics**, **country of residence**, **perception and clarity of marking dates**, **treatment of leftovers after cooking** and **perceptions around food packaging**.

The estimates of the Food Waste Frequency model are presented in Appendix A (Table A10). The interpretation of the odds ratio in these tables follows the same logic with Case Study 1. The main findings from the observed parameters are summarized below.

Demographics

1. **Younger people** tend to purchase more food than they need/planned in a more frequent basis than older people (significant at $p<0.001$).
2. From the 5 European countries that the survey was administered to, Estonia serves as the reference country, thus the country parameters are interpreted in a relative manner. Consumers in **Estonia have the highest frequency** of over-purchasing (hence generating more waste) followed by Spain (significant at $p<0.1$). Consumers from **Hungary report the lowest frequency** of over-purchasing ($p<0.001$) followed by **Greece** ($p<0.001$) while Netherlands stands somewhere in the middle ($p<0.01$)

Habits and food waste

1. Individuals who **prefer having leftovers after cooking**, are more likely to purchase food in excess of their needs (p<0.05).

Date marking

1. **Respondents who admit to not attentively checking expiration dates** are more prone to over-purchasing (p<0.001).
2. **Consumers discarding food due to surpassing both 'safe until' and 'best before' date, even if the food appears to be fine,** are more likely to over-purchase. The impact is stronger for 'best before date' (p<0.05 vs p<0.001).
3. **The belief that marking dates are mere suggestions** is associated with higher tendency to over-purchase (p<0.01).

Smart Packaging

1. Respondents **anticipating a decline in food quality with new packaging developments** are the most likely to over-purchase food (p<0.001).
2. Moreover, when respondents were asked **why they think it is more appropriate to keep food in its original packaging, those that replied 'I keep it if the packaging gives me confidence and guarantee'** were less likely to over-purchase (p<0.01).

Table A11 in Appendix A demonstrates the results for each food type separately, yet the main difference with the previous model is that the ordinal dependent variables have value in the 1-4 range that correspond to units of the respective categories.

Here are the most interesting findings, when we compare the coefficients across the models as well as with the previous model for the total food waste:

Demographics

1. **Gender** does not significantly impact overall food waste, except for beverages where males tend to waste higher quantities (p<0.1).
2. **Younger individuals** demonstrate a higher propensity to waste across all food types compared to their older counterparts (significant at p<0.001).
3. **Urban residence** is associated with a higher quantity of wasted potatoes (p<0.05).
4. The **number of household members** is positively correlated with the waste of fruits (p<0.1).
5. **Improved financial situation** within the last 3 years is linked to higher meat waste (p<0.05).
6. Higher **education levels** are associated with a lower tendency to waste potatoes (p<0.05), meat (p<0.05) and beverages (p<0.05).
7. Across the surveyed European countries with Estonia as the reference, **Spanish** individuals tend to be higher wasters of bread (p<0.001) and fruits (p<0.05), **Greeks** waste the least potatoes (p<0.001), **Hungarian**s are the lowest wasters of meat (p<0.001), fruits (p<0.001) and dairy (p<0.001), while the **Dutch** are the highest wasters of beverages (p<0.001).

Habits and food waste

1. **Preference over leftovers after cooking** has varied effects. The reference category is people that are indifferent about leftovers. Compared to those individuals, people that **dislike leftovers** are more likely to waste more meat (p<0.01) and beverages (p<0.05). Those who **prefer having leftovers** are more likely to waste more dairy (p<0.05)

Date marking

1. Frequent **checking of expiration dates for fridge-stored food** is associated with less waste of meat ($p<0.05$), fruits ($p<0.01$) and dairy ($p<0.1$).
2. The **perception of attentiveness in checking expiration dates** that was statistically significant in the previous model is NOT significant regarding wasting potatoes.
3. **The perception of what the 'safe until' date indicates** did not have an effect on the frequency of over-purchasing, but it does have on food waste levels for various food types. In particular, respondents that replied '**eating the food will cause us a disease**' tend to waste more food across all types apart from meat. On the other hand, respondents that replied '**The quality of the product begins to deteriorate**' tend to waste less meat ($p<0.1$), fruits ($p<0.01$) and beverages ($p<0.01$). The effect of the latter is even stronger, when respondents were asked for their **perception on what the 'best before' date indicates**.
4. **The notion that marking dates are mere suggestions** is associated with higher food waste across all food types, except for bread.

Smart Packaging

1. Respondents **favouring changing to airtight containers with lids** are less likely to waste food across all types, except for bread and meat.
2. Those **keeping food in its original packaging if it is comfortable for immediate use** are associated with higher bread waste ($p<0.01$), and lower waste on fruits ($p<0.001$) and beverages ($p<0.1$).
3. **Confidence and guarantee in packaging** lead to higher bread waste ($p<0.05$) and lower waste on meat ($p<0.01$), fruits ($p<0.001$) and beverages ($p<0.001$).

Remarkably, the model focused on **waste levels for potatoes** demonstrates superior model fit compared to all other food types. Looking back at the results, there are a few factors where potatoes differentiate from other food types (i.e. country, residence location and education) and that potentially explains **the increased explanatory power in understanding waste dynamics**.

While the models above provide useful insights on the demographics, perceptions and behaviours/habits that affect over-purchasing and food waste levels, it is also observed that the **respondents in general underestimate their FW levels** and **overestimate their performance in avoiding food waste**. For this reason, the next step of the analysis was to divide the sample in clusters based on their wasting behaviour and explore if there are distinct "**types of wasters**". Following this approach, we can ensure that even if the dependent variables of reported food waste levels and frequencies prove to be unreliable in absolute terms, the relative food waste performance of the various clusters still provides valuable insights towards our research objectives.

Clustering Analysis

The dependent variables used in the food waste regression models, collectively offer a comprehensive view of different dimensions and patterns of food waste behaviours within the dataset. By employing these variables for clustering, the aim is to **identify distinct groups** and **characterize diverse waste behaviour profiles within the sample population**. Subsequently, the identified clusters will be examined concerning the over-purchasing variable, as well as the regressors that we used for the models and even the behavioural items that were excluded earlier to avoid reducing the sample size.

The clustering methodology that was implemented was this of K-modes (see Box 2 in Case Study 1 for more details). In Figure B7 in Appendix B it can be observed that the critical point for our data, lies somewhere between 5 and 8. We have selected 5 clusters following the same logic as before.

The detailed profiles of the individuals that belong to the 5 clusters are presented in Appendix B (Figure B8). Here is the summary of the information demonstrated in the figure:

- **Eco-Affluent Individuals** (Cluster 0): This group, predominantly the oldest and less likely to live in a big city/metropolis, stands out as the most mindful cluster with the lowest tendencies for over-purchasing food and food waste across all categories. Despite facing the worst income deterioration over the last 3 years, their higher household income, education levels, and strong environmental consciousness contribute to their sustainable practices. Hailing mostly from Spain and Hungary, they believe that expiration dates ('safe until' and 'best before') are regulatory rather than health indicators. Their confidence in checking dates attentively, changing packaging for preservation, and neutral view towards smart packaging innovations reflect their food waste beliefs and attitudes.
- **Urban Over-Buyers** (Cluster 1): Characterized by large households in urban settings, this cluster displays the second highest over-purchasing behaviour and the highest food waste. With lower education levels and incomes less affected over the last three years, they are more likely to be from Estonia or Greece. Driven by reasons such as time constraints and discounts abundance, they exhibit a lack of attentiveness to expiration dates and a higher likelihood of discarding food. They believe in social responsibility, in the need for fines for food wastes and they are convinced that companies shorten expiration dates for commercial reasons and to minimize responsibility. Scepticism towards smart packaging hints a more traditional approach to food preservation.
- **Conscious consumers** (Cluster 2)**:** Mainly female with above average income and education, this cluster displays average over-purchasing and high bread waste but low waste in other categories. Hailing predominantly from Spain**,** they prioritize environmental protection, economic considerations, and a desire to give food a second life. They feel guilty about throwing away expired food, they don't believe in fines for food waste, and they have a different interpretation of expiration dates for meat, fish and dairy. They tend to change the original packaging with alternative methods, and they think that smart packaging could be efficient with the appropriate instructions.
- **Status-Driven Wasters** (Cluster 3): This young, predominantly male group, residing in large households, exhibits the highest over-purchasing and significant food waste, particularly in fruits and beverages. More likely to be from the Netherlands, they purchase more than they need/planned and waste food to showcase social status and indulge in culinary experimentation. They don't feel responsible or guilty when they throw away expired food and they think that longer expiration dates indicate worst taste and lower quality. They show a clear preference towards changing original packaging for quality maintenance.
- **Ethical Moderates** (Cluster 4): This group, with the lowest income and household size, tends to reside in rural areas and is more likely to be from Hungary. Despite their lower economic status, they display the second lowest over-purchasing behaviour and generally low food waste, except for beverages. They abstain from wasting food primarily due to a belief in its inherent wrongness. While not as concerned about environmental impact, they place importance on not being wasteful, they keep the original packaging if it gives them confidence and guarantee, but they think that in general it is harmful because it involves a lot of plastic.

The distribution of the respondents across different clusters, led by the Eco-Affluent individuals representing 72% of the total European sample, is depicted in **Figure 128**. While Eco-Affluent individuals may dominate the sample, there is a concern that this group might be underreporting their food waste behaviours. This underreporting could skew the overall assessment towards more

favourable and sustainable practices. Consequently, the observed patterns and conclusions should be interpreted with caution.

Figure 128 Cluster Sizes
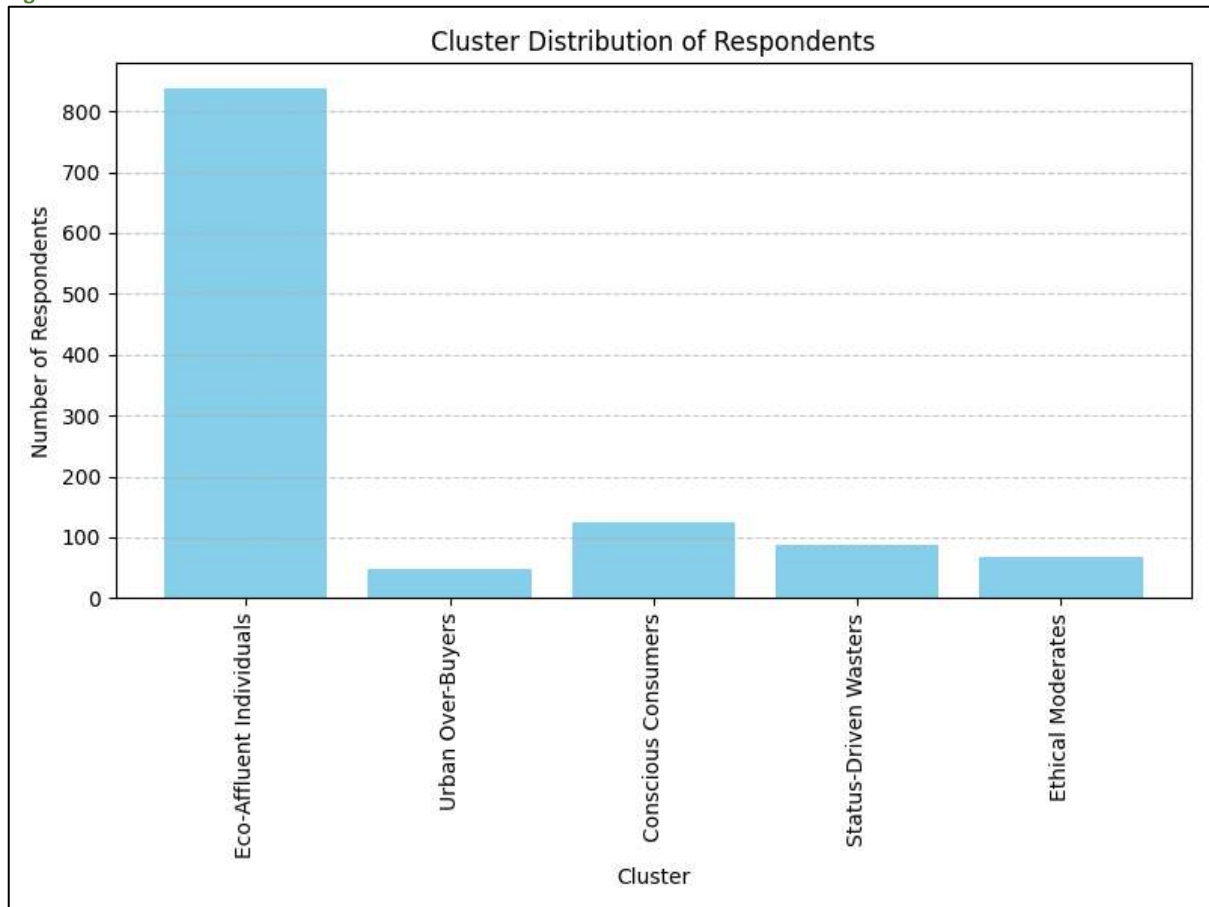
Comparing the clustering results with the regression results, the **negative relationship of food waste with age is visible** as the Eco-Affluent group with low food waste and low levels of over-purchasing has the highest average age, while Status-Driven Wasters with the highest level of over-purchasing and relatively high food waste levels has the lowest average age. Moreover, with regards to the **nationality** there is an agreement with the regression results as **Estonians** that have the highest frequency of over-purchasing are overrepresented in the 'Urban Over-Buyers' group and the **Hungarians** that have the lowest frequency are overrepresented in the 'Ethical Moderates' group.

As a final test, it was important to confirm if the difference-in-means between the demographics of the various clusters was statistically significant. The statistical validation process that we followed (see Appendix B for more details) ensured the robustness and reliability of the clustering outcomes, by highlighting statistically significant differences between their demographics.

Factor Analysis

The three main reasons for using factor analysis in this study were discussed in detail earlier in this Chapter for Case Study 1.

Explanatory Factor Analysis (EFA)

The results of EFA (see details on the technique in Box 3 for Case Study 1) are presented in Appendix C (Table C8). In order to increase the clarity of the tables, we first encode the items of the

questionnaire in the question groups (dimensions) that were presented to the respondents **(Table 10).** The item names correspond to the respective variable names in the dataset.

Table 10 Behavioural items and Questionnaire Categories (CS 6)

Dimensions	Items
Reasons for buying more food than needed/planned	RB1: We don't have time and we buy a lot and rarely RB2: An abundant purchase offers us sales and discounts RB3: Buying a lot is an indication of high social status RB4: Because we cook much more than the portions we need RB5: Because we like to store food in case of unforeseen events RB6: We like to experiment with new ingredients but sometimes these do not work for us
Interpretation of expiration date depends on the type of food	IED1: Meat (packed/canned options) IED2: Fish (packed/canned options) IED3: Fruits and vegetables (packed/canned options) IED4: Cheese and dairy IED5: Pantry food
Reasons to throw away expired or out-of-date foods	RTA1: Using them seems to be indicative of having lower status RTA2: People think they are of poorer quality RTA3: Socially it is well seen, it is a symbol of having good ethics RTA4: In society throwing them away represents abundance and good economic level
Reasons to NOT throw away expired or out-of-date foods	RNTA1: For solidarity, because he/she thinks there are households without food RNTA2: For the environment, since goods are used in favor of the planet RNTA3: Because you shouldn't waste food RNTA4: Because food can be given a second life RNTA5: For economic reasons RNTA6: Because they do not pose a health risk if used well RNTA7: Because they trust the manufacturer and the quality of their products even out of date
Perceptions and beliefs on throwing away expired food	PB1: I am embarrassed to throw away expired food or outside its preferred date PB2: I feel responsible for throwing away expired food or outside its preferred date PB3: I feel guilty for wasting food PB4: It seems ethical to throw away food in good condition, even if it has exceeded the best before date PB5: I think it's important for people in general, not to waste food PB6: I think the authorities should fine us for throwing food PB7: I think the authorities should penalty us for throwing food
Reasons influencing companies into shortening their product expiration dates	RSED1: Companies want to ensure the quality of the products and shorten the dates RSED2: Companies shorten dates because they do not want returns RSED3: Companies shorten dates so that products rotate more RSED4: Companies use it as a marketing element, thus minimizing responsibilities
	PLED1: It is a product with many additives

Dimensions	Items
Perception of longer expiration dates in similar food items	PLED2: The product will have a worse taste and/or texture
	PLED3: The product is artificial
	PLED4: Low quality product
Perception of Smart Packaging	PSP1: If new packaging is developed to ensure the durability of food, what do you think its quality will be

The optimal number of factors was calculated by using the eigenvalues, which indicate the variance explained by each factor extracted from the dataset (Figure C2 in Appendix C). Looking at the elbow plot in C2, it seems that the optimal number of factors to include is around 10. Since the 10th factor had no meaningful interpretation, we proceeded the analysis with 9 factors instead. The total explained variance from the 9 factors identified is 48.60%, which is very satisfactory.

The factor loadings of the remaining items vary with some of the factors (e.g. Wasting Food Regulation) having very high values and some others (e.g. Food Waste Feelings) having values closer to the threshold.

Confirmatory Factor Analysis (CFA)

To align the identified factors from EFA with the hypothesized MOA structure we employ the qualitative coding tree from section 5 **(Figure 129).** The elements of the tree are depicted with the blue orthogonal boxes. The individual behavioural items are then linked to the closest constructs and the item codes are presented with red in picture. This corresponds to the 'a priori' categorization of the questions. However, after conducting the EFA in the previous subsection, the 9 factors that replace the individual items are depicted as ellipses that join the respective elements of the MOA tree.

Figure 129 MOA Structure with "a priori" allocation of items and final factors
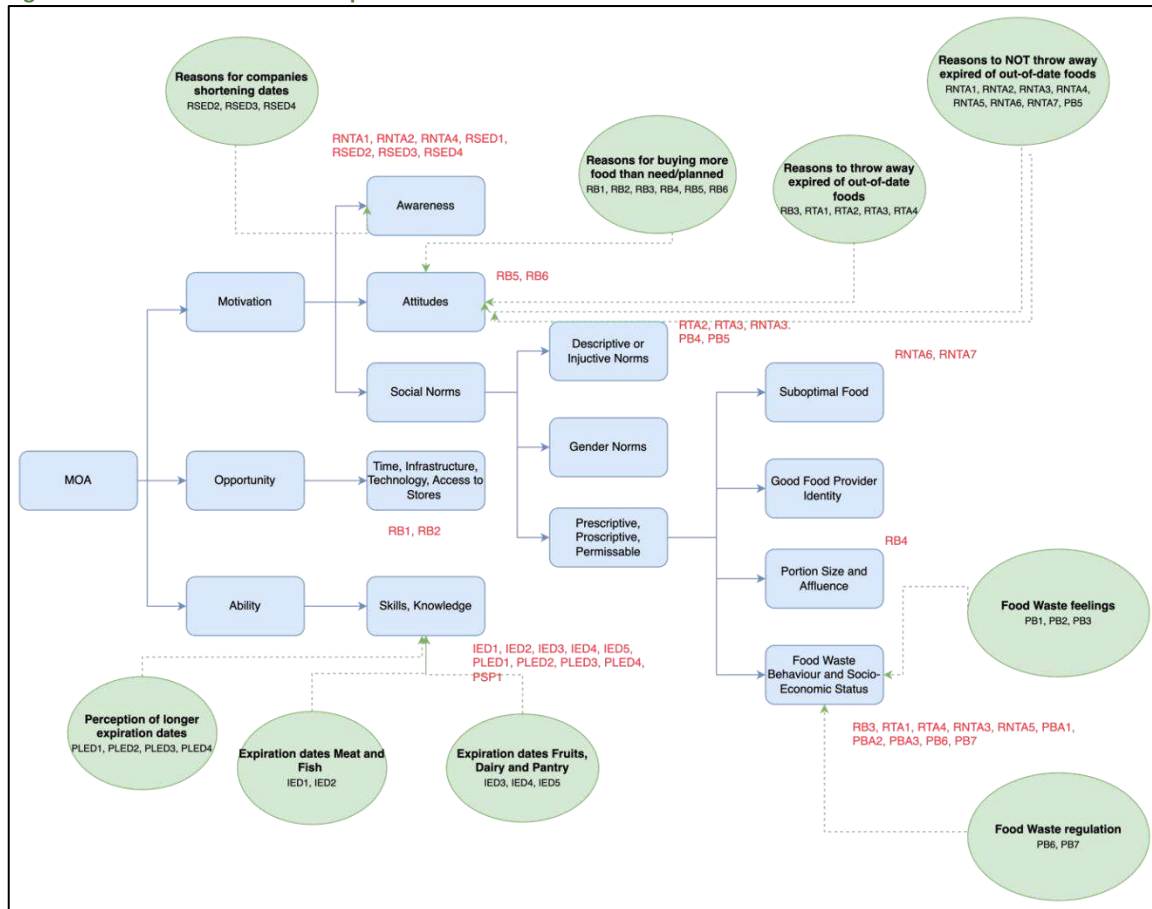
It can be seen in **Figure 129**, that the groups are following the structure of the question blocks in the survey rather than the MOA elements. Furthermore, some behavioural items remain in the hypothesized groupings but at the same there are several re-adjustments and items that are not included in the factors. For example, there is no factor associated with Good Food Provider, because this social norm was irrelevant for this particular case study. Likewise, there are no factors associated with Opportunity (while there were individual questions about time and sales availability), Descriptive and Injunctive Norms (candidates for this factor were grouped with other reasons to follow a certain behaviour), and Gender Norms (there were no questions that could be attributed to this type of norms).

A first-order CFA mode (see more details in Box 4 for Case Study 1) was designed to verify the relationship among the MOA constructs and their observed indicators. The results of the CFA models for the two countries are presented in Appendix C (Table C9). Along with the standardized loadings, there is a brief explanation on the process that was followed to improve model fit, as well as a presentation of the final values of the evaluation metrics.

Overall, an adequate model fit is reflected from RMSEA values that are below 0.06, and from CFI and TLI values that are between 0.90 and 0.95.

Structural Equation Modelling (SEM)

The results of the Structural Equation Model (see more details in Box 5 for Case Study 1) are visualized in **Figure 130.** In Table C10 in Appendix C, we present the standardized coefficients of the latent variables along with their standard errors.

In **Figure 130**, the direct 'causal' links between two variables are represented with blue color and a one-way arrow. Such an example is the relationships between Motivation, Opportunities and Abilities with Food Waste. On the other hand, bidirectional relationships between variables (i.e. correlations) are represented with red color and a two-way curved arrow.

Social norms, attitudes and awareness collectively shape motivation. For instance, **individuals with high scores in statements that express reasons for over-purchasing or throwing away expired food**, demonstrate **increased frequency of purchasing more than need/planned** ($\beta_1 * \beta_4 = 0.589$), hence implying higher food waste. It is interesting here to note, that Attitudes also include reasons for not throwing away expired food (e.g. solidarity, environment etc.) and this factor has the same positive effect on food waste as the other two. **Strong social norms that indicate embarrassment, guilt or responsibility for throwing away expired food (Food Waste Feelings) as well as beliefs that food waste should be fined** (**Food Waste Regulation**) have an influential role in shaping one's motivation and leading towards higher food waste ($\beta_1 * \beta_5 = 0.142$). This could possibly indicate a passive approach to food waste, where people feel bad for their behaviour but at the same time rely on external forces to conform themselves to the acceptable behaviour. Finally, **awareness reflects the individuals' explanation of the reasons that lead companies to shorten their products' expiration dates.** If the perception is that the companies take this decision for **marketing and economic reasons (instead of quality and safety reasons)**, this indirectly motivates them to higher food waste ($\beta_1 * \beta_6 = 0.060$). This could be attributed to their lack of trust towards food retailers.

Opportunities is positively and in a statistically significant way related to food waste ($\beta_3 = 0.308$). Individuals that over-purchase because of time unavailability or because of an abundance in discount are associated with a higher food waste. While these two variables enter the measurement model for the latent component "Attitudes", they also have a high relevance with "Opportunities", so they were added again to reflect this relationship.

Finally, **Ability that is a latent representation of the perception of expiration dates based on the type of foods**, does not have a statistically significant effect on over-purchasing and food waste ($\beta_2 = 0.064$).

Figure 130 Visualization of the SEM model with MOA framework
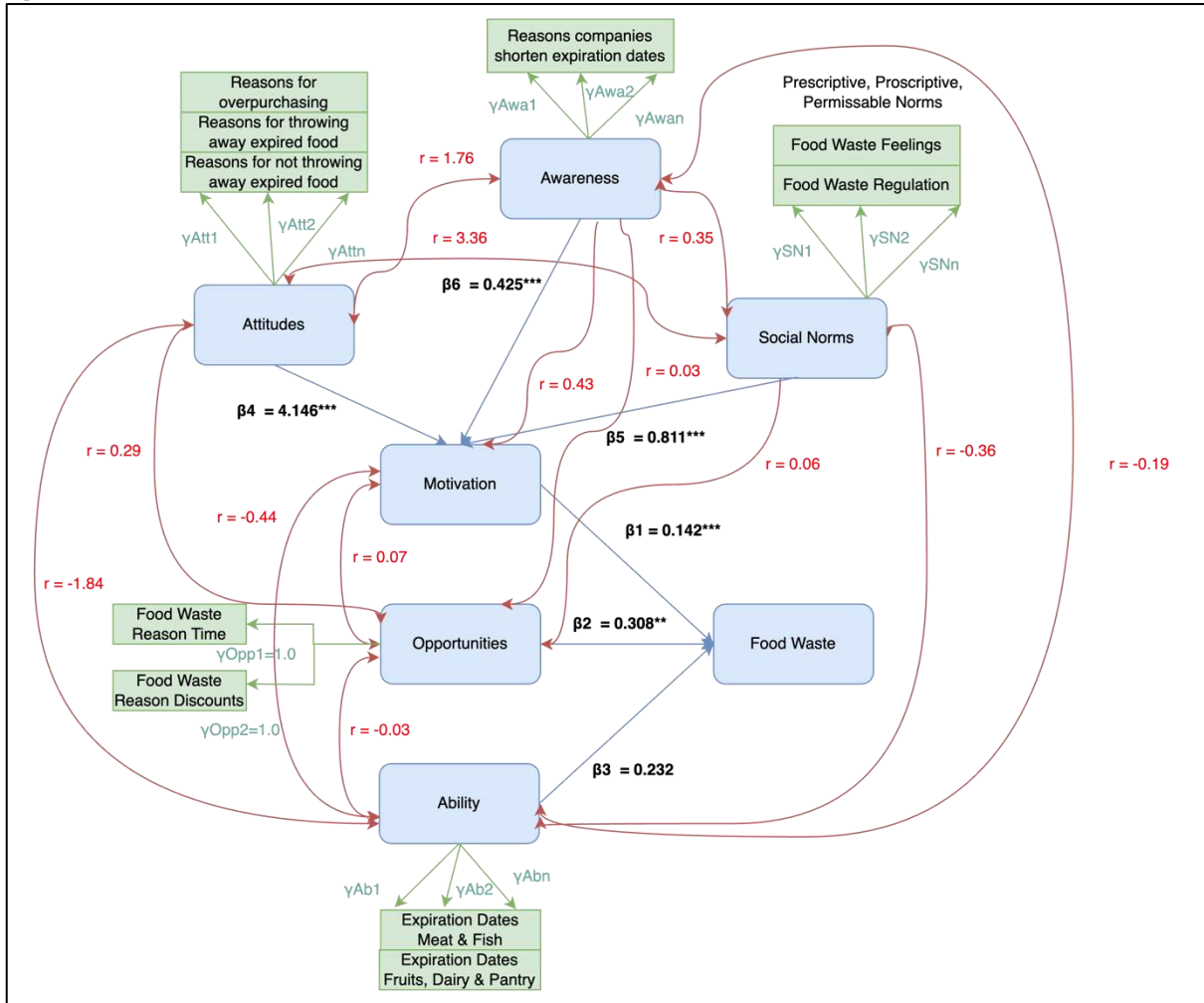
6   CORRELATIONS BETWEEN SOCIAL NORMS, EVIDENT BEHAVIOUR TOWARDS FW, AND FW LEVELS

Understanding the correlation between social norms, behavioural patterns towards food, and the resulting levels of food waste is crucial for devising effective strategies to mitigating undesirable outcomes. While each case study is unique, providing separate datasets and insights, this chapter provides a comprehensive overview. It utilizes the information in chapters 4 and 5 to explore the interplay between these elements across the various case studies as well as the actions outlined Task 1.2 of WP 1.

The most recurrent social norms identified in the case studies were "Good Provider Identity", "Suboptimal Food/Undesirable Food Quality", and "Portion Size and Food Affluence". The prevalence of these norms in the case studies and WP 1 is discussed below. Where possible, discussion includes the impact of cultural backgrounds, education, social and environmental responsibility, peer pressure, gender norms and household dynamics. It also recognizes the significance of interpersonal relationships and societal expectations in shaping behavioural patterns.

Good Provider Identity

"Good Provider Identity" refers to the desire to be a good parent or host. Therefore, the emphasis is placed on the amount of provided food, which often exceeds what is needed (Graham-Rowe et al. 2014). Evident particularly in case studies 1 and 4, and several interventions identified at the household level in WP 1, a key reason for food waste in the household sector is excess purchase and preparation of food. Being a good provider of food was evident across different geographic areas and contexts.

- **Preparation of excess food:** Across various data sources, there is a consistent trend of both private individuals and professionals preparing or ordering more food than necessary, particularly when hosting guests. This behaviour stems from a desire to ensure that guests and family members are well-fed and satisfied. Respondents from Belgium and Spain in CS 1 surveys reported that they tend to prepare/order more food than is strictly necessary when they are having guests. Or in CS 2, chefs were understandably keen to ensure that there always was enough food for customers. As one chef pointed out, *"We might have 150 confirmed orders in advance, but by the end of the week, we might have received 500 guests… we have to produce extra servings because something might get dropped, something may come back and be too dry… so many things can happen, so we always have to have extra"*. In CS 4, it was important for the parents to be good food providers. Even if individuals knew that lunch was thrown out, they still continued to provide it because "it's what you do…", especially as a parent in a societal context.
- **Providing a variety of food choices**: Respondents across different studies and regions mention serving a variety of foods to accommodate the preferences and dietary restrictions of guests and family members. This practice aims to cater to diverse tastes, in particular those of children for example, and to ensure that everyone feels included. According to the results of CS 1 surveys, in Spain, considerably less people indicated not to provide various foods compared to Belgium, which could be explained by cultural differences in national kitchens (tapas to share in Spain versus one dish per person in Belgium). In the Flanders FGI it was discussed that households should aim to provide variety of meals over the week. In Denmark (CS 4), interviewed parents noted that even though they focused on health, they also made something less healthy to ensure that food was provided regardless, as their children might not eat the fruits and vegetables which are considered healthy. Parents also acknowledged that although time pressures were high, gaining more knowledge on how to prepare healthy and more acceptable

lunch-packs to make sure food items remained appealing and in good condition during the time of consumption was necessary to encourage healthy eating habits in children and minimize food waste. One of the headmasters noted that there was also an opportunity to take advantage of the **multicultural aspect** in terms of food selection and present children with different kinds of foods to develop their taste preferences.

Portion size and food affluence

"Portion size" is taken to indicate how much is considered socially acceptable to eat, without being considered excessive, although it might be excessive in reality (Versluis and Papies, 2016; Zhao et al. 2019). Hosts want to ensure that their guests receive a sufficient amount. Serving too little might be considered bad etiquette. It is a norm found within households (e.g. CS 1) and in the food services industry (hotels and restaurants – case studies 2 and 3 respectively). The following behavioural patterns have been identified in association with this social norm:

- **Serving ample amounts of food**: Across different case studies, there is a common observation of a social norm that encourages hosts to provide ample food to their guests, reflecting a cultural value of hospitality and care. This norm is particularly evident in settings such as households, restaurants, and hotels, where serving large portions is often perceived as a gesture of generosity and consideration for the well-being of guests. The observed trends from the CS 1 household survey were very similar in Spain and in Belgium, with a strong tendency of serving large portions. In CS 1 and CS 2, a high proportion of food waste came from what customers left on their plates, especially in a self-service context (e.g. a buffet) when a full range of foods is provided for customers to choose from.
- **Role of control and choice**: There is a discussion around the importance of allowing individuals to decide their own portion sizes, especially in household settings (observed in the CS 1 surveys and Flemish focus group interviews). There is recognition that individuals should have autonomy over their food intake, except in extraordinary circumstances such as meals involving young children, the elderly, or individuals with specific dietary needs. Providing choice and flexibility in portion sizes is emphasized as a way to accommodate diverse preferences and reduce food waste.
- **Attention to personal satiety:** Data from the CS 3 consumer survey revealed a trend of individuals prioritizing personal satisfaction and satiety over finishing all the food on their plates. Many respondents demonstrate an awareness of their own dietary aspirations and a willingness to leave food uneaten if they are full or if the food is unappetizing. This suggests a sensible approach to food consumption based on personal needs and preferences.

Suboptimal food/undesirable food quality

"Suboptimal food/Undesirable Food Quality" refers to not buying, utilizing food in meal preparations, or eating it, due to "sensory deviations" - primarily unusual shape or colour (ICF et al. 2018, Stangherlin et al. 2020). According to the evidence-based analysis of FLW prevention actions that was undertaken in WP1, this social norm appeared more frequently than all the others and was most often found within the retail supply chain stage (33 out of 45 interventions). The commercialization of suboptimal food is a key mechanism for tackling food waste, with the retail sector perhaps having the most influence in terms of being at the nexus of the relationship between the primary sector (production) and consumers (consumption), and thereby being able to influence – directly (advertising campaigns for example) or indirectly purchase choices, such as via reward programs for buying certain foods (Hartmann 2021). The norm was also prevalent in the redistribution sector as well as primary production, processing and manufacturing, food services, and households, within the work of T1.2. The norm was evident to some degree in all the case

studies. Below are the resulting behavioural aspects of this social norm encountered across the case studies.

- **Hesitancy to utilize and consume suboptimal foods:** Cooks and professionals in the culinary field express hesitancy or reluctance to serve or utilize suboptimal food, especially in contexts where guest satisfaction is prioritized. In Norway (CS 2) and Slovenia (CS 3) chefs and restaurant managers have a strong sense of honour associated with their profession and the quality of their work, with only the best being good enough for guests. Thus, the visual aspect of food should be appealing for the guest in particular when it came to self-service (i.e. buffets). At the household level in Spain (CS 6), hesitancy to use "suboptimal food" was also noted. According to the consumer survey results, European consumers decide whether or not to eat food or throw it away, by determining how it looks and smells (Spain 28% - 38% depending on the type of product; Netherlands 17% - 24%; Hungary 20%- 24%; Estonia 21% - 30%) (FUDin & CITC-CITA 2024: 23-24). In Denmark (CS4), the social norm continually came up during discussions and interviews with parents, teachers, headmasters and students. Appearance, consistency, texture, taste and quality were important determinants for consumption for pupils. The resulting behaviour among pupils was overwhelmingly that they threw out food if they didn't like it or had too much, and/or were quite selective in what they did or did not consume.
- **Concerns in food donation practices:** There was notable tension observed in food donation practices between the desire to provide quality food to individuals in need, and concerns about maintaining brand reputation and consumer trust. This was largely with respect to expiry dates – in particular, donating food items after their "best before" date. The stigma surrounding donating food past its "best before" date often stems from concerns about safety and liability. Actors in the retail, food processing, and hospitality sectors interviewed in Hungary (CS 5) expressed reservations about donating products that, due to the distribution process (e.g., products requiring specific refrigeration), might no longer meet food safety standards once reaching their final destination. Concerns about maintaining brand image, efficiency, and meeting consumer expectations often influence decisions related to food donation or redistribution.
- **Efforts to increase acceptance of suboptimal foods:** Despite the hesitancy surrounding suboptimal food, there are efforts underway to increase the acceptability and utilization of such food items. Initiatives such as awareness-raising campaigns identified in WP1 (e.g. Kromkommer in the Netherlands for example) and scientific testing (e.g. VollCorner's initiative in Germany), aim to challenge perceptions about aesthetic standards and promote the consumption of imperfect but still safe and nutritious food[41].

In addition to the above-mentioned, there were several other social norms (initially not foreseen) that emerged in the case studies, affecting behaviour related to food waste generation and are therefore discussed here below.

Gender Norms

While the case studies did not specifically research the relationship between gender and food waste generation, certain gender norms affecting behaviour did emerge in the case studies' research.

- **Gender stereotypes and differences:** Participants in the Belgian focus group for CS 1 expressed disapproval of gender stereotypes related to food consumption, such as the expectation that mothers should eat children's leftovers or that women must be skinny to be beautiful. There is a

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[41] Kromkommer: https://www.kromkommer.com
VollCorner: https://www.zugutfuerdietonne.de/fileadmin/zgfdt/sektorspezifische_Dialogforen/Gross-und_Einzelhandel/Dialogforum_Fallstudien-Sammlung.pdf

recognition of the need to challenge and move away from these stereotypes. In Slovenia (CS 3), the consumer survey results demonstrate gender differences in eating preferences with men prioritizing larger portion sizes and tending to finish their plates, while women prioritize seasonal menu changes and are more likely to leave food uneaten when dining with company. These differences show potential variations in attitudes and behaviours related to food consumption based on gender norms. In Denmark (CS 4) while there was no evidence of any significant difference between boys and girls in regards of food choices or wasting certain types of food items, it was noted by one headmaster that generally boys more readily went outside to play during recess. This consequently might entail that the boys do not take the time to eat a packed lunch.

Date Marking

- **Consumer perception and behaviour**: The results of the CS 1 household survey as well as the CS 6 consumer survey suggest that consumers do not blindly adhere to date markings on food products. Many of the participants of the Flemish FGI as well as consumer interviewees in CS 6 indicate a willingness to rely on sensory cues such as smell, look, and taste to assess the freshness and safety of food items, even if the product is past the expiration date. However, there is a distinction between private consumption practices, where using food beyond its date is deemed acceptable, and more 'public' contexts, where there may be social stigma or judgment associated with such behaviour due to food safety concerns.
- **Professional practices:** Norwegian interviews with cooks and professionals in the culinary industry for CS 2 revealed a lack of familiarity with guidelines for using food items beyond their date markings. Professionals often rely on their own judgment and discretion when deciding whether to use such items, with concerns about guest reactions and maintaining standards of food quality influencing their judgements. Certification and training may play a role in shaping professionals' attitudes and practices regarding date marking and food safety. This challenge was not only evident in CS 2. In all the case studies there was room for more training on how and if to use products past their "best before" date. For the food services and redistribution sectors, the issue of food safety in relation to date marking played a prominent role, necessitating focused training.

Leftover management

- **Leftovers at home**: Freezing leftovers for later consumption is a common strategy reported in both Belgium and Spain, indicating a proactive approach to preserving excess food. Additionally, there is a tendency among respondents in both countries to avoid food spoilage or expiration by utilizing leftovers promptly or ensuring proper storage. However, there are instances of throwing away leftovers after hosting guests, albeit less frequently, suggesting a balance between adherence to proscriptive norms against food waste and practical considerations.
- **Leftovers at the restaurant**: In restaurant settings, there is evidence of a positive attitude towards taking leftovers home to prevent food waste. However, there are concerns about potentially associated social stigma, including perceptions of appearing poor or wasteful. This was observed both in the results of the CS 3 survey but also from a portion of the participants in the Belgian FGI for CS 1. Most restaurant managers in CS 3 addressed the issue of leftovers on the plate by actively encouraging customers to take the remaining food home. It is clear from the interviews that when asked about this practice of taking leftovers home, most managers estimated that only about 10-20% of customers take up the offer. Based on the case study's consumer survey, approximately a third of respondents occasionally request leftover food to be wrapped for further consumption. This suggests that a proactive and mindful approach toward managing food waste is currently applied only sporadically and by a minority of restaurant guests. Young people and families with children were identified by the managers as the main

demographic groups more likely to ask for leftovers, highlighting potential differences in attitudes among various customer segments. The inclination of families to take leftovers home was also observed in the results of the regression analysis for CS 3 survey data.

Peer pressure

- **Social pressure on children**: The social acceptance of food among peers plays a significant role in the school environment, as was evidenced in Denmark (CS 4). Via interviews with pupils, teachers, and headmasters it became apparent that foods individual children might like can be perceived as gross among their peers, making the individuals throw the foods out and subsequently changing their own taste towards the food items. While sensory aspects of the food are important to children (sight, texture, consistency, taste), the social context in terms of how that food is perceived by others is also important in influencing the child's behaviour.

Social and environmental responsibility

- Across surveys, interviews, and focus groups, there is a consistent perception that food waste should be avoided and minimized as much as possible. CS 1 survey results showed that both in Spain and Belgium throwing away food is widely perceived as an irresponsible behaviour, with a majority of respondents actively seeking to avoid food waste in their daily lives. Participants in the Flanders FGI emphasized moral, sustainability, and social reasons (over financial ones) when discussing motivations for waste reduction efforts. Meanwhile, restaurant managers and supply managers in Slovenian interviews (CS 3) expressed a sense of responsibility to reduce food waste, driven by personal values and beliefs. Waste was viewed as part of their ethical obligation and a need to balance environmental with cost considerations in their daily decision-making processes. In Denmark (CS 4), interviews indicated support for learning tools focused on the overall food system. The goal is to provide children with an understanding about how the modern food system operates and to facilitate further learning about sustainable development. Social and environmental responsibility also influenced decision-making processes related to food donations, as was demonstrated in Slovenia (CS 5). Socially aware company managers advocate for donations as a meaningful avenue for surplus redistribution, contributing to a more socially conscious approach to food management.

Cultural and generational influences

- **Generational shift in attitudes**: Participants across focus groups (Flanders for CS 1) and interviews (Spain for CS 1 and CS 6) noted a generational difference in attitudes towards food waste and food consumption. Younger generations, compared to older generations, tend to have different values and attitudes influenced by convenience foods, environmental concerns, and changing cultural practices.
- **Family influence:** Spanish IDIs for CS 1 and CS 6 highlighted that family, especially mothers and grandmothers, play a significant role in shaping individuals' attitudes and behaviours related to food and food waste. Cultural practices such as reusing leftovers, finishing everything on one's plate, and feeling guilty about wasting food are often passed down through generations. Survey data from Slovenia (CS 3) indicate that individuals' eating habits are influenced by cultural or parental upbringing, leading to behaviours like finishing everything on their plate. In Denmark (CS 4) it was apparent that parents had the prime responsibility to initiate daily conversation with their children about food consumption and waste. The overall sentiment from the interviews was that it is the parents who raise children and pass on their values to them. These examples suggest a lasting influence of primary socialization and cultural norms on eating habits and food waste-related behaviour.

This chapter has focused on providing an overview of the correlation between social norms, behavioural patterns, and how those ultimately affect food waste. The next chapter goes one step further in discussing the possible communication and learning strategies that need to be taken into account to address behaviours and mitigate food waste generation.

7 INSIGHTS FOR COMMUNICATION AND LEARNING

7.1 Understanding and Affecting Behaviour

A vast array of studies and theories within motivational psychology address the topic of how to affect behavioural change. One such theory, proposed by Fishbein and Ajzen, suggests that **behaviour is driven by intention, which is influenced by personal attitudes and perceived social norms** (Madden et al. 1992). Essentially, this theory highlights that individuals with a more positive attitude towards changing their behaviour and a greater conformity to desired behaviour among their peers are more likely to have a solid intention to modify their behaviour, thus increasing the likelihood of successful behavioural change. Additionally, **individuals' belief in their ability to perform the behaviour and confidence in overcoming obstacles are crucial factors**. This perspective aligns well with Arie Kruglanski's Motivational Readiness Theory, which emphasizes the importance of both desire and expectancy dimensions in pursuing goal-oriented actions. **It is essential for individuals to believe in their capability to succeed to effectively pursue a desired action, such as reducing food waste**. Mere desire alone will not suffice if individuals do not also have confidence in their ability to achieve success (Kruglanski et al. 2014). Moreover, Jack Brehm's theory of motivation, developed further by Wright (Brehm & Self 1989; Wright 1996), offers valuable insights into the dynamics of behavioural change. According to this theory, when the perceived difficulty of a particular action exceeds an individual's perceived ability to engage in it effectively, they are likely to disengage from the behaviour. For instance, in the context of reducing food waste, even **if someone has a strong motivation to waste less, if they lack the necessary skills and knowledge on how to do so effectively, the effort required to change their behaviour may become overwhelming**. Consequently, over time, their active involvement in wasting less food may diminish. Even the most fervent motivation may falter without the requisite skills and capabilities, leading to a lack of meaningful behavioural change. Hence, the MOA framework (Motivation, Opportunity, and Ability for behaviour change) is utilized to understand the aspects of behaviour changes of individuals.

In this context, both ability and opportunity within the MOA Framework are necessary to provide the support needed to bring about a change in food waste related behaviour (Van Geffen et al. 2016; Vittuari et al. 2023). Ability refers to skills and knowledge. Key components are accurate planning of food purchases and meal preparation (including with leftovers), knowledge about proper storage, and the capacity to assess food safety via labelling. Without ability, regardless of the amount of motivation, an individual is unable to effectively generate behaviour that facilitates less food waste. Ability is also not able to take place without opportunity, with opportunity referring to the availability and accessibility of materials and resources to change behaviour, such as time, technology, and storage equipment. Therefore, when seeking to encourage individuals to waste less food, it is crucial to influence the following factors**: personal motivations via social norms and attitudes,** as well an individuals' **ability and opportunity.**

Changing social norms is a multifaceted process that involves various strategies and approaches. While there is no one-size-fits-all solution, several evidence-based methods have been shown to be effective in influencing social norms. Social norm marketing campaigns aim to correct misperceptions about prevailing social norms by providing accurate information and promoting positive behaviours. It has been shown that **well-designed social norm marketing campaigns** can effectively change social norms (DeJong, 2002). Also, **mobilizing communities to address social issues collectively** can be a powerful way to change social norms. Community-based interventions that involve active participation from community members, local leaders, and organizations have successfully promoted behaviour change and shifted social norms (Pronyk et al., 2008). Community events, such as food waste awareness days or neighbourhood clean-ups, to engage residents in discussions and activities related to food waste reduction are examples. Community-based initiatives have been shown to foster social connections and collective action around food waste issues

(Garrone et al. 2014). Furthermore, **legislation and policy changes** can be crucial in shaping social norms by establishing **legal frameworks that support desired behaviours and discourage harmful practices.** For example, policies such as smoking bans in public places have helped to shift social norms around tobacco use (World Health Organization, 2009).

Studies have found that hands-on learning experiences can lead to behaviour change and increased confidence in food waste reduction practices (Gregory et al. 2018). **Integrating food waste education into school curricula** to teach students the importance of reducing waste and sustainable food practices is a key example. Incorporating food waste topics into science, social studies, and home economics classes can help instil lifelong habits. Research suggests that school educational interventions can positively impact children's attitudes and behaviours related to food waste (Beretta et al., 2021). The **development of user-friendly online resources**, such as websites, videos, and mobile apps, that provide information and practical tips for reducing food waste is also important. Interactive tools like meal planning apps or portion size calculators can help individuals make more informed choices. Research indicates digital platforms can effectively deliver food waste education (Tang et al. 2021).

Effective communication about food waste (FW) necessitates taking into account motivations (including social norms), abilities and opportunities. These elements play a crucial role in driving social change regarding FW behaviour. Merely enhancing abilities and opportunities without concurrently raising awareness and shifting social norms would likely yield limited benefits. Similarly, boosting motivation without providing the necessary tools to enhance abilities and opportunities would be ineffective. Based on the results of the case studies, this chapter looks at the various communication and learning possibilities that could affect behaviour and thus minimize food waste generation.

7.2 Communication and learning - per case study

<u>Case Study 1</u> (Households in Flanders, Belgium, and Spain in and off crisis period)

According to analysis of the case study results, the norms relating to **portion size and food affluence** and the **ability to provide enough food** was evident in the households in Flanders, Belgium and Spain. The case study's focus group interviews (FGIs) revealed that these are norms which are deeply rooted in social expectations and **motivate behaviours** centred around buying and serving food. These norms not only come into play when providing food for the family members, but rather particularly when entertaining guests. For example, when discussing the statement "a good host/hostess serves more food than is strictly necessary for the number of guests" the FGI participants unanimously perceived this statement as a good expression of what is present in different layers of society today, and the most impactful in terms of food waste generation within the household level. Seen by FGI participants as well as interviewees in Spain as an influence from the older generation – i.e. people who have lived during the war and known hunger - food affluence can be associated with wealth and well-being. While the survey, interviews, and FGI results demonstrate the importance of providing **enough food** (especially when entertaining), when it came to **portion size** the FGI demonstrated more **nuanced opinions**. It varied between support for pampering guests with a large portion of food, and others who did not prefer a large portion because it made it difficult for them to finish all the food served to them.

Interestingly, the FGI highlighted how people's connection with agriculture and food has changed over the past decades. Nowadays, more people are further removed from and thus may have **less affection and connection to agriculture** compared to some decades ago. In today's fast-paced world, the "ready-to-eat" (i.e. convenience meals) are popular instead of home-made ones, which require resources (time and skills). On the other hand, according to the respondents the new

generation has become more concerned with the **climate**, which can serve as a key **motivator** in terms of behaviour addressing food waste generation.

The survey results indicate the following patterns in behaviour when it came to purchase, preparation, storage, and use of leftover food.

- A majority of respondents in Flanders (62%) agreed to **impulse buying**, resulting in the purchase of more food products than planned. In Spain, the bulk of the respondents (67%) also agreed to this. In Flanders, as a result of the increase in food prices, 53% of respondents agreed to the statement **"We buy only what we really need",** while in Spain a reverse trend was observed with the majority (51%) of respondents being neutral to the statement.
- In Flanders, 79% of the respondents agreed that making a **shopping list** before going to the store, while in Spain 88% of respondents agreed. A majority of households in both Flanders and Spain indicated neutrality when it came to the effect of food price increases on the statement "We make a shopping list before we go to the store" (50 % and 61 % respectively).
- While 84% of respondents in Flanders noted that they **check what they have in stock** at home before going to the store, this figure came in at 83% in Spain.
- When it came to **meal planning** for the upcoming days, a majority of respondents in Flanders (59%) and 53% in Spain noted that they abided by this behaviour. A majority of households in both Flanders and Spain indicated neutrality regarding the effect of price increases on the statement "We plan meals ahead" (52% and 61 % respectively).
- While 80% of respondents in Flanders noted that they always give careful thought about the **quantity of food to be prepared** to enable complete consumption, in Spain this was observed with 69 % of respondents.
- In Flanders 73% of respondents agreed to **always preparing and/or ordering more food than is strictly necessary** for the expected number of guests, while in Spain was prevalent in 68% of respondents.
- In Flanders 92% of respondents and in Spain 90% of respondents, agreed to always first **using food close to expiration when preparing meals**.
- In Flanders 44% of respondents agreed that they use **tools during cooking and serving food**, while 38 % of respondents disagreed with this statement and 17 % were neutral. In Spain, a reverse trend was observed with a majority of respondents (49%) disagreeing to the use of tools during food preparation, while 36 % agreed and 16 % were neutral.
- A greater proportion of respondents (79%) in Flanders recorded noted that they regularly allow household members to **determine their own portion sizes**, while a similar trend could be seen in Spain with 63% of the respondents.
- In Flanders 78% of respondents agreed to sometimes letting guests determine their portion sizes, while in Spain this was observed in 82% of respondents.
- In Flanders, a majority (45%) of respondents agreed that they **serve larger portion sizes** than their family members are likely to eat during meal. Meanwhile in Spain, a reverse trend was observed with a majority of the respondents (51%) not agreeing to serving a larger portion than what family members were likely able to consume during the meal.
- When it came to **use of leftovers**, in Flanders 86% of respondents, and in Spain 90% of respondents agreed to the re-use of leftover ingredients from previous meals in future meals. As a result of the increase in food prices, 54 % of respondents in Flanders agreed to re-use of leftovers while in Spain 61% of respondents were neutral to the reuse of leftovers because of the food price increases.
- In Flanders 74% of respondents disagreed to always **throwing away food** after they host guests while in Spain this was the case for 87% of the respondents.

- While 44% of the respondents in Flanders noted that they **gave leftover food to guests** to take home with them, in Spain a majority (54%) of respondents disagreed to giving out leftover food to guests.
- The majority (77%) of respondents in Flanders noted that they always **freeze food** that is not consumed quick enough. In Spain this trend was also evident with 77% of respondents.
- In Flanders 63% and in Spain 71% of respondents disagreed to always throwing away food when the **expiration date has passed.**

The FGI, in-depth interviews, and statistical patterns shed light on what opportunities exist so that strategies can be put in place to address food waste. In both Spain and Flanders, a majority of the respondents admitted to **impulse buying.** This does not necessarily conflict with the majority of respondents in both geographical locations also indicating that they make a shopping list before going to the store. Despite shopping lists being made, impulse buying can still take place in the store. Making consumers **fully aware of impulse buying** and **how to curb it** might help reduce the purchase of excess food. While the majority of respondents in Flanders and Spain noted that they gave careful consideration to the quantity of food bought and prepared in order to enable complete consumption, a majority in both locations also admitted to preparing and/or ordering more than was strictly necessary. Moreover, in Flanders a majority of respondents agreed that they served **larger portion sizes** than what they knew could be consumed by household members. This signals that despite being mindful of not buying and preparing too much food, the deeply rooted social expectation of being a **good food provider** (i.e. the desire to be a good parent, host, and therefore emphasis is placed on amount of food provided, often exceeding what is needed; Graham-Rowe et al. 2014), still comes into play. While it is difficult to change this norm, what perhaps can be done is to ensure that **whatever is prepared and leftover afterwards, that it is indeed used** – whether that be in future meals or that leftover portions are given to guests to take home with them for example. With 44% of respondents in Flanders noting that they gave leftovers to guests to take home with them after a meal, and 54% of respondents in Spain disagreeing to give leftovers to guests, there is room to incorporate behaviour where **leftovers are better utilized and not discarded**. Participants in the FGI in Flanders also highlighted that addressing food waste, should be a shared responsibility when entertaining guests, by distributing leftovers to invitees to take home at the end of a party or social gathering. Within the household, everyone must be made aware if there are leftovers in the fridge, so that they can eat them. Closely related to this is the ability (knowledge, skills) and opportunity (equipment) to **know how to use leftovers.** The survey statistics and interviews indicate that the majority of respondents already agree to the importance of re-use of leftover ingredients, hence the motivation is already present and can be utilized to further promote abilities and opportunities in this respect. More attention should be devoted to **training on usage of cooking tools**. In both locations, although particularly in Spain, the statistics demonstrate that cooking and serving tools are not utilized by a clear majority of respondents. Another activity that can take place to address portion size, and raised by the participants in the FGI, is to permit household members and guests to decide their portion size – albeit, depending on the context and that some negotiation takes place in certain cases (such as with very young children for example). In the case of young people and children, "you finish what you serve yourself" ought to be put forth as a way to educate them about the value of food. Participants in the FGI strongly supported **increased communication between the one who prepares and serves the food and the receiver** in order to facilitate **tailored portion sizes.**

Case Study 2 (Hospitality Sector in Norway – hotels)

Being involved in daily food purchases, meal planning and the production thereof, chefs influence the overall ingredient and food purchases, preparation of meals, food storage, and use of leftovers. The objective of the in-depth interviews with chefs (9) was to explore how strategies of food production and procurement differ due to staff's formal education and ultimately what can be done

to address these differences to minimize food waste generation. Regarding the interviews, 3 chefs with **formal education** and 6 chefs **without formal education** were selected with non-probability sampling and an in-depth interview protocol with questions was adhered to in each interview.

There was a particular social norm that emerges which affects chefs' behaviour in relation to food - from purchase planning to usage of leftovers – **suboptimal food**. Suboptimal food being defined as not buying, utilizing food in meal preparations, or eating it, due to "sensory deviations" primarily unusual shape or colour (ICF et al. 2018; Stangherlin et al. 2020). The interviews demonstrated that all the chefs have a strong sense of honour associated with their profession and the quality of their work. **Only the best is good enough** for guests. For example, the chefs questioned what guests would think about using leftovers or food past expiry dates for meal preparation, and thus deferred from doing so. Additionally, the visual aspect of food should be appealing for the guest. From the interviews it became apparent that there is a **hesitancy to utilizing any suboptimal** (i.e. visually unappealing), **or leftover food** in meal preparations. As one chef noted that guests *"expect proper meals and not leftover food"* to be served to them. Or, as another chef highlighted, guests utilize the hotels' food services because they believe a good service will be delivered for what they are paying, *"They come to us for a reason, and I believe that reason is that we deliver a good product that matches what they pay for. I don't think they come to us because they know we handle food waste in a specific way"*. On the other hand, chefs did not hesitate to use leftovers and suboptimal food for themselves or the staff in the canteen.

There was also caution taken to utilize food that had passed the **best before date**. The chefs believed that guests would react with disbelief if they found out they were served food that had passed the best-before date, even though several admitted that it does selectively happen. There were certain items where a few chefs indicated that they would feel comfortable still using the product such as spices, flour, and sugar, while none of the chefs would do so for fresh items such as fish or proteins in general. There was a gap in knowledge among the chefs about familiarity with guidelines for using food items after the best-before date. The use of items after such a date is essentially up to each individual chef, and they take the initiative whether or not to use the product. All the chefs reported that they were concerned about **serving safe food** and **often chose the safest solution** by discarding food when in doubt. There is a significant **potential** here to reduce food waste without risking food safety. The lack of formal education may lead some of chefs without certification to be more inclined in their approach to waste food, based on personal judgment and experience.

All the chefs demonstrated great **motivation** and commitment to addressing food waste. There was a **personal importance** placed on the issue. Statements made by chefs such as *"…It is very important for me. I don't like to throw (away) food, so if I can make the change, I'm always open to do that"* are examples of this. The majority of chefs without formal education came from other countries and talked about backgrounds with strict attitudes toward food waste and food disposal. Chefs from other countries may bring strong attitudes against food waste from their home countries, which can be deeply rooted in their cultural norms. However, despite having personal motivation, those without formal training and less professional experience, had **less insight into routines and practices for handling food and leftovers safely and correctly**. While they displayed genuine and heartfelt attitudes toward discarding food, some lacked the knowledge to make effective choices in terms of minimizing food waste generation.

Meanwhile, chefs with certification appeared to have **more knowledge of what was practical and theoretically possible** while expressing frustration over current practices, as in the example of potatoes and oxtails (given that only experienced/educated chefs are capable of handling such a variety of ingredients). All the chefs were aware of the "chain of command" in terms of the input that they could give or decisions that they could make when it came to menu planning,

procurement, and meal preparation. While none of them indicated that they should be more involved in the decision-making process in order to minimize food waste, chefs with formal training and more experience were able to provide examples of **specific practices to reduce waste**, having learned specific techniques and procedures for handling food and leftovers safely and efficiently. One such example is given by a chef interviewee when stating, *"For brie cheese, we have some leftover bits, but I found a solution where I can use it. I can make cheese sauce with cream. Boil the cream and add brie, and it becomes a cheese sauce"*. Or another example that was stated, *"When we make cucumber salad, we have leftover cucumber peels. So, we give the peels to the bar, they dry it, make powder out of it, and use it as a garnish for cocktails. The same goes for cucumber cores and seeds - the bar uses them to make juice for cocktails. So, we save and give them to the bar twice a week. Additionally, we have leftover ginger julienne, which we use for broth and marinades"*. This contrasts with chefs without formal education and less experience, who are more influenced by their own norms based on personal experiences and cultural backgrounds.

There were several challenges encountered within the kitchen, which provides vital information needed to determine how best to help kitchen staff to address those challenges and to what extent they might affect food waste levels. One challenge mentioned by various chefs was **storage facilities** – in particular the need for adequate size fridges and freezers. For example, one chef noted, *"I think that we don't have enough space. This is a returning problem, and we are trying to solve it because we're going to be remodelling soon, but at this moment we don't have enough space to store nicely so that we have a good overview"* (interviewee 5). *"The storage areas here are quite small, especially during "heavy hitter" days with 1,000 lunches and 800 banquets. We lack refrigeration space. We often end up procuring the raw ingredients on the same day we produce the dishes. It makes planning and preparing in advance a bit difficult"*. Several of the chefs highlighted that with more storage space, they could order certain items less often and that it would not only help to **preserve some food for a longer period of time,** but thus also aid with **procurement planning**. Another way that effective storage helps chefs is in regards to **oversight** of what is already available to be used in meal preparation, and what ought to be first utilized with **visibly seeing the expiration and best before dates.** As a chef noted, *"Effective storage also helps...sometimes we cannot find the things you are looking for and it might expire, and because of that and it can go to waste"*. Improved storage facilities are linked to yet another challenge voiced by several chefs - being able to predict how much food will be needed over the course of a specific period of time. In the food industry it is key to always have enough food available, otherwise there simply is no business, but there is a certain level of **unpredictability** to the nature of the work. As one chef said, *"We might have 150 confirmed orders in advance, but by the end of the week, we might have received 500 guests…we have to produce extra servings because something might get dropped, something may come back and be too dry…so many things can happen, so we always have to have extra"*.

Based on the interviews conducted with chefs, there are several actions that can be taken to augment communication and learning strategies that might help kitchen staff generate less food waste. **Language understanding** was a barrier in the interviews and is most likely also a hindrance in daily operations, especially for chefs who do not speak Norwegian and have not had formal training or minimal experience in the kitchen. In such situations it becomes challenging to convey routines, principles, and techniques that can lead to a reduction in food waste in daily operations. For chefs with **formal culinary education and experience**, much of this is already in place, making it easier to achieve a common understanding regardless of language comprehension. Communication among kitchen staff is identified by several of those interviewed as a critical factor in limiting food waste. An example of the importance of communication is evident at one of the hotels where one of the interviewed chefs, working as a sous-chef, "manages" a place for food leftovers and tries to engage colleagues in collaboration to collect leftovers in a "common place for re-use". One of the other chefs interviewed at the same location was unaware of the common place to collect leftovers. It is an example of room for improvement in communication, requiring a **more systematic approach to**

sharing information among kitchen staff. Focus on communication can also relate to what options there are outside of the kitchen environment for leftover or surplus food, such as **donations** or working with outside entities (such as "Too Good To Go" - TGTG) to **sell surplus food at a reduced price**. Although there were no negative reactions from the chefs to donations or working with entities such as TGTG, several of the chefs were unaware if donations took place or what TGTG entailed.

While food safety is paramount and all necessary legislation needs to be abided by, there are no **guidelines or company policies regarding date labelling of food items**, **in particular for best-by items.** Most chefs state that they have procedures for date labelling of self-produced items and mark the production date on their own goods. Date labelling plays a role in the use of food ingredients and leftovers. There is flexibility in how food leftovers are handled, providing chefs with a certain degree of freedom to be creative and resourceful in their approach to food waste, without compromising food safety. It was also notable that several of the chefs (5) indicated the possibility to make last minute changes to the menu plan, so there is the chance to adjust and perhaps use leftovers or surplus ingredients, but kitchen staff needs to how to do this effectively. **Training in how to utilize surplus food, as well as food that is past its best-by date,** can help all chefs, in particular those with no formal training or minimal experience to use food in new methods that can lower food waste levels within the kitchen.

The need for effective storage was discussed here-above, with emphasis placed on the effect that storage has on the procurement process, longevity of food items, but also on usage of ingredients. Regarding the latter point, knowledge about **organization of the storage** space/facility is equally important. **Rotation of items** was mentioned by several of the chefs, in terms being able to clearly see all the food items and utilizing the oldest ones first. One chef said, *"When we get deliveries, we always put the new items in the back"*. Another chef highlighted the importance of order within the storage facility, *"Order! Putting things where they belong, so we can see what we have and avoid opening multiples of the same item"*. The importance of **efficiency** and **quality control** in kitchen work is paramount. This can be seen in the use of **FIFO** ("First In First Out") and other routines highlighted by chefs for order and cleanliness. These indirectly contribute to reducing food waste, which is desirable in professional kitchen environments.

Case Study 3 (Food Services Sector in Slovenia – restaurants)

Generally, restaurant managers had a negative attitude toward food waste and recognized it as an issue that needs to be addressed. A **personal sense of responsibility** emerged from the interviews to take steps to reduce food waste and a firm belief that their personal values do have a significant influence on the overall approach to minimizing waste in their establishments. For example, one manager noted, *"To be honest it makes me uncomfortable to see how much good food is wasted…"*. Of note is that while all restaurant managers exhibited concern about food waste and a firm belief to address it, there was a slight difference between managers depending on the size of their business. Managers of restaurants that were family businesses tended to take a more personal perspective, and consequently were more precise when it came to actively addressing the issue. The personal sense of responsibility was not the only motivating factor however – the **financial costs of food waste** were also important. Restaurants cooperate with utility companies for the collection of food waste. These companies collect biological waste and provide records of the waste collected, which helps restaurants monitor their waste generation. However, the more food waste there is, the higher the cost of disposal for restaurants. Managers therefore recognize the economic impact of food waste, as **waste disposal and food waste collection services can be very costly** for their operations. Therefore, the economic aspect also serves as an important **motivator** for restaurant managers to minimize food waste.

The consensus among managers was that the highest proportion of food waste comes from what customers leave on their plates, especially with the **self-service style,** such as buffets. One manager noted, *"The most waste occurs, for example, in this buffet style of food, the buffet style of service, because you must always provide the guest with a full range of food"*. However, food left on customers' plates when ordering a la carte from the menu was another evident concern for the restaurant managers. Such leftover food could signal either dissatisfaction with the meal or that the portion size was too large. Some restaurants had implemented a strategy to minimize food waste from plates by either **reducing the portion sizes in their a la carte menu** or **providing smaller plates** for the self-service buffet. While some managers noted that the plates were perhaps too big, predominantly the sentiment among managers was that quality should supersede quantity. *"We in our restaurant do not skimp and we strive for quality food, and we attract guests not by quantity but by quality and variety. We are known for good food and not for large portions"*. There was also acknowledgement, that it is a **difficult issue to address** due to the varying perceptions of what is considered "too large a portion". For example, one manager said, *"That's difficult…this is a topic that is an eternal dilemma because we are different people. We probably do not have portions that are too small, because then I suppose we would not have a visit like that every day and we would not have regular customers coming back, so the portions are probably not too small. If they are too big, you would see that by the leftovers on the plates…According to the norms, we know what the quantity should be."*. The difficulty of determining the correct portion size was also evident in the consumer survey. The results suggested that there is a range of opinions and experiences among the respondents when it comes to portion sizes. Different individuals have different perceptions and experiences related to the size of the food they are served at restaurants. Approximately 29% of respondents feel that they often receive larger portions than they initially expected when ordering from the menu, and 44% of respondents state that they do not have a problem with the portion sizes they receive.

Most restaurant managers address this issue of leftovers on the plate, by actively offering to customers to take any remaining food home. It is clear from the interviews that when asked about this practice of **taking leftovers home**, most managers estimated that only about 10 to 20% of customers take up the offer. Some mentioned that there may be social norms at play, such as being ashamed to take leftovers home or being judged to be greedy by other customers. Restaurant managers also estimated that it is mostly young people, or families with children, who request the leftovers. While some restaurants provided wrapping (foil) or containers for the leftovers, others requested payment for the containers. Interestingly, offering leftovers to restaurant staff was also a common practice. There definitely appeared to be room to encourage more customers to take home leftovers. Based on the consumer survey, 38.40%, fall into the category of requesting leftover food to be wrapped **sometimes.** This suggests a proactive and mindful approach toward managing food waste and indicates that a substantial portion of the surveyed population occasionally opts to take home leftovers, but it may not be a consistent practice for them. Perhaps **not having to pay for the containers,** and rather than asking customers, make it **restaurant policy to automatically wrap any leftover food and give it to customers** after their meal, might facilitate less food waste.

Usage of leftover food for future meals, depended largely on **food safety** and how applicable it was to utilize the food. For example, one manager said, *"In our case the basic element is that what is left can be used according to the HACCP system and what can be used can be used for lunch the next day or appetizers. In our case the waste is mostly only on the guests' plate, and this food can't be used anymore"*. Or another manager who highlighted, *"We use the leftover food from the buffet the next day, also for lunches for our employees, but if there are such things that can't be used, they surely go to waste, like fish…there are some things that need to go to waste"*.

Another aspect that was discussed during interviews was the benefit of having customers **order in advance**, in order to facilitate **more efficient meal preparation.** While generally viewed in a positive

light by managers, the interviews demonstrated that pre-ordering did not happen often. As one interviewee noted, *"We only have pre-orders for maybe 10%, the rest happens on the fly"*. Moreover, pre-ordering was highly dependent on the type of food service being offered – such as a la carte or self-service. Results from the consumer survey show that a significant portion of respondents (36.9%) would be willing to pre-order their meals if it was offered at a slightly discounted price (10% cheaper). However, the majority (63.1%) was not convinced by this discount alone, which might indicate that people value convenience or other factors more than a small price reduction. The condition of a more substantial discount (30% cheaper) was more appealing to respondents, with over half (52.5%) indicating their willingness to pre-order under these terms. In addition, making it a requirement to reserve a table when ordering ahead, also received strong support from 69% of respondents. Thus, combining a substantial **price discount**, along with the **convenience of knowing that a table will be automatically reserved**, may help encourage pre-ordering for food institutions where this is possible, such as a la carte services.

All managers acknowledged the importance of **training** for their staff. For example, one of the managers noted, *"Our head of the kitchen has now attended training, and we are waiting for this project, which I mentioned earlier, as part of which we will also have training on the topic of food waste and how we can plan meals even better. So, we are definitely aware that there is no development without education. And we always like to look at examples of good practice. And we are aware that we can achieve our goals only through education and new knowledge"*. In addition to training, the majority of restaurants already had a **designated person responsible for handling food waste**. This was usually the kitchen manager who was responsible for and knowledgeable about the HACCP system[42]. Only a few of the restaurants did not have a designated person, and either did not deem it necessary, or rather **approached the issue collectively** among all kitchen staff. One such example was highlighted by an interviewee, *"We don't have an exclusive person who would only work on food waste. However, we have system solutions that we use within the entire staff. Everyone has their duties regarding food waste"*.

Restaurants are actively working on lowering food waste via the incorporation of waste-reduction methods. Some material resources that aid in minimizing food waste were identified through the interviews. Inventory management programs, for example, help maintain optimal stock levels, or specialized equipment like a device mentioned in one interview that processes food waste into organic granules. Another measure to reduce food waste, mentioned by all restaurant managers, was the **opportunity to order supplies on an "as-needed" basis.** This approach allows for more frequent and smaller deliveries, which allows restaurants to have fresh ingredients without overstocking. They are enabled to do so as they are working with local suppliers. Keeping low stock also allows them to reduce the risk of overstocking perishable items like vegetables as well as use up their supplies before the expiry date. A few restaurants also indicated that they have the opportunity to personally pick up fresh produce to ensure high quality.

The **abilities** of restaurant staff have a significant impact on the amount of food waste generated in a restaurant setting. Effective **planning of purchases** ensures that the restaurant orders supply on an as-needed basis, preventing overstocking and reducing the likelihood of food expiring before it can be used. Proficiency with food preparation skills allows staff to utilize ingredients fully and creatively, turning potential waste into edible dishes. For example, surplus food can be used to make new dishes, demonstrating the creative and innovative repurposing of food that might otherwise be wasted. Leftover food, such as bread, can be repurposed into new dishes for the following day, such

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[42] European Food Safety Authority – HACCP:
https://www.efsa.europa.eu/en/glossary/haccp
A hazard analysis and critical control point (HACCP) is a system that identifies, evaluates and controls hazards to food safety. It is implemented by food businesses to ensure safe production, storage and transport of food.

as bread dumplings. Additionally, having strict controls on food acceptance from suppliers ensures that only quality ingredients that meet certain standards are used, which can prevent waste due to spoilage.

Also, **proper storage technique** is an important factor for restaurants to minimize food waste. By understanding and implementing correct storage methods, the shelf life of ingredients can be extended, which minimizes spoilage and waste. For instance, knowing how to store different types of vegetables, dairy products, and meats at the **right temperature and humidity levels** can prevent them from going bad prematurely. Additionally, **inventory management,** such as rotating stock so that older items are used first helps ensure that ingredients are used before they expire. Furthermore, **efficient storage planning** can **reduce overstocking,** by only storing what is necessary and maintaining a lean inventory, restaurants can avoid having excess ingredients that may not be used before their **"use by"** or **"best before" dates.** This knowledge of storage is part of a larger strategy of supply management, which includes having almost daily deliveries for sensitive foodstuffs like meat and dairy products, ensuring that these items are fresh, and reducing the likelihood of waste. When asked about current discussions to replace the "use by" date with "best before," in order to allow usage of a product even after it has passed the date, there was general support, but also mixed reactions from the managers. Some noted that it might be more beneficial for household consumption, since in the food services sector there are strict standards that must be adhered to. *"…it would depend on who bears the responsibility. For example, food that has a three-day shelf life can maybe still be used on the fourth day, but that can't be said for sure. As catering service providers, I believe we take great care in these things. Even if it is deemed appropriate, we discard a raw material that still has some shelf life if we observe that some sensory change has happened. To put it another way, what you just said would not be advantageous to us since we must still assess the goods because there are significant obligations when there are health risks"*. Overall, these abilities contribute to a comprehensive approach to managing food supplies efficiently, which is essential for minimizing food waste in the restaurant industry.

Another domain that was explored within the interviews was the possibility of **donating surplus food** or working with other entities to **sell surplus food at a discounted rate.** Regarding food donation, while willing to do so, none of the restaurants were engaged in donating surplus food. The main reason for this was prevalent **legislation** and **processes** (food safety, packaging, transport for example) that had to be adhered to in order to make a donation. *"We would have to do a lot of paperwork if we were to donate food. It's quite a difficult thing yes. There's the packaging, because each portion must be individually packed, each portion must be weighed, each portion must be in the HACCP heating cooling system and recorded when it goes out. That is what the law requires. Also, the temperature when the food is packed must be recorded and the temperature when the food is transported must be recorded"*. Or another example noted by an interviewee, *"No, we do not do that, because the legislation in this area requires a lot of additional work and is quite complicated. Giving what you want costs a lot more than throwing it away. We must first guarantee that the transportation system is in place and then declare traceability to avoid health issues. Giving leftover food to charities would be expensive and time-consuming, so we choose to not work with charities sadly"*. Even though the majority of managers were not familiar with the app "Too Good To Go", once explained what it was, they were generally positive about it. There was some hesitancy in terms of how it could be put in place, keeping in mind adherence to legislation, but they did think it was a good idea if possible. A streamlined, systematic process for food donation, involving where possible less bureaucracy, could perhaps **facilitate two currently under-utilized avenues to make use of surplus or leftover food.**

To round out the interviews, the case study interviewed 5 supply mangers. Like restaurant managers, the suppliers expressed a concern about the importance of avoiding food waste, **citing environmental and cost considerations**. When asked what they could be doing differently or better

to reduce food waste, some managers emphasized that they were already doing everything they could. Most acknowledged the necessity for **better coordination between production and sales** of the food in the restaurant. To that effect, some of the supply managers noted that **long-term contracts** with **defined quantities** could contribute to more **efficiently planned orders**, and that **communication** as regards more specific needs from restaurants might contribute to more efficient planning. With the fresh food market being so complex due to the perishable nature of the food, supply managers stressed the importance of knowing the proper storage, transportation, and shelf-life techniques. Similar to restaurant managers, an understanding prevailed that **ordering on an "as needed" basis and locally,** would facilitate reception of the freshest ingredients, while keeping stocks small and encouraging lean production. Suppliers affirmed that **education and training** can contribute to reducing food waste, with some suppliers highlighting annual training for employees.

Case Study 4 (Schools in Denmark – food waste, obesity and malnutrition)

The case study data demonstrates that there is already **awareness from the various actors interviewed about food waste** within the context of environmental consequences and its effects on the climate, world hunger, and waste of resources. Food waste is not seen as being positive, and from the research there was a consensus that there should be more consciousness about the issue as well as more action than there is now. The current **motivation** among adults for reducing food waste was **largely financial**. Amongst the pupils, there were reflections about being wasteful and "throwing out money" by saying, *"…It also costs money, if you just throw it out, then it's just like throwing money out…".* During the interviews with pupils, some of them were leading the discussion, while others just followed the opinion of the leading ones. But all groups (parents, teachers, headmasters and pupils) agreed that awareness should be raised, and more initiatives introduced to enhance parents' ability regarding proper food management, especially on reducing food waste. It was also mentioned that learning activities for pupils should focus on how the food system works through hands-on and practical activities.

The two most important findings from the case study related to food waste are that social norms affect food behaviour of pupils and that there is a communicative discrepancy between children and adults as they have different ideas and perspectives regarding their own food behaviour. However, pupils' attitude toward perception of food quality is one of the major factors that lead to wasting food especially from the lunch-pack.

Pupils´ attitude on perception of food quality

The pupils' attitude toward food waste and when they are prone to throwing out food, are mostly related to the perceptions, preferences and expectations about taste, texture and freshness and their individual interpretation of quality. The types of food most wasted because of perceived bad quality are fruits and vegetables. Teachers expressed their worries about pupils' attitude of being "selective and picky", and is one of the challenges that leads them in the direction of not eating enough from the lunch-pack and consequently throw out food. Teachers also witnessed that pupils value sweet, salty and fatty food but not so much green and healthier food options. It seems that the pupils have developed a selective repulsion towards many fruits and vegetables. Not only does this behaviour impact food waste but also the health of the pupils which is why it is crucial to focus on how to create a positive attitude towards certain foods. To do this, it is important to work on the communication between the pupils, parents, and the school to avoid that the pupils keep throwing out their lunch box.

Social norms as a motivational factor

In this case study, the most prominent social norm evident was that of **"suboptimal food/undesirable food quality"**, serving as a key motivator for food waste related behaviour among children.

- *Appearance & Consistency*: There are many examples of foods that are mentioned as being "broken" or "wrong" such as brown bananas, apples with dots or bread that is torn. The terms 'mushy', 'moist', 'greasy' and 'gooey' are also mentioned in a negative context. For example, bread that is wet or a sandwich with too much dressing. These experiences are inconsistent with the individual's perception of how food should be or what is "right" and is therefore perceived as bad and thrown out. Appearance of liver-paste, and pasta with meat sauce are considered bad to eat.
- *Texture*, *Taste & Quality*: Fruits and vegetables snacks for example banana and tomatoes become uneatable and will be thrown out mainly due to their changed texture. It could also be a dish that in the individual's opinion should be composed in a certain way, such as a burger with a nugget instead of a patty, making the burger "wrong" and undesirable. When the food is stored in boxes, they are more likely to develop smells, undesired consistencies and appear less fresh and appetizing. Also, there is a tendency towards the processed foods being seen as more satisfying in taste as opposed to rye bread that is described as dry and boring.
- *Social acceptance*: The social acceptance of the food among peers also plays a significant role. Pupils describe behaviour among each other where they observe something and then repeat it. This can be explained as some kind of repetitive behaviour related to vicarious learning or modelling why you do what others are doing. A consequence is that it becomes more "acceptable" to throw out food if a lot of food is already in the trash even though the individual knows it is not good to do so. Thus, the social context seems to play a major role. Some foods also appear to be more "popular" than others. This is clearly a social dynamic providing an example of how norms can be created in a group, fuelled by external influences such as peer pressure or social media advertising for example.

In summary the research data indicates that it is important that the food is "right"- in a social context in terms of how it is perceived, as well as a quality context regarding how it is prepared and served. It should be appetizing in relation to smell, consistency, and taste.

Another social norm evident was that of **"good food provider"**. It was important for the parents to be good food providers. In the data there were examples of parents who knew that the lunch was being thrown out but still continued to provide the food because "it's what you do…" as in that's what you do as a parent in a societal context. Also **the lunchbox is very imbedded in Danish culture** and it felt unnatural to not provide it. The parents also emphasised that even though they focused on health, they also made something less healthy to ensure that food was provided regardless, as their children might not eat the fruits and vegetables which are considered as being healthy.

The **resulting behaviour** among pupils was overwhelmingly that they threw out food if they didn't like it or had too much. They were also affected by how others behaved - so if they saw someone throw out food, it made it more acceptable for them. There were also children who were very selective and picky in terms of what they did and did not want to eat based on appearance, texture, taste of the food.

Communication

One of the biggest themes that emerged from the interview was the need for proper communication. In general, there was a lack of **communication between children and parents**. With

a few exceptions, data showed that children threw out their lunch and their parents didn't know about it because there was little to no feedback. The lack of feedback seemed often to be caused by **lack of trust** by the children who feared being yelled at, shamed, or guilted by their parents. Consequently, they would rather throw out the food and pretend that it was good, creating a negative loop of the parents giving them the same kind of food, which the children did not eat either because they thought it was healthy or they simply forgot that the individual doesn't like it anymore. Some of the pupils expressed their stress when parents asked what they want in the lunch-pack and were unable to provide concrete answers although they were open to try something new. For example, this could happen at the supermarket where the pupils are overwhelmed with choices.

When interviewing the parents, they believed that the pupils ate what the parents had prepared for them. This coincides with the fact that the pupils throw out the food without telling their parents. Teachers emphasized the need to provide thorough information for the pupils when talking about food waste, as realistic arguments are necessary when talking about the subject. Some of the parents shared their strategy of creating empathy by providing their children with the bigger picture about world hunger and encouraging their children to feel grateful for what they do have.

Throughout the interviews there was a pattern describing how the children were not really **included in the preparation of their lunch** and therefore food items that they actually did not like were included in their lunch. Either the parents did not really take in consideration what food items their children did or did not like (i.e. focus on the need for more healthy options which sometimes may be less appealing to the child) or they simply did not know. These food items were then thrown out, and in most cases the children did not tell their parents as it was not immediately addressed when the lunch was eaten. However, there were some examples where the children were asked what they wanted in their lunchbox. The overall **environment and context within which children were asked for their opinion and participation** proved to be important. For example, if at a store, children could be overwhelmed by the question considering all the choices at that moment available to them and therefore unable to decide. This could be addressed by **requesting input rather in a calm home environment and having suggestions handy for instance with pictures.**

Teachers and pupils both agreed that **parents have a responsibility to initiate the conversation** with their children. It is important for parents to inquire about lunchtime, if their children ate their lunch or not, and listen to and address the input provided to them, while making sure that their children are not scared to provide any positive or negative feedback. It is equally important to have continuous communication - **on daily basis** - in order to create a feedback loop between the parents and children. One of the interviews revealed that in one case a family had an established **feedback loop** so that there was an agreement for the pupil to bring back home food that was not eaten. This gave rise to a routine that encouraged food to not be wasted (i.e. thrown away), but the possibility of it being eaten at home, and an opportunity for **mutual learning and increasing trust between parent and child.** One teacher did highlight that this is understandably not always easy and a sensitive topic since it relates to the parent-child relationship. But taking children seriously is important and initiating a discussion is a first step. Parents generally acknowledged the importance of such conversations. For example, one parent said, *"Yes, that mutual dialogue is hugely important, and even though they are children who are going to talk, you also have to show them that you respect what they say…you really have to keep that dialogue at the children's level. When they come up with the suggestions themselves, and when you then work from the suggestions and the solutions/options they come up with, then they also take some ownership"*.

Knowledge and Responsibility

Another key theme was building knowledge. With busy daily routines, parents did not always have an interest to work on the issue of food waste and could lack knowledge about it. Even though it is

the children who may throw out lunch food, it was apparent from the interviews that parents also needed more **knowledge on how to prepare healthy and more acceptable lunch-packs,** and how to make sure **food items remained appealing** and in good condition during the time of consumption (i.e. approximately 6 hours after preparation). As one parent noted, *"…it is super important that parents also get involved. In other words, it is the parents who raise children. It is the parents who pass on these values to their children…"*. It was agreed by all teachers that parents have a major responsibility to **take charge in motivating their children** to not throw away food unnecessarily, and rather consume it properly.

Throughout the interviews, discussion emerged about who has the **responsibility** to help children understand the importance of food consumption and the repercussions of food waste – is it the teachers, parents, or the children themselves? While parents should be educated about food waste, teachers can also play their part in several ways. One of those ways is to **ensure an appropriate eating environment and eating culture at school.** Teachers can facilitate, but are not able to monitor each student´s consumption and behaviour. In most cases (standard lunch breaks) the teacher leaves the students alone. What ensues, is that the pupils "take charge" by for example establishing a YouTube connection on the classroom video beamer, drawing the curtains, and creating an ambiance in which pupils could choose to eat, choose to look at the videos or surf on their mobiles. In other words, it is a lunch environment that is not conducive to healthy or sustainable eating. The data provides strong evidence that these kinds of socio-physical spaces in which there is no teacher involvement is one of the possible explanations for the kind of adverse behaviour in which it becomes "street credible" to throw out lunch bags, or as this counterculture is referred to: "see what I dare to do" behaviour.

Learning and Education

Interventions could take place targeting the eating environment. In the interviews there is a pattern of a very unstructured eating culture and environment, with children eating lukewarm lunches in the classroom by themselves. It could be relevant to work on **implementation of proper eating environments** and **create a lunch culture** at the schools which would encourage children to eat their food and not throw it out. One of the headmasters noted that there was an opportunity as well to **take advantage of the multicultural aspect in terms of food selection.** *"I think the multicultural aspect comes in and is very important. We need to be aware of and take advantage of the different ethnicities into our thinking around food. We have the potential to be able to present the children many different kinds of foods, for many different taste experiences, and I think we should cultivate that at school"*.

Apparent learning tools from the interviews could be alterations to already existing initiatives such as **home economics classes**. An extended form of home economics could be a learning tool, as it is mentioned that the pupils seem interested and engaged during these classes. By extending home economics and making it interdisciplinary, it is possible to combine both practical education in cooking, gardening, harvesting etc. while implementing knowledge on topics such as health, food waste, and sustainability. By extension, an interdisciplinary **PBL (project-based learning)** project or project week on food, health and sustainability could be used. Often these kinds of actions are organised **transversally across schools** and attached for instance to teaching related to Sustainable Development Goals (SDGs), as well as **across different subjects** as projects or theme weeks in which one or more classes participate.

The learning tools should focus on the **overall food system** and provide an understanding about how our modern food system works and how pupils can help to improve it. By incorporating an overall food systems approach, it facilitates teaching about the sustainable development goals and general education about sustainable development. This kind of teaching makes it easier for students to see

the **links between food production, consumption, waste,** and the climate crisis. One teacher highlighted, *"I've come to realize that one of the gaps that I didn't foresee is that the kids need a good understanding of action and relations before they understand waste because it is really hard to explain what waste is, if you don't have any understanding of parts of the system"*. Furthermore, the educational tools on food and food waste can be incorporated with other **STEM subjects** like Science, Math, Design and other extra curriculum activities. An example is the "math against food waste" initiative. This was a learning event organised as a project for middle schoolers over a couple of weeks in preparation for the September 29th, the International Food Waste Day. In this particular case, the math teacher used the data collected on foods, types and amounts as input for the teaching in mathematics. A spin-off of the "Math Against Food Waste" initiative was a project in the coding classes in which the teacher used food waste as a topic for children's own development of apps. *"There's also a lot of fun activities I've been using in Math going on three years now…working a lot with food waste and statistics, and I think that is a great way to teach about both food waste and to get data that is age appropriate to kids …that's pretty cool and I think a good way to teach Math"*.

Examples of some specific ways to communicate messages/learning to pupils and parents:

- Poster "10 good questions (or ways of parent child dialogues) you can ask your child" (about food, eating and preferences).
- Check list/planner "do you like…. Yes/no" and what and how to put some food item in the lunch-pack. (maybe with illustrations of foods).
- A "How To" guide to include the child in the preparation of lunch (could also be a parent – child workshop).
- A possible "school-home conversation app", which essentially would provide suggestions of how to broach the subject of food waste with one's child.
- Professionally developed app which should facilitate the engagement of pupils.
- PBL-based theme week to work with different societal issues and connect them.
- A general agenda for school organised workshops including parents and children to facilitate the communication and explore the issue of food waste.

Ultimately, it is about making an effort at both the home and school environments. Parents set the tone, by engaging constructively and in a positive manner with their children in conversations about food – their likes, dislikes, habits, opinions, healthy options, and should be responsible for becoming knowledgeable about the issue of food waste, including how much to prepare, what to prepare, and what to do with leftovers. The school environment can augment that with providing conducive environments for eating and courses on the overall food system, healthy consumption, and creative ways of incorporating the topic of food waste into curricula. It is a necessary combined effort.

Case Study 5 (Food Banks' Mediated Supply Chain in Hungary)

A key social norm that emerged in case study 5 was that of **"suboptimal food/undesirable food quality"**. This was largely in respect of expiry dates – in particular, donating food items **after their "best before" date.** It is a topic that sparks discussions on waste, food safety, and social responsibility. The stigma surrounding donating food past its best before date often stems from concerns about safety and liability. The **importance of food safety** is a significant deterrent for companies when considering food surplus donation. Concerns about potential liability, risks of contamination, and adherence to stringent food safety plays a significant role in **motivating** a corporation as to whether donation is the correct choice. Companies' perception about what the public thinks influences their actions. Some retail or processing companies shy away from donations due to fear of **legal repercussions** and consequently **negative public perception**. There is variation however regarding the type of food product. For example, canned and preserved products are more manageable when it comes to safety and quality, so they often constitute an item suitable for

donation. Meanwhile frozen products and certain fresh food require the maintenance of a cool chain supply network (customs freezers, fridges for example) and can inhibit donations - especially if the companies do not know or trust the entities (NGOs, charitable organizations) managing those products.

A new segment of surplus food redistribution appeared and is growing in Hungary: organizations like *Munch* which sells surplus food at a discounted price[43]. This consequently reduces the amount of food that is donated and distributed by NGOs. With the cornerstone of many corporate decisions being efficiency and profitability, discounting surplus products might appear to be a more economically viable choice for them compared to donations, in particular for risk-averse companies. This approach aligns with their profit-driven mind set, allowing them to recoup at least a portion of their invested costs. In comparison, the act of donating surplus food involves logistical complexities and costs. Coordinating with charitable organizations, ensuring proper storage and transportation, and addressing potential legal concerns around food safety and liability require human and economic resources that can impact a company's bottom line. The immediate financial impact of discounting is economically more quantifiable than the seemingly indirect, intangible benefits of donating.

Accepting a wide range of food donations, including perishable and non-perishable items, enables NGOs to diversify their food offerings and cater to varying dietary needs. NGOs interviewed in the case study were deeply committed to providing high quality food to their beneficiaries, and consequently they often put in place strategies to preserve and check the quality of food before donation. This is however fairly unknow to donors. **Enhanced communication** and **collaboration** between companies and NGOs/charitable organizations about the food management process is vital to facilitate donations, but to also foster an efficient process with **as minimal food waste as possible**. The issue of **understanding date marking** is crucial. Helping companies understand the nuances between best before dates and expiration dates, as well as the **food safety measures and proper storage and handling practices implemented** by charitable organizations, can encourage more donations and alleviate concerns.

In parallel, encouraging a deeper **understanding of the long-term social implications of donations** could bring forth a more positive approach to corporate social responsibility, and provide a positive outcome regarding a company's **corporate reputation**. While sustainability remains a crucial consideration, its effects may not be as immediately discernible or tangible in surplus redistribution decisions. Companies may view sustainability as a longer-term goal and might already have separated initiatives dedicated to reducing their environmental footprint, such as waste reduction strategies, energy-efficient practices, or sustainable sourcing. Additionally, the complexities surrounding sustainability measurements and the long-term impact on the environment may seem less straightforward than the tangible and direct impact of providing immediate assistance through surplus food donations. Fostering a culture of understanding and highlighting the positive impacts of donating food can bridge the gap between companies' fears and the genuine need for donations, ensuring that more food reaches those who can benefit from it, while not compromising safety. Encouraging companies to understand the immense impact their surplus but slightly imperfect products can have on those in need is essential. This understanding starts with the **leaders of the corporation.** The majority of interviewees within companies (from HORECA, retail, processing sector) agreed that **personal attitude of company managers** significantly influences a company's decisions about food donation. While understanding the social implications of donation, how it can bolster corporate reputation without compromising safety, is hard to instil in a company if the corporate leaders are not in support of it. Managers with a heightened social consciousness

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[43] Munch:
https://munch.hu/?lang=en_US

recognize the impact of food surplus on both environmental sustainability and societal well-being. They perceive surplus not merely as excess inventory but as an **opportunity to make a positive difference in addressing hunger and reducing waste**. This mind-set leads them to advocate for donation as a meaningful avenue for surplus redistribution. By promoting donation initiatives and emphasizing the importance of giving back to the community, these managers can inspire employees and stakeholders to align with the company's broader social objectives. Their commitment to social causes influences not only immediate decisions but also shapes the company's long-term strategies, contributing to a more socially conscious and impactful approach to surplus management.

HORECA businesses appear to be more proactive than retailers and producers in actively implementing various measures to minimize surplus food. Besides **active collaboration with local food banks and charities** to donate surplus food, some strategies were made evident from the interviews regarding the design of menus that minimize waste by utilizing ingredients across multiple dishes to reduce excess inventory (**menu optimisation**), the use of **flexible portion sizes** to prevent over-serving and the use of **composting programs** to recycle organic waste. NGOs and charitable organizations focused rather on social welfare, often advocating for food surplus to be redirected toward feeding programs, food banks, and shelters. Their primary objective is to alleviate hunger and ensure that surplus food reaches those in need, and not per se to address food waste generation.

The level of awareness about food waste and its implications in the HORECA sector has seen a notable increase in recent years. There is a growing recognition within this sector of the significant impact food waste has on both the **environment** and the **financial implications**, which serve as motivators to address the issue. HORECA actors realize that wasted food not only represents lost revenue but also contributes to larger environmental issues such as greenhouse gas emissions, land use, and water wastage. While there is a noticeable level of awareness, there is still room for progress to be made, with some businesses needing additional **education and resources** to fully understand the financial and environmental implications of food waste. **Government regulations, incentives, and industry standards** can further encourage HORECA businesses to adopt more sustainable practices regarding food waste management, including donation.

Finally, there is also the need to **increase social awareness** (via campaigns and projects for example) among the general public about the relationship between food waste generation and the possibilities for food donation to bring about positive social impact. **Consumers** generally see donation as a low priority within their overall shopping decisions, hence this also affects the importance given to the issue for the retail, processing, and HORECA actors. These actors do not really understand (and are not interested in) the effect of food donation on the life of people in need, they do not understand why food donation is more important than discounted sales.

Although the case study does not explicitly address **gender** and **intersectional differences**, it is crucial to recognize their potential impact. Intersectional differences, including age, socio-economic status, and geographical location, may influence individual attitudes and behaviours regarding food waste. **Tailoring communication and educational packages to consider these differences** can enhance the effectiveness of initiatives. Strategies may need to vary based on generational preferences, economic circumstances, and cultural backgrounds. Communication should be tailored to encourage a social norm that emphasizes the importance of providing help to those most in need, while demonstrating how surplus food can play a key role in this respect.

Case Study 6 (Date marking and sustainable, smart food packaging – focus on Spain)

All industries work under strict rules and laws about food safety, applying the FIC Regulation with respect to date marking[44]. Microbiological analysis must be done for the establishment of expiration dates, while organoleptic and physicochemical ones are used for best-before date establishments. Considering the differences between "**best-before**" and "**use-by**" dates, the first one is presented as a quality indicator (freshness, taste, aroma…), while the latter date refers to the last day a product is safe to consume, and those were clear definitions for all the industries that were interviewed within case study 6. Industries thought that in general there was a misunderstanding between those two different terms for the average consumer.

Industries' perception of consumer understanding about date-marking was supported by the interviews (15) conducted within the case study with consumers in Spain. Dates were mainly checked when it came to fresh products, including fruits, vegetables, dairy products, meat, fish, and generally anything that was not packaged. The other caveat was the **type of date that was being checked** – i.e. "use-by" / expiration date or "best-before date". This related directly to not only awareness about the dates, but also understanding what they meant and consequently if and how they were utilized. While all respondents were aware that a date existed, there was evidence that there was **not always an understanding about the difference between the two dates**. For 8 of the respondents, it was clear what the distinction was between the two dates, but for 6 of the respondents they thought the dates meant the same thing or were not aware that there was more than one date. Misunderstanding about what date-markings mean is also evident in the multi-country (Spain, Greece, Netherlands, Hungary, Estonia) consumer survey conducted within the case study. Many consumers were not clear about the difference between "best before" and "safe until", especially in Spain and Estonia (Spain 54%; Greece 47%; Netherland 50%; Hungary 47%; Estonia 62%).

Industry interviewees were asked to score (from 1 to 5) possible reasons why consumers throw away their products (in relation to date marking). According to the industries interviewed, **loss of organoleptic characteristics** (understood as appearance, taste, flavour) was the most probable reason why consumers threw away food close to the expiration date (score of 101 points), followed by **possible risk for health** and **bad quality** (score of 86 and 84 respectively). Industry didn't see the loss of nutritional value and less healthy as important reasons why consumers throw away their products. There was definite alignment with data that emerged from the interviews with consumers. Several consumer interviewees noted that as soon as a product was beyond its indicated **expiration date**, that they were more **inclined to throw it away**. The overwhelming reasoning for this action was a concern about the product's **safety**, as evident with one consumer interviewee when stating *"if you don't know…well, I'll throw it away just in case"*. Or another example from a consumer was, *"…because it's cooking, and cooked food sometimes has dairy products or creams, and you don't have to risk having that because it immediately creates bacteria"*. However, there were a majority of respondents (12 of them) who also noted that before they threw out the food that had expired, they did evaluate it based on **sight, smell and/or taste**. So in this respect, it **depended on the product** itself. The consumer survey produced similar data. According to the survey results, European consumers decide whether to **eat food or throw it away**, by determining **how it looks and smells** (Spain 28% - 38% depending on the type of product; Netherlands 17% - 24%; Hungary 20%- 24%; Estonia 21% - 30%).

Another interesting discussion with industry representatives was about the **differences in behaviour towards date-marking depending on the context**. All participants agreed that people act differently

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[44] EU law on food information to consumers ([Regulation (EU) No 1169/2011](#)):
https://food.ec.europa.eu/safety/labelling-and-nutrition/food-information-consumers-legislation_en

in relation to best-before dates or expiration dates depending on who is the final consumer, with extra care used for children and old people, or if the product is expensive. Also, when the product is served in a social setting, consumers might be more attentive to the expiration date – i.e. they wouldn't take the risk with a product close to expiration, which is probably related to social acceptance and safety of the food.

The interviews with consumers demonstrated that a key variable at play in terms of expired food being thrown away or not, was **who the food was meant for – oneself, other family members or friends**. There was a mixture of responses, with 5 respondents stating that if the food was for other family members or friends, they would rather use food that was not expired, while 3 respondents believed that if the expired food was safe enough for themselves, then it would also be for anyone else, and 1 respondent replied that it depended on the type of food (i.e. fresh product, dairy, meat, fish versus packaged food). The majority of respondents (8) **trusted that the regulation behind the date-marking was there to ensure that the product was indeed safe to eat**. For example, one consumer interviewee said, *"I think that with regards to food and something that is sold to the public, there are tremendous security measures. If not, the company takes a lot of risks and I think that the last thing those companies want are troubles of the kind that there has been an intoxication. I don't think so, it's all pretty much under control"*.

When asked about the ease of use of date-marking, 8 interviewees (consumers) responded that it was not easy, but rather **confusing to interpret**. The difficulty was primarily with the "best-by" date in terms of what that entailed for quality and safety of the product. One respondent highlighted that what was needed for consumers was more information and **education about the different dates**, with other interviewees noting that it was also sometimes **physically hard to locate and see the dates**, depending on the product, and that this too had to be addressed. While the majority of respondents (8) highlighted that date-marking was not easily understood by themselves, these respondents also felt that this was the case for the population at large.

Ultimately, when it came to discerning whether and how date-marking had an effect on food waste generation, it was clear that date-marking had an effect, but how this took place was not straightforward. There was not just one reason. Expiry date played a role, but as did the type of product, for whom the food was intended, food safety concerns, and the level of understanding of what "best-by" and "use-by" meant. Among these reasons, the one that can be actively altered is the **level of understanding** and was highlighted by 8 interviewees (consumers) as a component leading to more food waste. One of the take-home messages from the analysis of food waste related to date marking was that initiatives to reduce food waste should focus on making **improvements in labelling**, and campaigns to teach or inform consumers about the meaning of date marking, mainly for those food product categories where there is a higher level of misunderstanding for consumers. The greatest opportunities for reduction of food waste in relation to date marking are for **dairy products, fresh juices, fresh meat and fish.**

Industry interviewees generally agreed that packaging was a key point in determining the shelf-life of a product and very relevant to avoid loss of organoleptic characteristics. Many of the industry representatives (40%) indicated that their respective companies were already making innovations in packaging or doing research about it, however smaller companies were in need of more support (public funding) in this regard. Interviews indicated that an important **consumer habit related to packaging** where industry could perhaps influence consumers was the change of packaging once the product was opened at home. Most industry interviewees (60%) agreed that there was no need to change containers, but that they didn't communicate this to the consumers. About half of the consumer interviewees (7) noted that they **kept food in its original packaging** for **practicality and convenience.** For example, one consumer interviewee said, *"For convenience and because I think it's silly, what's the point, it doesn't make sense"*. This may point to either apathy towards preserving

food, or simply lack of knowledge among these respondents in terms of how to preserve food. The thought process was also that the food already has come in a particular package, so there was no necessity to change it.

During consumer interviews, respondents were given a broad explanation of what smart packaging entailed, and thereafter asked if they supported the introduction onto the market of smart packaging options. All 15 interviewees gave their support to the idea and such initiatives. The respondents were supportive of it because they thought that it would be **beneficial in addressing food waste**, but also possibly help consumers to understand if a product was still **safe to eat**. They indicated that when it came to packaging, they were looking for something that was **convenient**, **easy to understand** with **clear instructions**, and that would help to facilitate optimal **preservation** of the product. There were reservations raised however, particularly when it came to the cost of the smart packaging, in respect of to what extent it might increase the **price of the product.**

Packaging is an important but at the same time hard matter to address. Regarding shelf-life of products, it can be a key element to take into account. Sometimes the innovations are focused on materials, reducing or even eliminating plastic from the equation. However, not all the products are better preserved with plastic alternative materials. The acceptance of products by consumers is important for the company's financial results. Many of them agreed that any innovation should be analysed, and that it should improve the shelf-life, be sustainable and not harm the utility of the packaging, and of course not affect loss of revenue for the company. **Innovations should address economic costs, sustainability, reduction of waste, but keep the proper food safety conditions.** Achieving such a balance is complicated, but most of the interviewees agreed it was necessary to invest in research, and to work on better informing consumers about the benefits of smart packaging.

Key communication and learning strategies that would facilitate a reduction in food waste related to date marking and smart packaging:

- Better communication at all levels among food chain actors - from industry to consumers through distribution and government institutions (policy makers), customizing to emphasize the benefit and providing information to tackle the challenges.
- Making date marking easier to understand, with its meaning being clear and legible.
- More communication through social campaigns focused on date marking and smart packaging.
- Consumers obtain a better understanding of date labelling, so that they can differentiate between "use by" – as an indicator of food safety – and "best before" – as an indicator of quality.
- Information or guidance to encourage consumers to make informed choices. A good idea would be for industry to join forces with consumer research.
- Industry action to supply information about packaging innovations to raise awareness for consumers about product improvement.
- Fostering of initiatives already taken by industry in food waste reduction and promote new ones.
- Packaging innovations needs high investments, so Institutional awareness is required to increase funding.

7.3   Similarities for communication and learning across the case studies

While each case study is unique, with often differing geographic and supply chain stage foci, there are a few similarities that have emerged among the case studies when it came to communication and learning strategies to mitigate food waste generation.

1. A better understanding about date-marking:
This was an issue evident to some extent in every case study. At the household, food services, redistribution, and industry level it was evident that clarity is needed on what the different date-markings mean - in particular when it came to food safety - or if it was a mere indicator of overall quality. To this effect, more coordination is needed across the supply chain to determine what date marking information is vital to have on products (i.e. legally obligated), how that information ought to be presented on the package, and the form of communication about it to not only consumers, but all food supply chain actors, so that there is a common understanding.

2. Training in procurement, storage, meal planning, and usage of leftovers:
The necessity to increase training on the various stages of ingredient procurement to what can be done with leftover and surplus food was prevalent across the case studies. Within the food services sector there is a certain level of unpredictability in that the required amount of food can be altered with little advance notice, making such skills more vital.

3. Enhanced communication and collaboration:
Although it might appear to be a "catch all", the importance of communication and collaboration among actors in the supply chain cannot be underestimated. This is evident in the above-mentioned issue of date marking where clarity is needed on what the dates mean, and how best to provide that clarity. Another example is the enhanced communication and collaboration necessary between companies and NGOs/charitable organizations regarding food management processes (storage, distribution, safety protocols) in order to facilitate donations with as minimal food waste as possible. Or case study 4 which highlighted the need for parents to take an active role in initiating conversations with their children about their eating habits, and that this communication be continuous to create a feedback loop between the parents and their children.

This chapter has looked at the various possibilities, per case study, in regards to communication and learning/education strategies that should be taken into account in order to address food waste generation. Analysis in this chapter can be utilized as input for upcoming work within package 4 of the CHORIZO project. Work Package 4 will look at the role of science and education in the domain of food waste, the development of social norms-focused communication products for consumers, economic actors and policy makers, as well as introducing capacity building activities for food chain actors.

8 CONCLUSIONS

8.1 Summary of key findings

In this chapter we aim to provide an overview of the food-related social norms identified across the 6 case studies conducted in the CHORIZO project. The findings are **divided into four higher-level food-related social norm categories** identified earlier in the deliverable: Suboptimal Food/Undesired Food Quality, Good Provider Identity, Portion Size and Food Affluence, and Associations between Food Waste behaviour and Socio-economic Status[45].

Figure 131 presents each social norm, a brief description of the norm, and the case study and country where the social norm was evident. The figure reveals that the most prevalent social norm was that of **Suboptimal Food/Undesirable Food Quality** – it was evident in each of the case studies. This observation underscores the significance of this particular social norm and the issues that emerged within it, which influence food waste behaviour across different contexts. The **pattern of key issues being addressed** across the case studies for this social norm were: (i) checking (or not) the date marking; (ii) use (or not) of products past expiration; (iii) use (or not) of leftovers/surplus food; and (iv) the importance of food safety and quality when it came to purchase and use of a product.

Figure 131 Representation of social norms evident in the case studies

Associations Between Food Waste Behaviour and Socio-Economic Status	Sub-optimal Food/Undesirable Food Quality
Associations that are made about one's socio-economic status based on their actions regarding food purchase (i.e. if go to food banks might be considered poor for example, or taking leftovers home), preparation, and consumption.	Not buying, utilizing food in meal preparations, or eating it, due to "sensory deviations" such as unusual shape or colour. *Key issues:* - Checking (or not) the **date marking** (CS 1, 2, 3, 5, 6) - Use (or not) of products **past the "best-by" date** (CS 1, 2, 3, 5, 6) - Use (or not) of **leftovers**/surplus food (all case studies) - Importance of **food safety and quality** (all case studies)

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[45] A full description of the four food-related social norms is given in chapter 4 of this deliverable.

Portion Size and Food Affluence	**Good Provider Identity**
Portion size is taken to indicate how much is considered socially acceptable to eat, without being considered excessive (although it might be excessive in reality).	The desire to be a good parent, host, and therefore emphasis is placed on amount of food provided, often exceeding what is needed.

CS 1 ⬭ (CS 1, Belgium and Spain, households)
CS 2 ⬠ (CS 2, Norway, hotels)
CS 3 ▭ (CS 3, Slovenia, restaurants)
CS 4 ▲ (CS 4, Denmark, schools)
CS 5 ⬡ (CS 5, Hungary, redistribution)
CS 6 ◇ (CS 6, EU-wide, with focus on Spain, date marking and food packaging)

Besides the food-related social norms discussed here above, there were also **other social norms** that emerged in the case studies:

- Family of Origin Influence: Older generations instil values of finishing all food on one's plate, rooted in past experiences of scarcity, fostering a sense of respect towards food (case studies 1, 6).

- Economic Conservation Norms: A societal emphasis on saving financial resources and minimizing waste, reflecting economic concerns (all case studies).

- Environment: A growing social consciousness about the effects of waste (including food waste) on the environment, and the need to address it (all case studies).

- Challenging Gender Norms: Traditional norms regarding portion sizes based on gender or eating leftovers are questioned, emphasizing individual preferences and waste reduction (case studies 1, 3).

- Cultural Influences: Societal norms and beauty standards influence food-related behaviours, adding complexity to waste reduction efforts (case study 1).

- Peer pressure: Social acceptance of food among peers plays a significant role in the school environment. While sensory aspects of food (sight, texture, consistency, taste) are important to children, the social context in terms of how that food is perceived by others is also important in influencing the child's behaviour (case study 4).

- Efficiency and Quality Control: Regulations emphasize efficiency and quality control, possibly indirectly contributing to food waste (case studies 2, 3, 5, 6).

- Corporate Social Responsibility: A heightened social consciousness among businesses recognizing the impact of food surplus on both environmental sustainability and societal well-being (case studies 2, 3, 5, 6).

8.2   Limitations of the study

The case studies provide crucial insights into the social norms and motivations that influence behaviour related to food waste, as well as delve further into what abilities and opportunities exist to address those behaviours. However, there are some limitations of the study, which are mentioned here below and should be taken into consideration by the reader.

- While most of the supply chain stages were covered by the case studies, research and analysis was **not conducted on the primary production stage**.

- While case studies were deliberately selected to represent diverse geographical and socio-economic contexts across Europe, it also brought with it **challenges in data processing** where certain nuances of expression were prone to being lost or misinterpreted during translation into English.

- There was difficulty for most of the case studies to obtain **systematic and reliable data on food waste levels.** At the household level this was particularly evident. It is not uncommon for an individual to underestimate their role in food waste generation, with variety of eating routines as well as self-reporting errors coming into play. For example, according to a Eurobarometer report of 2014, 86% of survey respondents reported that they believed they wasted "relatively little" amounts of food in their household, while recent statistics from Eurostat highlight that in 2020 around 131 kg of food waste per inhabitant was generated in the EU, and of this 131 kg, households generated 70 kg (Eurobarometer 2014: 28; Eurostat 2023)[46].

- Although there have emerged some key conclusions from the case studies on gender and food waste generation, the case studies were **not geared to systematically researching the role of gender** in food waste-related behaviour.

- While the reflections in this deliverable are based on responses coming out of Focus Group Interviews (FGIs), in-depth interviews, and surveys, the responses may align with a **social-desirability bias,** meaning that the answers may be crafted to meet societal expectations or conform to perceived norms. While it is crucial to acknowledge this, it is also an inherent challenge in any research study, and it is unlikely to be able to completely eliminate this bias.

8.3   Implications for future research and policy

The objective of the CHORIZO project has been to provide a better understanding about what drives behaviour related to food waste generation. The project has focused on understanding the social norms (rules and expectations that are socially enforced) that influence food waste related behaviour. Social norms and behavioural insight are at the heart of CHORIZO.

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[46] Eurobarometer (the wording "relatively little" meaning no more than 15 percent of food in the home): https://op.europa.eu/en/publication-detail/-/publication/e3932343-3c82-4a5f-8a1a-e22eafd050a6

Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Food_waste_and_food_waste_prevention_-_estimates#Amounts_of_food_waste_at_EU_level

This deliverable focused on presenting the overall results of 6 separate case studies, with each one pertaining to a particular stage of the supply chain. These case studies allowed for the generation of detailed, more nuanced, and robust data about social norms and food waste-related behaviour. It is information that will be utilised to **inform work in other work packages** of the project. In particular, the data generated is important for the modelling efforts in work package 3, as well as the learning and communications, and capacity building strategies to address food waste to be developed in work package 4.

Externally, this is research that **contributes to and builds upon global and EU research, debate, and data on social norms and food waste related behaviour** (Bicchieri 2006; Cialdini et al. 1991; ICF et al. 2018; Stangherlin et al. 2020; Graham-Rowe et al. 2014; Versluis and Papies, 2016; Zhao et al. 2019; and Middleton et al. 2018; Vittuari et al. 2023). While this specific deliverable provides analysis in accordance with what has been outlined in the Grant Agreement, closer dissection of the data from each case study can also provide information that is more **specific to a geographic context and/or supply chain stage.** The results of the case studies can be utilized to **shape current as well as future case studies and interventions** addressing food waste, by providing a reference for what social norms and behaviours are evident and the options available to address that behaviour. **Public sector led initiatives and policy** may also benefit from the case studies' efforts, such as those coming from the European Commission and individual member states. One such example is the European Commission's legislative proposal of July 2023 establishing legally binding food waste reduction targets to be achieved by EU member states by 2030[47]. A key topic under discussion is the level of food waste reduction per stage of the supply chain. The current proposal is that food waste levels in the processing and manufacturing sector are to be reduced by 10%, by 30% in retail and distribution, and by 30% in consumption. While actual reduction in the amount of food waste is vital - especially considering the broader economic, social, and environmental ramifications outlined in this deliverable - the reductions will be difficult to achieve if it is not also accompanied by a clear process. Ultimately that process will rely on the understanding of what are the driving forces generating food waste, and thus where to focus attention to address behaviour and achieve the targets. In the fight against food waste generation, efforts need to be applied towards understanding the social norms and motivations influencing behaviour, as well as providing the abilities and opportunities to change those behaviours.

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[47] Proposal for a Directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste, COM(2023) 420 final: https://food.ec.europa.eu/safety/food-waste/eu-actions-against-food-waste/food-waste-reduction-targets_en

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10 APPENDICES

10.1 Appendix A: Correlations and Regression Analysis Results

This Appendix contains the following:

- **Visual Bivariate Graphs for CS1 (Figures A1 and A2)**: These graphs illustrate the relationship between food waste and selected regression variables individually, providing insights into their potential associations.
- **Correlation Tables for CS1 (Figures A3 and A4):** Correlation tables present the pairwise correlation coefficients between variables, aiding in understanding the strength and direction of their relationships.
- **Ordinal Logistic Regression Results for CS1 (Tables A1-A6):** Detailed tables with estimates of food waste regression models for Belgium and Spain in CS1.
- **Linear Regression Results for CS2 (Tables A7 and A8):** Detailed tables with estimates of food waste regression models for the breakfast experiment in Norway.
- **Marginal effects of interaction terms for CS2 (Figures A5-A7):** The marginal effects of the interaction terms that were added to the regression models and discussed in detail in Chapter 5, are visualized here.
- **Correlation Table for CS3 (Figure A8):** Correlation table present the pairwise correlation coefficients between variables, aiding in understanding the strength and direction of their relationships.
- **Ordinal Logistic Regression Results for CS3 (Table A9):** Detailed table with estimates of the two variables that reflect food waste behaviour (leftover amounts and frequency of taking leftovers home) as well as a model of the latter controlling for the former.
- **Visual Bivariate Graphs for CS6 (Figure A9)**: These graphs illustrate the relationship between over-purchasing frequency and selected regression variables individually, providing insights into their potential associations.
- **Correlation Table for CS6 (Figure A10):** Correlation table presents the pairwise correlation coefficients between variables, aiding in understanding the strength and direction of their relationships.
- **Ordinal Logistic Regression Results for CS6 (Tables A10 and A11):** Detailed tables with estimates of food waste regression models for European countries in CS6.

Software/Programming language

Our preferred library for the ordinal logistic regression analysis for CS1, CS3 and CS6 in Chapter 5 is "polr" of the programming language R, due to its specific focus on modeling ordinal response variables. While there were equivalent packages to conduct the analysis in Python, polr offered a built-in flexibility of using the available sample weights.

The linear regressions that were used for the analysis of the breakfast experiment data in CS2 were conducted in R.

Figure A1: Food waste distribution against regression features for the Belgian subsample in CS 1
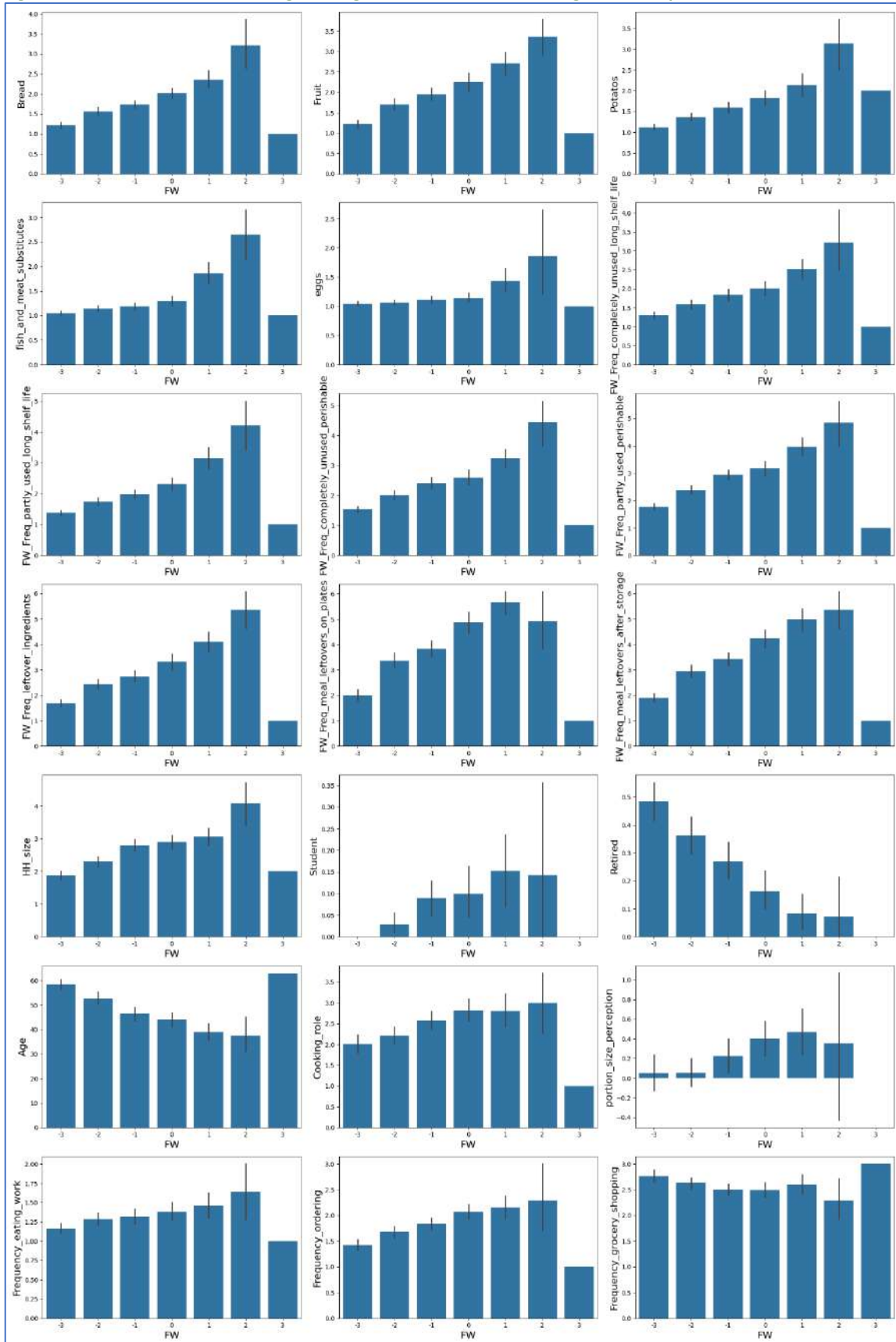
Figure A2: Food waste distribution against regression features for the Spanish subsample in CS 1
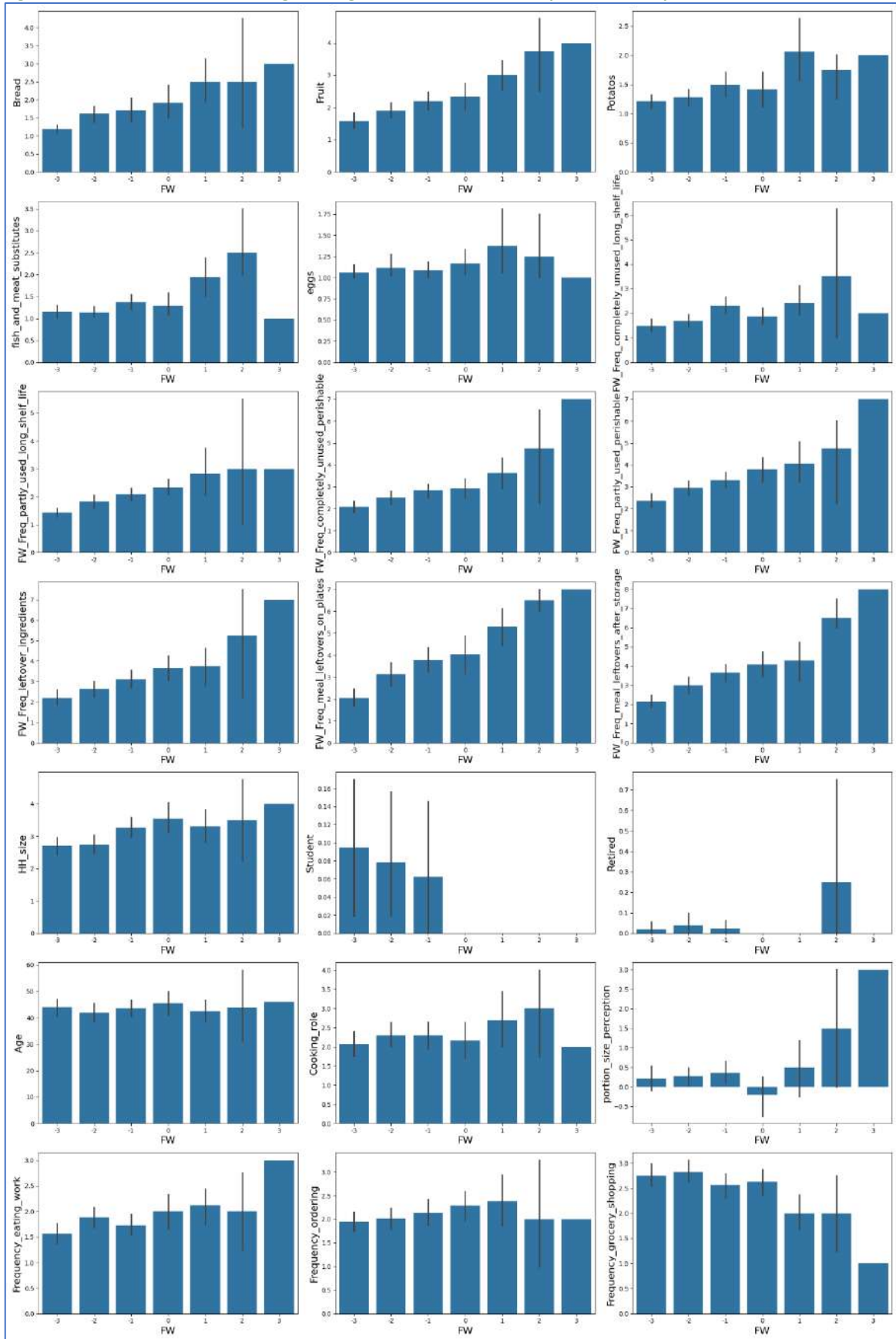
Figure A3: Correlation table for the Belgian subsample in CS 1
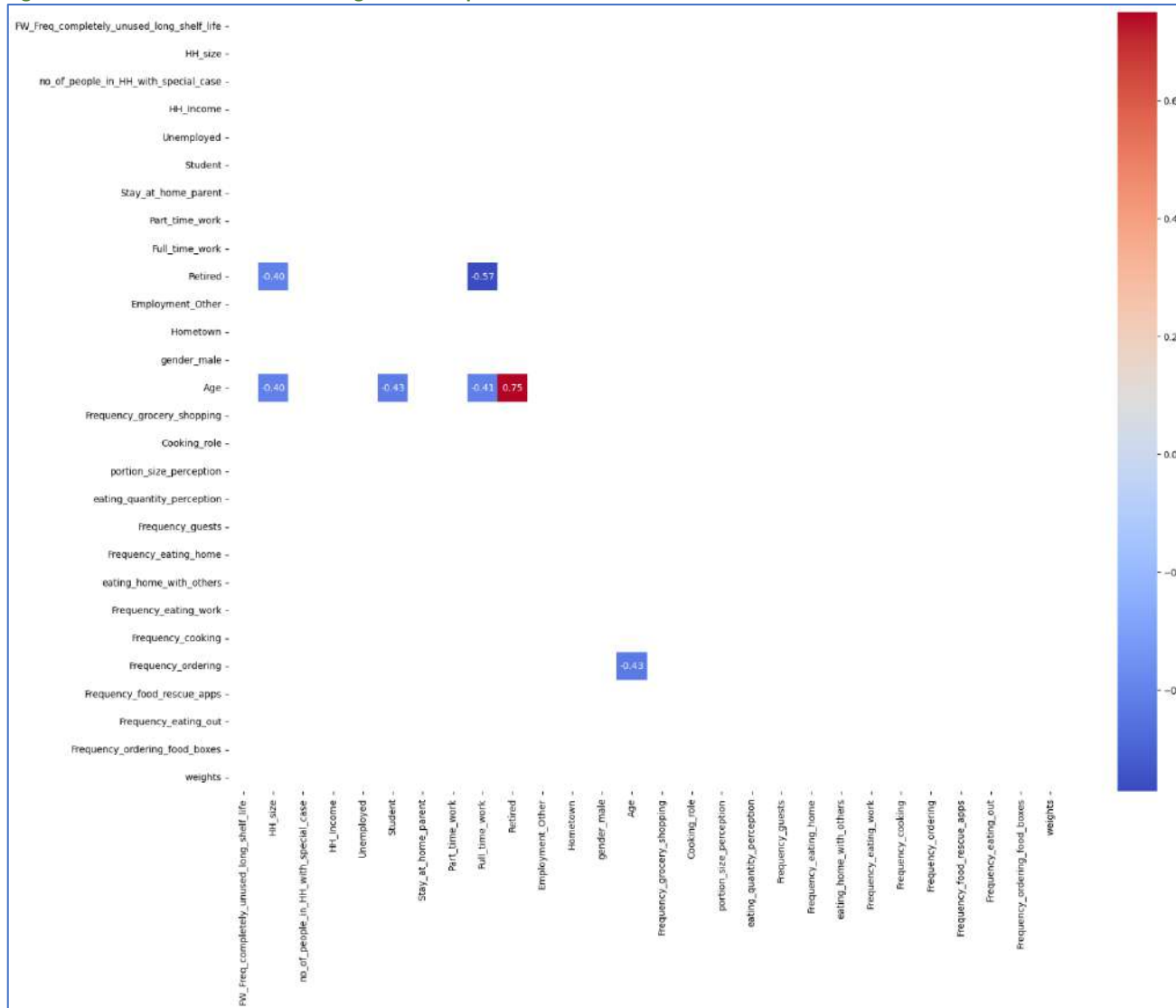
Figure A4: Correlation table for the Spanish subsample in CS 1
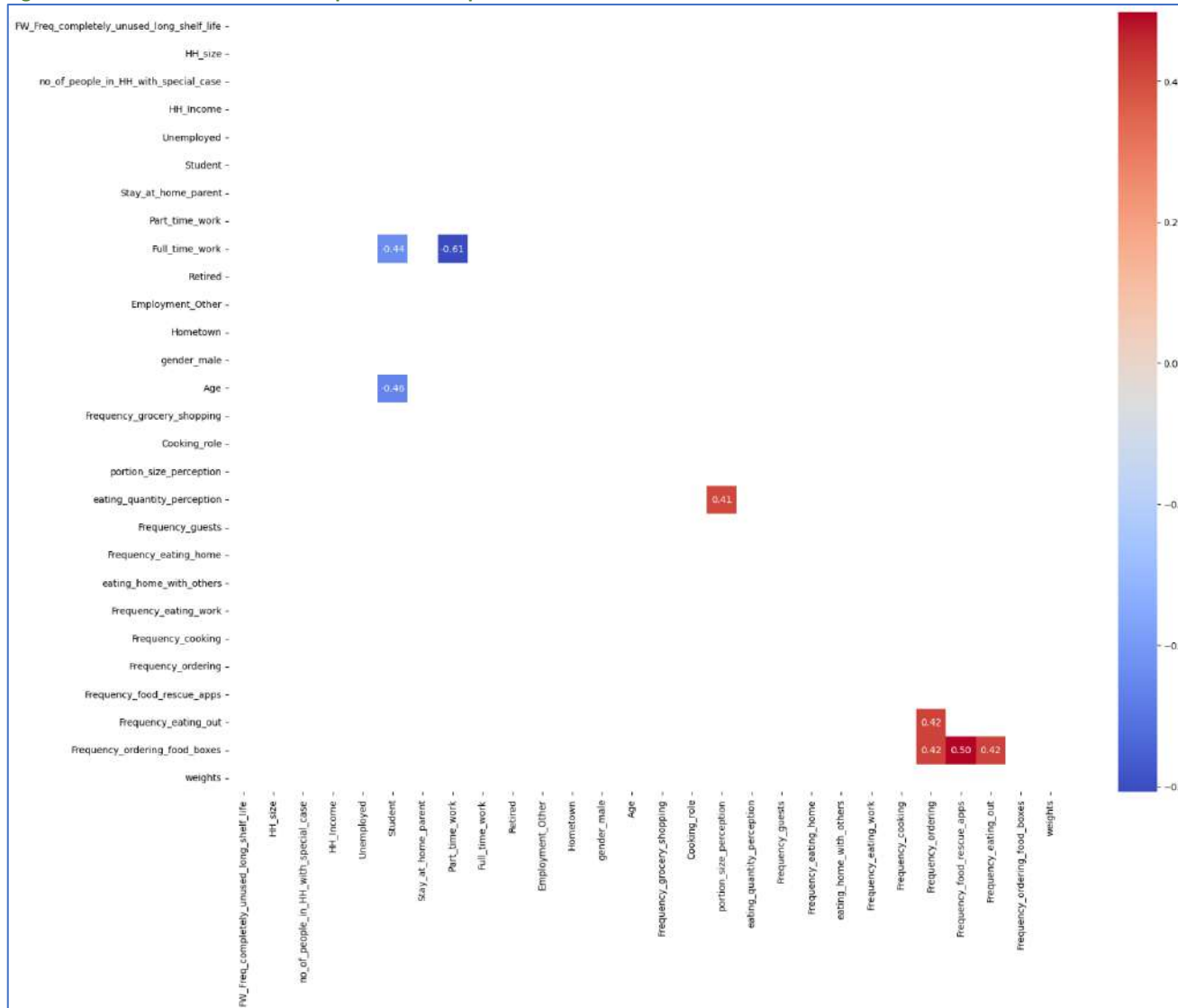
Table A1: OL regression of total reported food waste for Belgium (left) and Spain (right) in CS 1

	Food Waste		Food Waste
-3|-2	-0.23 (0.80)	-3|-2	-0.73 (0.72)
-2|-1	1.22 (0.17)	-2|-1	0.83 (0.68)
-1|0	2.49** (<0.01)	-1|0	2.05 (0.32)
0|1	3.62*** (<0.01)	0|1	3.40+ (0.10)
1|2	5.64*** (<0.01)	1|2	4.37* (0.04)
2|3	8.15*** (<0.01)	2|3	7.69** (<0.01)
HH_size	0.50*** (<0.01)	HH_size	0.31* (0.03)
no_of_people_in_HH_with_special_case	0.41* (0.01)	no_of_people_in_HH_with_special_case	0.00 (1.00)
HH_Income	0.18* (0.03)	HH_Income	0.46* (0.03)
Full_time_work	-0.10 (0.53)	Full_time_work	0.13 (0.69)
Hometown	-0.02 (0.66)	Hometown	-0.18+ (0.08)
gender_male	-0.04 (0.78)	gender_male	-0.02 (0.96)
Age	-0.02** (<0.01)	Age	0.01 (0.47)
Frequency_grocery_shopping	-0.22* (0.02)	Frequency_grocery_shopping	-0.57** (<0.01)
Cooking_role	0.11* (0.02)	Cooking_role	0.08 (0.53)
portion_size_perception	0.03 (0.68)	portion_size_perception	0.04 (0.76)
eating_quantity_perception	0.15** (<0.01)	eating_quantity_perception	0.27* (0.02)
Frequency_guests	0.04 (0.52)	Frequency_guests	0.43*** (<0.01)
Frequency_eating_home	-0.01 (0.96)	Frequency_eating_home	-0.46+ (0.08)
Frequency_eating_work	0.07 (0.58)	Frequency_eating_work	0.09 (0.69)
Frequency_cooking	-0.17 (0.12)	Frequency_cooking	-0.19 (0.36)
Frequency_ordering	0.42*** (<0.01)	Frequency_ordering	-0.22 (0.27)
Frequency_food_rescue_apps	-0.19+ (0.05)	Frequency_food_rescue_apps	-0.14 (0.36)
Frequency_eating_out	0.15 (0.19)	Frequency_eating_out	0.48+ (0.07)
Frequency_ordering_food_boxes	0.09 (0.46)	Frequency_ordering_food_boxes	0.11 (0.70)
Num.Obs.	766	Num.Obs.	197
AIC	2271.5	AIC	609.7
BIC	2387.5	BIC	691.8
RMSE	2.03	RMSE	2.09

Table A2: Extended OL regression of total reported food waste for Belgium in CS 1

	Food Waste Extended Model
-3|-2	-2.95* (0.05)
-2|-1	-0.96 (0.52)
-1|0	0.70 (0.64)
0|1	2.26 (0.13)
1|2	4.80** (<0.01)
2|3	6.67*** (<0.01)
HH_size	0.49*** (<0.01)
no_of_people_in_HH_with_special_case	0.18 (0.33)
HH_Income	0.12 (0.24)
Full_time_work	-0.07 (0.73)
Hometown	-0.01 (0.85)
gender_male	0.01 (0.96)
Age	-0.02** (<0.01)
Frequency_grocery_shopping	-0.14 (0.21)
Cooking_role	0.12 (0.15)
portion_size_perception	-0.09 (0.27)
eating_quantity_perception	0.08 (0.24)
Frequency_guests	0.01 (0.86)
Frequency_eating_home	-0.14 (0.38)
Frequency_eating_work	0.19 (0.20)
Frequency_cooking	0.28* (0.04)
Frequency_ordering	0.19 (0.11)
Frequency_food_rescue_apps	0.01 (0.92)
Frequency_eating_out	-0.02 (0.87)
Frequency_ordering_food_boxes	-0.18 (0.24)
MealPrepping	-0.02 (0.76)
CheckStock	-0.09 (0.27)
GroceryList	0.15* (0.02)
ImpulseBuying	0.05 (0.39)
LongerShelfLife	-0.14* (0.03)
Cooking_EstimateAmounts	-0.03 (0.75)
Cooking_UseTools	0.05 (0.27)
Cooking_ReuseIngredientsLeftovers	-0.25** (<0.01)
Cooking_Pleasing	-0.03 (0.58)
Cooking_ServeLargePortions	0.06 (0.34)
Cooking_DecidePortionSize	0.07 (0.27)
LastMinuteChanges	-0.08 (0.14)
AlwaysLeftovers	0.10 (0.16)
FoodSpoiled	0.28*** (<0.01)
ForgetLeftovers	0.18** (<0.01)
FollowDateMarking	0.22*** (<0.01)
FreezeFood	0.01 (0.88)
HeadofFamily_Pleaser	0.11 (0.15)
headofFamily_0FW	-0.40*** (<0.01)
FamilyMember_FinishPlate	-0.10 (0.18)
Males_LargerPortion	0.02 (0.72)
Females_Skinny	-0.08 (0.20)
Parent_FoodAffluence	-0.03 (0.78)
Parent_FinishPlate_A	0.05 (0.56)
Parent_FinishPlate_O	-0.20** (<0.01)
Parent_FinishPlate_injSN	-0.08 (0.23)
Mothers_EatLeftovers	-0.04 (0.58)
Guest_FinishPlate1	-0.08 (0.29)
Num.Obs.	607
AIC	1569.1
BIC	1802.8
RMSE	2.09

Table A3: OL regression of reported food waste by food type in Belgium in CS 1

	Bread Waste	Fruit Waste	Potatos Waste	Fish and Meat Waste	Eggs Waste
1|2	1.35 (0.16)	2.40* (0.01)	2.00* (0.04)	5.35*** (<0.01)	0.99 (0.53)
2|3	4.28*** (<0.01)	3.12** (<0.01)	3.43*** (<0.01)	6.97*** (<0.01)	2.16 (0.17)
3|4	5.84*** (<0.01)	4.65*** (<0.01)	5.25*** (<0.01)	9.23*** (<0.01)	4.31** (<0.01)
4|5	6.87*** (<0.01)	7.45*** (<0.01)	6.23*** (<0.01)	11.26*** (<0.01)	4.90** (<0.01)
HH_size	0.54*** (<0.01)	0.30*** (<0.01)	0.38*** (<0.01)	0.30** (<0.01)	0.38** (<0.01)
no_of_people_in_HH_with_special_case	0.25 (0.16)	0.27 (0.11)	0.46** (<0.01)	0.63** (<0.01)	0.11 (0.64)
HH_Income	0.44*** (<0.01)	0.11 (0.25)	0.26** (<0.01)	0.36** (<0.01)	0.66*** (<0.01)
Full_time_work	0.32+ (0.07)	0.19 (0.28)	0.15 (0.41)	0.45+ (0.05)	0.07 (0.82)
Hometown	0.04 (0.37)	-0.02 (0.69)	0.00 (0.91)	0.17** (<0.01)	0.06 (0.48)
gender_male	0.06 (0.70)	0.17 (0.28)	-0.43* (0.01)	0.46* (0.04)	-0.08 (0.78)
Age	0.00 (0.92)	0.00 (0.58)	0.00 (0.73)	-0.01 (0.36)	-0.02+ (0.07)
Frequency_grocery_shopping	-0.27** (<0.01)	-0.20* (0.05)	-0.17 (0.11)	-0.20 (0.16)	0.01 (0.96)
Cooking_role	0.02 (0.73)	-0.06 (0.26)	0.02 (0.74)	0.14+ (0.06)	-0.19+ (0.09)
portion_size_perception	-0.05 (0.50)	-0.02 (0.81)	-0.06 (0.45)	-0.16 (0.13)	-0.19 (0.14)
eating_quantity_perception	0.08 (0.16)	0.16** (<0.01)	0.12+ (0.05)	0.01 (0.94)	0.26* (0.03)
Frequency_guests	-0.03 (0.62)	-0.09 (0.23)	0.11 (0.13)	0.06 (0.54)	0.05 (0.68)
Frequency_eating_home	0.26+ (0.07)	0.13 (0.37)	0.08 (0.60)	0.01 (0.97)	-0.33 (0.20)
Frequency_eating_work	-0.13 (0.33)	-0.06 (0.65)	-0.01 (0.92)	0.04 (0.81)	-0.16 (0.50)
Frequency_cooking	-0.52*** (<0.01)	-0.15 (0.20)	-0.25* (0.04)	-0.13 (0.43)	-0.72*** (<0.01)
Frequency_ordering	0.58*** (<0.01)	0.50*** (<0.01)	0.32** (<0.01)	0.65*** (<0.01)	0.42* (0.02)
Frequency_food_rescue_apps	-0.25* (0.02)	-0.04 (0.70)	-0.11 (0.30)	0.06 (0.63)	-0.07 (0.67)
Frequency_eating_out	0.43*** (<0.01)	0.54*** (<0.01)	0.05 (0.71)	0.22 (0.22)	0.01 (0.97)
Frequency_ordering_food_boxes	-0.01 (0.92)	0.10 (0.46)	0.24+ (0.07)	0.12 (0.47)	0.52** (<0.01)
Num.Obs.	766	766	766	766	766
AIC	1386.7	1655.5	1420.9	794.2	500.5
BIC	1493.5	1762.3	1527.6	901.0	607.3
RMSE	1.69	1.98	1.60	1.23	1.11

Table A4: OL regression of reported food waste by food type in Spain in CS 1

	Bread Waste	Fruit Waste	Potatos Waste	Fish and Meat Waste	Eggs Waste
1|2	1.45 (0.55)	1.40 (0.54)	-9.50*** (<0.01)	2.47 (0.44)	4.37* (0.04)
2|3	3.10 (0.21)	2.60 (0.26)	-7.37*** (<0.01)	3.94 (0.22)	7.69** (<0.01)
3|4	4.88+ (0.05)	4.44+ (0.06)	-5.74*** (<0.01)	6.03+ (0.06)	
4|5	5.08* (0.04)	6.48** (<0.01)			
HH_size	0.23 (0.15)	0.13 (0.37)	-0.15 (0.44)	-0.12 (0.62)	0.31* (0.03)
no_of_people_in_HH_with_special_case	1.18 (0.30)	-0.72 (0.51)	-13.75*** (<0.01)	1.92+ (0.07)	0.00 (1.00)
HH_Income	0.08 (0.77)	0.09 (0.72)	-0.54+ (0.08)	-0.11 (0.76)	0.46* (0.03)
Full_time_work	0.18 (0.65)	0.47 (0.20)	1.02* (0.03)	1.52* (0.02)	0.13 (0.69)
Hometown	-0.20+ (0.09)	-0.10 (0.39)	-0.05 (0.71)	-0.06 (0.72)	-0.18+ (0.08)
gender_male	0.82* (0.03)	-0.51 (0.15)	-0.38 (0.37)	0.28 (0.59)	-0.02 (0.96)
Age	-0.02 (0.27)	-0.04* (0.01)	0.03 (0.11)	-0.01 (0.82)	0.01 (0.47)
Frequency_grocery_shopping	-0.73** (<0.01)	-0.31 (0.12)	-0.52* (0.04)	-1.34*** (<0.01)	-0.57** (<0.01)
Cooking_role	0.04 (0.75)	0.10 (0.47)	-0.15 (0.36)	-0.20 (0.33)	0.08 (0.53)
portion_size_perception	-0.09 (0.55)	-0.01 (0.93)	0.18 (0.31)	0.35 (0.12)	0.04 (0.76)
eating_quantity_perception	0.53*** (<0.01)	0.48*** (<0.01)	0.44** (<0.01)	0.32+ (0.09)	0.27* (0.02)
Frequency_guests	0.23+ (0.08)	0.37** (<0.01)	0.11 (0.44)	0.49** (<0.01)	0.43*** (<0.01)
Frequency_eating_home	-0.87** (<0.01)	-0.30 (0.32)	-0.93** (<0.01)	-0.62 (0.14)	-0.46+ (0.08)
Frequency_eating_work	0.21 (0.39)	0.44+ (0.07)	0.51+ (0.07)	0.58 (0.10)	0.09 (0.69)
Frequency_cooking	0.33 (0.16)	0.52* (0.03)	0.93* (0.01)	0.11 (0.76)	-0.19 (0.36)
Frequency_ordering	-0.09 (0.68)	0.09 (0.69)	0.42 (0.12)	0.44 (0.17)	-0.22 (0.27)
Frequency_food_rescue_apps	0.20 (0.23)	0.66*** (<0.01)	0.59** (<0.01)	1.07*** (<0.01)	-0.14 (0.36)
Frequency_eating_out	0.70* (0.02)	0.20 (0.51)	-0.10 (0.77)	-0.31 (0.48)	0.48+ (0.07)
Frequency_ordering_food_boxes	-0.65* (0.04)	-0.81** (<0.01)	-0.21 (0.53)	-0.87* (0.05)	0.11 (0.70)
-3|-2					-0.73 (0.72)
-2|-1					0.83 (0.68)
-1|0					2.05 (0.32)
0|1					3.40+ (0.10)
Num.Obs.	197	197	197	197	197
AIC	416.8	487.0	326.2	263.8	609.7
BIC	492.4	562.6	398.5	336.1	691.8
RMSE	1.79	2.16	1.38	1.29	2.09

Table A5: OL regression of reported food waste frequencies by food category in Belgium in CS 1

	FW frequency Unused Long Shelf Life	FW frequency Partly Used Long Shelf Life	FW frequency Completely unused perishable	FW frequency Partly used perishable	FW frequency Leftover ingredients	FW frequency Meal leftovers on plates	FW frequency Meal leftovers after storage
1|2	0.99 (0.30)	0.26 (0.79)	-0.58 (0.53)	-1.37 (0.14)	-0.16 (0.86)	0.60 (0.50)	0.05 (0.95)
2|3	2.76** (<0.01)	2.36* (0.02)	1.23 (0.18)	0.68 (0.46)	1.36 (0.13)	1.80* (0.04)	1.56+ (0.08)
3|4	4.04*** (<0.01)	3.53*** (<0.01)	2.24* (0.01)	1.64+ (0.07)	2.13* (0.02)	2.24* (0.01)	2.15* (0.02)
4|5	5.29*** (<0.01)	4.56*** (<0.01)	3.26*** (<0.01)	2.60** (<0.01)	2.99** (<0.01)	2.65** (<0.01)	2.69** (<0.01)
5|6	6.57*** (<0.01)	5.62*** (<0.01)	4.55*** (<0.01)	3.73*** (<0.01)	4.04*** (<0.01)	2.98*** (<0.01)	3.47*** (<0.01)
6|7	7.96*** (<0.01)	6.87*** (<0.01)	6.23*** (<0.01)	5.76*** (<0.01)	5.28*** (<0.01)	3.84*** (<0.01)	4.73*** (<0.01)
HH_size	0.06 (0.39)	0.15* (0.04)	0.18* (0.01)	0.20** (<0.01)	0.12+ (0.07)	0.30*** (<0.01)	0.27*** (<0.01)
no_of_people_in_HH_with_special_case	0.21 (0.23)	0.32+ (0.10)	0.08 (0.64)	0.11 (0.55)	0.24 (0.16)	-0.03 (0.86)	0.32* (0.04)
HH_Income	0.08 (0.39)	0.05 (0.55)	0.17+ (0.06)	0.00 (0.99)	0.09 (0.30)	0.10 (0.23)	0.07 (0.40)
Full_time_work	0.23 (0.15)	0.32* (0.04)	0.10 (0.53)	0.28+ (0.07)	0.52*** (<0.01)	0.30* (0.05)	0.27+ (0.07)
Hometown	0.02 (0.54)	0.05 (0.24)	0.06 (0.11)	0.03 (0.44)	0.02 (0.62)	0.03 (0.35)	0.01 (0.81)
gender_male	0.16 (0.30)	0.22 (0.16)	0.34* (0.02)	0.35* (0.02)	0.31* (0.04)	0.23 (0.10)	0.50*** (<0.01)
Age	-0.01* (0.03)	-0.03*** (<0.01)	-0.02** (<0.01)	-0.02*** (<0.01)	-0.01+ (0.10)	0.00 (0.55)	0.00 (0.34)
Frequency_grocery_shopping	-0.30** (<0.01)	-0.22* (0.02)	-0.26** (<0.01)	-0.23* (0.01)	-0.18* (0.05)	-0.03 (0.71)	-0.16+ (0.08)
Cooking_role	0.04 (0.40)	0.04 (0.41)	0.03 (0.52)	0.03 (0.52)	0.17*** (<0.01)	0.10* (0.04)	0.14** (<0.01)
portion_size_perception	-0.13+ (0.06)	-0.06 (0.41)	0.02 (0.73)	-0.04 (0.54)	-0.12* (0.05)	-0.10 (0.12)	-0.02 (0.80)
eating_quantity_perception	0.04 (0.46)	0.08 (0.15)	0.18*** (<0.01)	0.16** (<0.01)	0.15** (<0.01)	0.11* (0.03)	0.08 (0.10)
Frequency_guests	0.16* (0.01)	0.12+ (0.06)	0.03 (0.65)	0.05 (0.40)	0.07 (0.25)	0.11+ (0.07)	0.05 (0.39)
Frequency_eating_home	0.14 (0.32)	0.19 (0.16)	0.09 (0.50)	0.25+ (0.06)	0.11 (0.42)	0.29* (0.02)	0.16 (0.21)
Frequency_eating_work	0.16 (0.21)	-0.02 (0.85)	-0.04 (0.72)	-0.11 (0.36)	-0.09 (0.44)	0.00 (0.99)	0.05 (0.65)
Frequency_cooking	-0.13 (0.30)	-0.18 (0.13)	-0.20+ (0.08)	-0.22+ (0.05)	-0.29* (<0.01)	-0.21* (0.05)	-0.28* (0.01)
Frequency_ordering	0.47*** (<0.01)	0.47*** (<0.01)	0.36*** (<0.01)	0.39*** (<0.01)	0.49*** (<0.01)	0.43*** (<0.01)	0.56*** (<0.01)
Frequency_food_rescue_apps	-0.13 (0.20)	-0.05 (0.60)	-0.03 (0.73)	-0.06 (0.55)	-0.16+ (0.10)	-0.29** (<0.01)	-0.20* (0.03)
Frequency_eating_out	0.24* (0.05)	0.30* (0.01)	0.22+ (0.06)	0.20+ (0.08)	0.25* (0.03)	0.25* (0.03)	0.17 (0.14)
Frequency_ordering_food_boxes	0.05 (0.69)	0.13 (0.31)	0.15 (0.21)	0.18 (0.14)	0.15 (0.24)	-0.06 (0.58)	0.01 (0.96)
7|8			7.34*** (<0.01)		8.03*** (<0.01)	5.46*** (<0.01)	8.00*** (<0.01)
Num.Obs.	768	768	768	768	768	768	768
AIC	1742.5	1857.0	2149.6	2350.6	2469.8	2899.4	2710.8
BIC	1858.6	1973.1	2270.3	2466.7	2590.5	3020.1	2831.5
RMSE	1.89	2.13	2.44	2.88	2.98	4.15	3.62

Table A6: OL regression of reported food waste frequencies by food category in Spain in CS 1

	FW frequency Unused Long Shelf Life	FW frequency Partly Used Long Shelf Life	FW frequency Completely unused perishable	FW frequency Partly used perishable	FW frequency Leftover ingredients	FW frequency Meal leftovers on plates	FW frequency Meal leftovers after storage
1|2	4.20* (0.04)	4.60* (0.03)	1.41 (0.46)	1.94 (0.31)	4.72* (0.01)	0.73 (0.70)	0.98 (0.60)
2|3	6.17** (<0.01)	6.86** (<0.01)	3.77+ (0.05)	4.52* (0.02)	6.28** (<0.01)	2.04 (0.28)	2.88 (0.12)
3|4	7.20*** (<0.01)	8.32*** (<0.01)	4.99* (0.01)	5.66** (<0.01)	7.11*** (<0.01)	2.69 (0.15)	3.67* (0.05)
4|5	7.83*** (<0.01)	9.64*** (<0.01)	5.97** (<0.01)	6.51*** (<0.01)	7.99*** (<0.01)	3.07 (0.10)	4.34* (0.02)
5|6	9.00*** (<0.01)	9.96*** (<0.01)	7.58*** (<0.01)	7.97*** (<0.01)	8.86*** (<0.01)	3.55+ (0.06)	5.16** (<0.01)
6|8	10.15*** (<0.01)						
HH_size	0.18 (0.18)	0.23+ (0.09)	0.09 (0.49)	0.05 (0.66)	0.06 (0.60)	0.26* (0.04)	0.19 (0.14)
no_of_people_in_HH_with_special_case	0.92 (0.36)	1.99* (0.03)	0.41 (0.65)	1.40 (0.14)	2.23* (0.01)	0.30 (0.73)	0.36 (0.66)
HH_income	0.39* (0.05)	0.40* (0.04)	0.47* (0.02)	0.62** (<0.01)	0.29 (0.14)	0.05 (0.80)	0.31 (0.11)
Full_time_work	0.09 (0.79)	0.10 (0.78)	0.79* (0.02)	1.01** (<0.01)	0.66* (0.04)	0.69* (0.04)	0.18 (0.57)
Hometown	-0.18+ (0.05)	0.03 (0.78)	-0.05 (0.56)	0.06 (0.51)	0.07 (0.39)	-0.06 (0.45)	0.08 (0.33)
gender_male	-0.15 (0.65)	-0.15 (0.65)	-0.08 (0.80)	0.09 (0.78)	0.13 (0.67)	-0.02 (0.94)	-0.54+ (0.09)
Age	0.01 (0.57)	-0.01 (0.60)	-0.02 (0.23)	-0.05*** (<0.01)	0.00 (0.93)	-0.01 (0.42)	0.01 (0.63)
Frequency_grocery_shopping	-0.12 (0.50)	0.14 (0.44)	-0.08 (0.65)	0.01 (0.95)	0.08 (0.64)	-0.11 (0.54)	0.03 (0.84)
Cooking_role	0.08 (0.49)	-0.02 (0.87)	0.24* (0.04)	0.25* (0.03)	0.08 (0.48)	0.22* (0.05)	0.08 (0.46)
portion_size_perception	0.03 (0.84)	0.03 (0.82)	0.09 (0.48)	-0.07 (0.59)	-0.02 (0.88)	0.23+ (0.09)	0.02 (0.88)
eating_quantity_perception	0.14 (0.25)	0.14 (0.23)	0.24* (0.04)	0.28* (0.02)	0.30* (0.01)	0.21+ (0.07)	0.37** (<0.01)
Frequency_guests	0.06 (0.64)	-0.27+ (0.07)	0.03 (0.85)	0.05 (0.72)	-0.01 (0.93)	-0.01 (0.92)	0.20 (0.13)
Frequency_eating_home	-0.07 (0.81)	-0.34 (0.22)	0.05 (0.84)	0.02 (0.93)	0.14 (0.60)	-0.26 (0.30)	-0.03 (0.91)
Frequency_eating_work	0.17 (0.40)	0.30 (0.14)	0.40* (0.04)	0.32+ (0.09)	0.36+ (0.06)	0.37+ (0.05)	0.42* (0.03)
Frequency_cooking	0.01 (0.95)	0.22 (0.36)	-0.07 (0.75)	0.34 (0.12)	0.05 (0.80)	0.02 (0.92)	-0.18 (0.39)
Frequency_ordering	0.36+ (0.09)	0.37+ (0.07)	0.01 (0.97)	0.16 (0.42)	0.32 (0.10)	0.53** (<0.01)	0.50* (0.01)
Frequency_food_rescue_apps	0.00 (0.99)	-0.07 (0.70)	0.09 (0.58)	-0.13 (0.40)	-0.11 (0.48)	-0.20 (0.20)	-0.16 (0.33)
Frequency_eating_out	0.49+ (0.06)	0.36 (0.16)	0.39 (0.11)	0.06 (0.82)	0.25 (0.29)	-0.05 (0.85)	-0.04 (0.88)
Frequency_ordering_food_boxes	-0.02 (0.93)	0.15 (0.58)	0.09 (0.71)	0.07 (0.77)	-0.06 (0.82)	0.05 (0.84)	-0.09 (0.73)
6|7		10.39*** (<0.01)	8.55*** (<0.01)	9.54*** (<0.01)	10.92*** (<0.01)	4.51* (0.02)	6.45*** (<0.01)
7|8				12.04*** (<0.01)	6.57*** (<0.01)	8.15*** (<0.01)
Num.Obs.	197	197	197	197	197	197	197
AIC	516.0	498.6	613.9	652.6	701.7	745.0	729.0
BIC	598.1	580.7	696.0	734.7	787.1	830.4	814.3
RMSE	2.11	2.09	2.84	3.32	3.24	3.90	3.61

Table A7: Linear Regression of Food Waste per guest with and without the proportion of business travellers in CS 2

Baseline Model

Characteristic	Beta[1]	SE[2]	95% CI[2]	p-value
Guests	0.02***	0.001	0.02, 0.02	<0.001
Control				
control	—	—	—	
positive	-0.73*	0.343	-1.4, -0.06	0.033
provocative	1.3***	0.360	0.57, 2.0	<0.001
Hotel				
C Trondheim	—	—	—	
C Union	-0.50	0.354	-1.2, 0.20	0.2
cc tollboden	0.14	0.360	-0.56, 0.85	0.7
CI Gardermoen	0.35	0.433	-0.50, 1.2	0.4
CI Trondheim	-1.6***	0.376	-2.3, -0.87	<0.001
Q Airport Stavanger	-1.7***	0.370	-2.4, -0.96	<0.001
Q Riverstation	-4.1***	0.335	-4.8, -3.4	<0.001
The Thief	3.7***	0.358	3.0, 4.4	<0.001
weekend				
FALSE	—	—	—	
TRUE	1.5***	0.208	1.1, 1.9	<0.001
as.factor(month(Date))				
3	—	—	—	
4	0.26	0.305	-0.33, 0.86	0.4
5	0.80*	0.404	0.01, 1.6	0.048
6	0.02	0.399	-0.77, 0.80	>0.9
7	0.90*	0.397	0.12, 1.7	0.024
8	0.73	0.437	-0.13, 1.6	0.10
No. Obs.	1,093			
R²	0.580			
Adjusted R²	0.574			
AIC	5,474			

[1] *p<0.05; **p<0.01; ***p<0.001
[2] SE = Standard Error, CI = Confidence Interval

Model with business guests

Characteristic	Beta[1]	SE[2]	95% CI[2]	p-value
Guests	0.02***	0.001	0.02, 0.03	<0.001
Control				
control	—	—	—	
positive	-0.52	0.345	-1.2, 0.15	0.13
provocative	1.5***	0.368	0.81, 2.3	<0.001
Hotel				
C Trondheim	—	—	—	
C Union	0.12	0.381	-0.63, 0.87	0.7
cc tollboden	1.0*	0.417	0.22, 1.9	0.013
CI Gardermoen	0.90*	0.450	0.01, 1.8	0.046
CI Trondheim	-1.5***	0.380	-2.2, -0.71	<0.001
Q Airport Stavanger	-1.0**	0.401	-1.8, -0.26	0.009
Q Riverstation	-3.5***	0.358	-4.2, -2.8	<0.001
The Thief	4.2***	0.378	3.5, 5.0	<0.001
weekend				
FALSE	—	—	—	
TRUE	1.1***	0.227	0.67, 1.6	<0.001
as.factor(month(Date))				
3	—	—	—	
4	0.17	0.304	-0.43, 0.77	0.6
5	0.50	0.410	-0.31, 1.3	0.2
6	-0.41	0.413	-1.2, 0.40	0.3
7	0.30	0.420	-0.53, 1.1	0.5
8	0.06	0.467	-0.85, 0.98	0.9
business	-2.8***	0.649	-4.0, -1.5	<0.001
No. Obs.	1,074			
R²	0.590			
Adjusted R²	0.584			
AIC	5,366			

[1] *p<0.05; **p<0.01; ***p<0.001
[2] SE = Standard Error, CI = Confidence Interval

Table A8: Linear Regression of Food Waste per guest with additional interaction metrics in CS 2

Guest Type Interactions

Characteristic	Beta[1]	SE[2]	95% CI[2]	p-value
business_guest	0.019***	0.002	0.016, 0.023	<0.001
other_guest	0.028***	0.002	0.024, 0.032	<0.001
Hotel				
C Trondheim	—	—	—	
C Union	-0.056	0.367	-0.776, 0.664	0.9
cc tollboden	0.804*	0.383	0.053, 1.555	0.036
CI Gardermoen	1.017*	0.456	0.123, 1.911	0.026
CI Trondheim	-1.366***	0.382	-2.116, -0.617	<0.001
Q Airport Stavanger	-1.104**	0.385	-1.858, -0.349	0.004
Q Riverstation	-3.570***	0.346	-4.250, -2.890	<0.001
The Thief	4.246***	0.366	3.527, 4.964	<0.001
weekend				
FALSE	—	—	—	
TRUE	1.206***	0.219	0.778, 1.635	<0.001
as.factor(month(Date))				
3	—	—	—	
4	0.171	0.305	-0.427, 0.769	0.6
5	0.661	0.355	-0.036, 1.358	0.063
6	-0.223	0.360	-0.929, 0.484	0.5
7	0.453	0.364	-0.261, 1.166	0.2
8	0.323	0.385	-0.433, 1.079	0.4
other_guest * Control				
other_guest * positive	-0.003	0.002	-0.008, 0.001	0.2
other_guest * provocative	0.011**	0.003	0.004, 0.018	0.001
business_guest * Control				
business_guest * positive	-0.002	0.002	-0.006, 0.002	0.4
business_guest * provocative	0.003	0.002	-0.001, 0.008	0.13
No. Obs.	1,074			
R[2]	0.592			
Adjusted R[1]	0.584			
AIC	5,367			

[1] *p<0.05; **p<0.01; ***p<0.001
[2] SE = Standard Error, CI = Confidence Interval

Weekend Interactions

Characteristic	Beta[1]	SE[2]	95% CI[2]	p-value
business_guest	0.020***	0.002	0.016, 0.023	<0.001
other_guest	0.027***	0.002	0.022, 0.031	<0.001
Hotel				
C Trondheim	—	—	—	
C Union	-0.027	0.367	-0.747, 0.693	>0.9
cc tollboden	0.791*	0.383	0.039, 1.543	0.039
CI Gardermoen	1.030*	0.456	0.135, 1.925	0.024
CI Trondheim	-1.371***	0.384	-2.124, -0.617	<0.001
Q Airport Stavanger	-1.104**	0.385	-1.859, -0.349	0.004
Q Riverstation	-3.571***	0.346	-4.251, -2.891	<0.001
The Thief	4.238***	0.366	3.519, 4.956	<0.001
weekend				
FALSE	—	—	—	
TRUE	1.795**	0.694	0.434, 3.156	0.010
as.factor(month(Date))				
3	—	—	—	
4	0.150	0.305	-0.449, 0.748	0.6
5	0.744*	0.357	0.043, 1.445	0.038
6	-0.169	0.364	-0.884, 0.546	0.6
7	0.541	0.369	-0.184, 1.265	0.14
8	0.374	0.387	-0.386, 1.134	0.3
I(business * weekend)	-0.368	1.16	-2.640, 1.903	0.8
other_guest * Control				
other_guest * positive	-0.001	0.003	-0.006, 0.004	0.7
other_guest * provocative	0.012**	0.004	0.004, 0.019	0.002
business_guest * Control				
business_guest * positive	-0.002	0.002	-0.005, 0.002	0.4
business_guest * provocative	0.003	0.002	-0.001, 0.008	0.2
Control * weekend				
positive * TRUE	-1.029*	0.485	-1.981, -0.078	0.034
provocative * TRUE	-0.250	0.545	-1.320, 0.819	0.6
No. Obs.	1,074			
R[2]	0.593			
Adjusted R[2]	0.585			
AIC	5,368			

[1] *p<0.05; **p<0.01; ***p<0.001
[2] SE = Standard Error, CI = Confidence Interval

Three-way interactions

Characteristic	Beta[1]	SE[2]	95% CI[2]	p-value
business_guest	0.022***	0.004	0.014, 0.030	<0.001
other_guest	0.041***	0.006	0.030, 0.052	<0.001
Hotel				
C Trondheim	—	—	—	
C Union	-0.071	0.367	-0.791, 0.650	0.8
CI Gardermoen	1.112*	0.458	0.213, 2.010	0.015
CI Trondheim	-1.347***	0.383	-2.090, -0.596	<0.001
Q Airport Stavanger	-1.055**	0.385	-1.810, -0.301	0.006
Q Riverstation	-3.587***	0.346	-4.267, -2.908	<0.001
The Thief	4.271***	0.366	3.553, 4.990	<0.001
cc tollboden	0.820*	0.382	0.070, 1.570	0.032
weekend				
Weekday	—	—	—	
Weekend	0.791*	0.402	0.002, 1.581	0.050
as.factor(month(Date))				
3	—	—	—	
4	0.132	0.304	-0.465, 0.728	0.7
5	0.619	0.356	-0.079, 1.318	0.082
6	-0.252	0.362	-0.963, 0.459	0.5
7	0.458	0.367	-0.262, 1.177	0.2
8	0.279	0.388	-0.483, 1.041	0.5
other_guest * Control * weekend				
other_guest * control * Weekday	-0.016*	0.006	-0.028, -0.005	0.006
other_guest * positive * Weekday	-0.014*	0.006	-0.026, -0.003	0.015
other_guest * provocative * Weekday	-0.003	0.007	-0.016, 0.010	0.6
other_guest * control * Weekend	-0.012*	0.006	-0.023, 0.000	0.044
other_guest * positive * Weekend	-0.019*	0.006	-0.030, -0.008	0.001
other_guest * provocative * Weekend				
business_guest * Control * weekend				
business_guest * control * Weekday	-0.004	0.005	-0.013, 0.005	0.4
business_guest * positive * Weekday	-0.005	0.004	-0.014, 0.003	0.2
business_guest * provocative * Weekday	0.000	0.005	-0.009, 0.009	>0.9
business_guest * control * Weekend	0.001	0.005	-0.009, 0.010	>0.9
business_guest * positive * Weekend	-0.003	0.005	-0.012, 0.006	0.5
business_guest * provocative * Weekend				
No. Obs.	1,074			
R[2]	0.596			
Adjusted R[2]	0.587			
AIC	5,366			

[1] *p<0.05; **p<0.01; ***p<0.001
[2] SE = Standard Error, CI = Confidence Interval

The point values in Figures A5-A7 represent the mean value, one standard deviation up and one standard deviation down, while the bars represent the confidence intervals of the predicted food waste for each value, as it was popularized in Aiken and West (1991).

Figure A5: Marginal effect of the interaction between message type and type of guest in CS 2
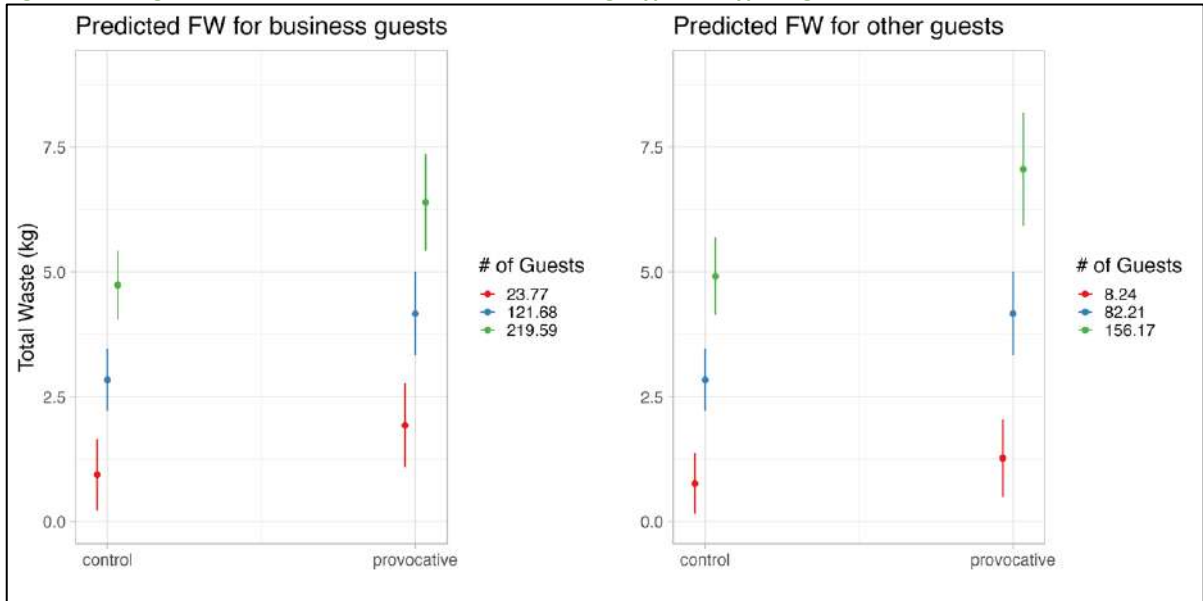
Figure A6: Marginal effect of the interaction between message type and weekend in CS 2
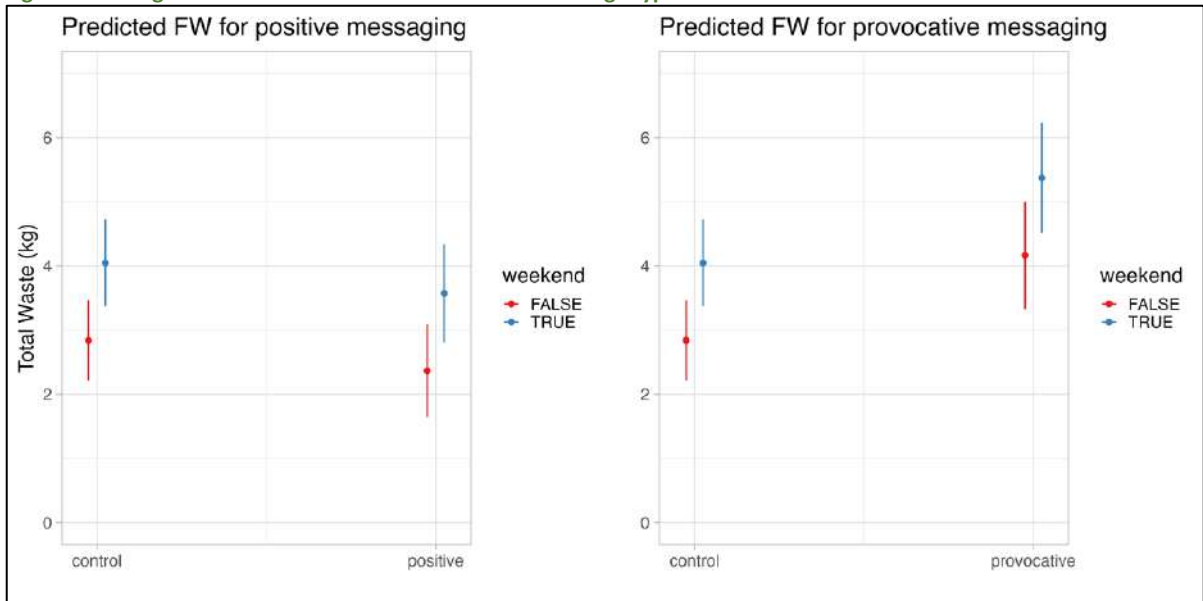
Figure A7: Marginal effect of three-way interaction between message type, guest type and weekend in CS 2

Figure A8: Correlation table for CS 3
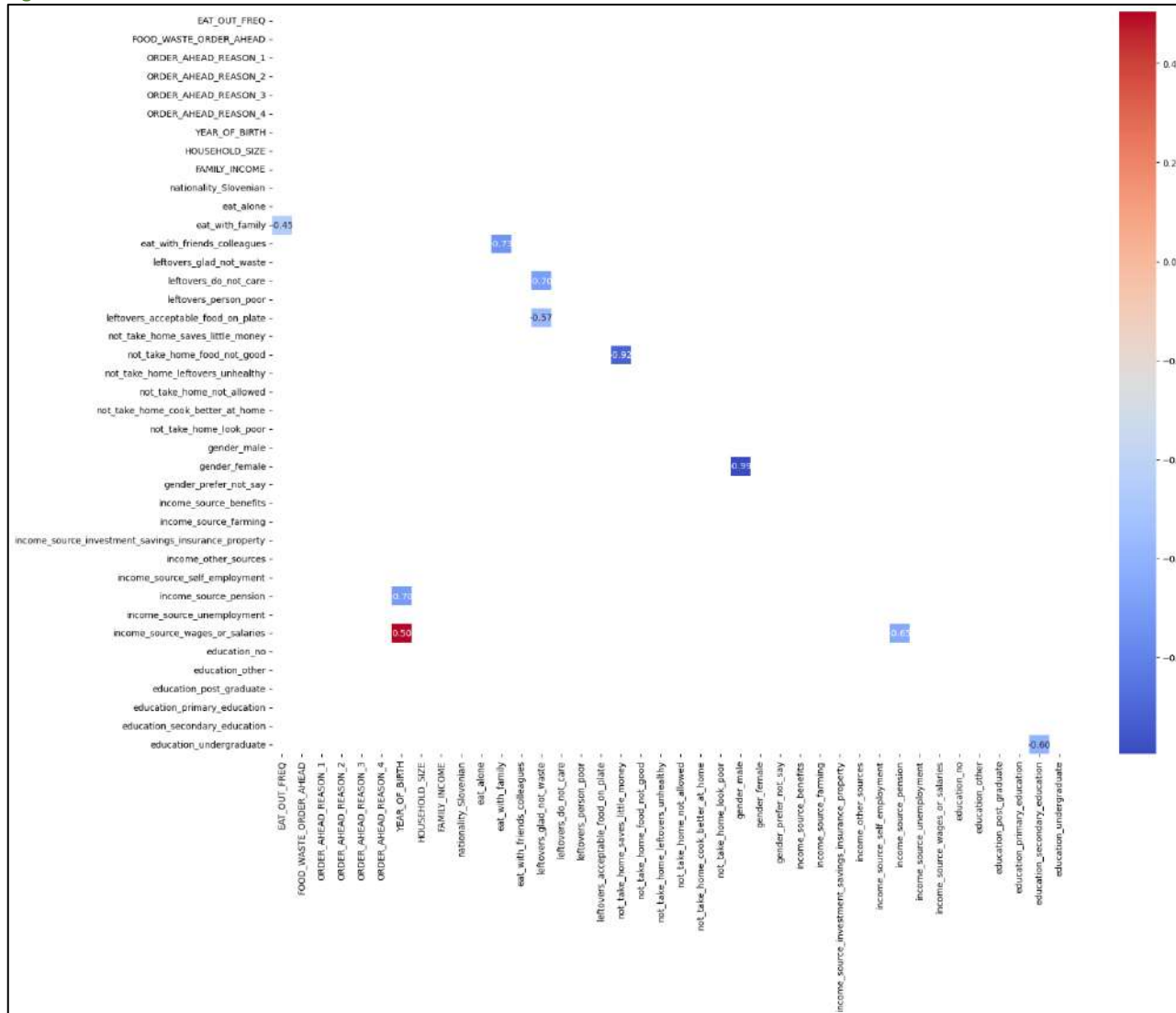
Table A9: OL regression of leftovers amount and frequency of taking leftovers home with and without controlling for the amount of leftovers in CS 3

	Leftovers Amount	Take Home Leftovers	Take Home Leftovers Controlling for Leftover Amount
1|2	-13.72*** (<0.01)	31.10*** (<0.01)	40.34*** (<0.01)
2|3	-10.96*** (<0.01)	33.18*** (<0.01)	42.54*** (<0.01)
3|4	-8.62*** (<0.01)		
4|5	-5.58*** (<0.01)		
EAT_OUT_FREQ	0.01 (0.84)	0.11+ (0.06)	0.11+ (0.07)
FOOD_WASTE_ORDER_AHEAD	0.04 (0.57)	-0.05 (0.51)	-0.05 (0.43)
ORDER_AHEAD_REASON_1	-0.38* (0.02)	-0.34* (0.03)	-0.24 (0.13)
ORDER_AHEAD_REASON_2	-0.62*** (<0.01)	-0.73*** (<0.01)	-0.59*** (<0.01)
ORDER_AHEAD_REASON_3	-0.25 (0.13)	0.00 (0.98)	0.02 (0.90)
ORDER_AHEAD_REASON_4	-0.12 (0.48)	0.55*** (<0.01)	0.63*** (<0.01)
YEAR_OF_BIRTH	0.00*** (<0.01)	0.02*** (<0.01)	0.02*** (<0.01)
HOUSEHOLD_SIZE	0.01 (0.86)	-0.19** (<0.01)	-0.20** (<0.01)
FAMILY_INCOME	-0.07 (0.52)	-0.03 (0.75)	-0.01 (0.90)
nationality_Slovenian	-0.99*** (<0.01)	-0.33*** (<0.01)	-0.12** (<0.01)
eat_alone	-0.31 (0.18)	-0.93*** (<0.01)	-0.90*** (<0.01)
eat_with_family	-0.16 (0.35)	-0.65*** (<0.01)	-0.64*** (<0.01)
leftovers_do_not_care	0.16 (0.56)	1.81*** (<0.01)	1.87*** (<0.01)
leftovers_person_poor	-0.55*** (<0.01)	2.06*** (<0.01)	2.46*** (<0.01)
leftovers_acceptable_food_on_plate	-1.13*** (<0.01)	2.77*** (<0.01)	3.25*** (<0.01)
not_take_home_food_not_good	0.34* (0.03)	-0.01 (0.95)	-0.07 (0.66)
not_take_home_leftovers_unhealthy	0.74*** (<0.01)	1.60*** (<0.01)	1.72*** (<0.01)
not_take_home_not_allowed	1.28*** (<0.01)	-0.36*** (<0.01)	-0.75*** (<0.01)
not_take_home_cook_better_at_home	16.82*** (<0.01)	2.12*** (<0.01)	1.46*** (<0.01)
not_take_home_look_poor	1.60*** (<0.01)	13.31*** (<0.01)	12.78*** (<0.01)
gender_male	0.60*** (<0.01)	0.25+ (0.08)	0.11 (0.46)
gender_prefer_not_say	-0.73*** (<0.01)	-1.76*** (<0.01)	-1.76*** (<0.01)
income_source_farming	-1.08*** (<0.01)	-0.37*** (<0.01)	-0.09 (0.41)
income_source_investment_savings_insurance_property	-0.58*** (<0.01)	-0.29*** (<0.01)	-0.11*** (<0.01)
income_other_sources	-1.52*** (<0.01)	-1.42*** (<0.01)	-1.09*** (<0.01)
income_source_self_employment	-0.51*** (<0.01)	-0.19* (0.03)	-0.15+ (0.10)
income_source_pension	-0.74*** (<0.01)	-0.97*** (<0.01)	-0.81*** (<0.01)
income_source_unemployment	-0.09 (0.20)	0.00 (1.00)	-0.02 (0.80)
income_source_wages_or_salaries	0.06 (0.70)	0.12 (0.46)	0.12 (0.45)
education_no	-0.13*** (<0.01)	-1.60*** (<0.01)	-1.33*** (<0.01)
education_other	0.74*** (<0.01)	1.35*** (<0.01)	1.33*** (<0.01)
education_primary_education	1.37*** (<0.01)	0.84*** (<0.01)	0.63*** (<0.01)
education_secondary_education	0.76*** (<0.01)	0.52*** (<0.01)	0.41** (<0.01)
education_undergraduate	0.23 (0.15)	0.30+ (0.06)	0.27 (0.10)
LEFTOVERS_AMOUNT			0.87*** (<0.01)
Num.Obs.	792	792	792
AIC	1556.9	1540.5	1487.2
BIC	1734.6	1708.8	1660.2
RMSE	3.99	1.76	1.77

Figure A9: Over-purchasing frequency against regression features in CS 6

Figure A10: Correlation Table in CS6
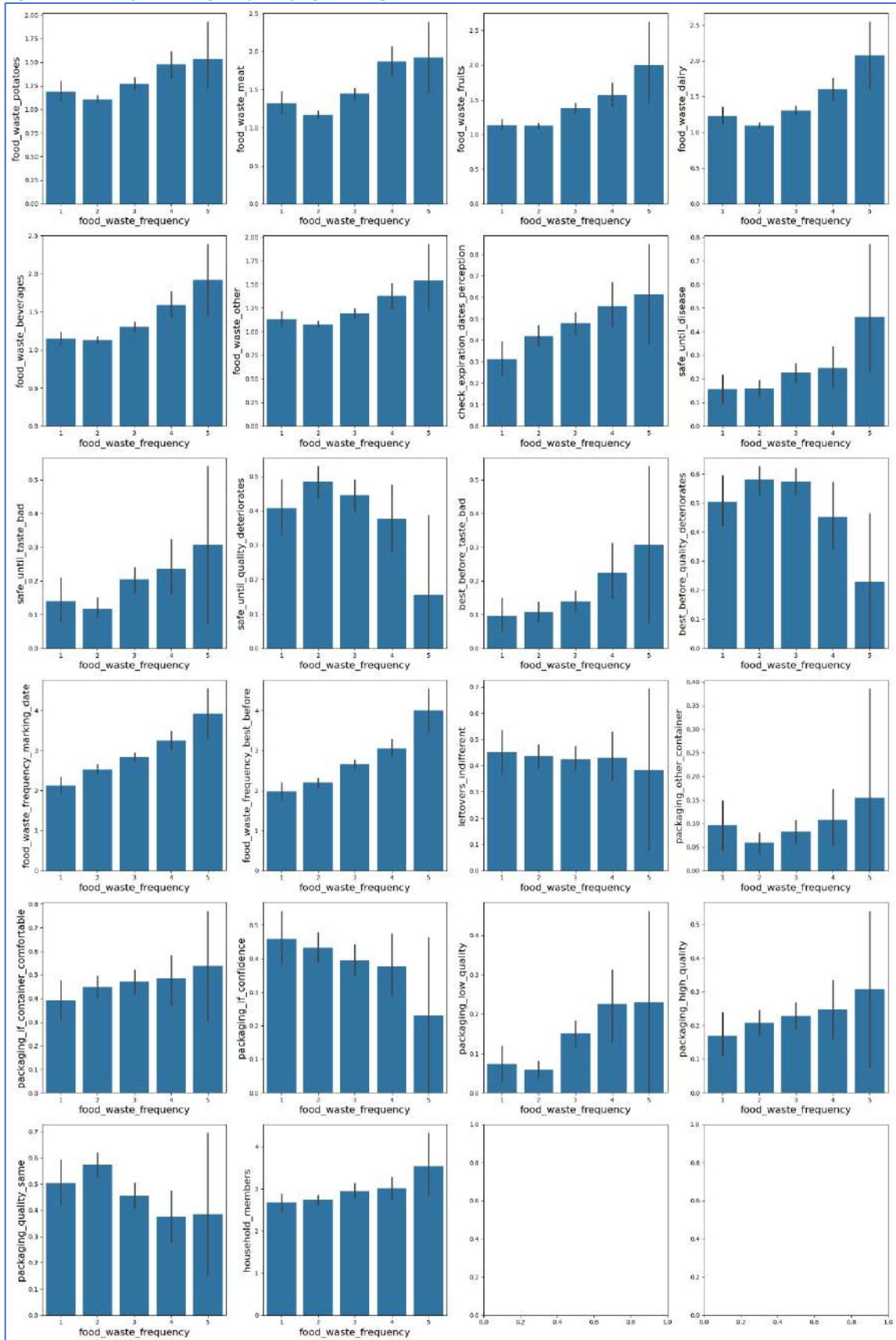
Table A10: OL regression for frequency of over-purchasing food in CS 6

	Food Waste Frequency	Food Waste Frequency with Stepwise Selection
1|2	41.06*** (<0.01)	46.48*** (<0.01)
2|3	43.48*** (<0.01)	48.88*** (<0.01)
3|4	45.98*** (<0.01)	51.36*** (<0.01)
4|5	48.26*** (<0.01)	53.64*** (<0.01)
check_dates_room_temperature	-0.06 (0.36)	
check_dates_fresh_food	-0.03 (0.65)	
check_dates_meat_fish	0.03 (0.65)	
check_expiration_dates_perception	0.40*** (<0.01)	0.42*** (<0.01)
safe_until_disease	0.09 (0.56)	
safe_until_taste_bad	0.12 (0.47)	
safe_until_regulatory_reasons	0.07 (0.57)	
safe_until_quality_deteriorates	0.05 (0.70)	
best_before_disease	-0.07 (0.72)	
best_before_taste_bad	0.08 (0.65)	
best_before_regulatory_reasons	0.09 (0.48)	
best_before_quality_deteriorates	0.04 (0.74)	
marking_dates_clear	-0.09 (0.38)	
food_waste_frequency_marking_date	0.16* (0.03)	0.17* (0.02)
food_waste_frequency_best_before	0.38*** (<0.01)	0.36*** (<0.01)
marking_dates_more_or_less	0.06 (0.55)	
marking_dates_compulsory_before	-0.13 (0.25)	
marking_dates_suggestion	0.33** (<0.01)	0.37* (0.02)
leftovers_no	0.19 (0.19)	
leftovers_yes	0.33* (0.03)	0.28+ (0.05)
leftovers_None	0.12 (0.49)	
leftovers_Other	-0.19* (0.02)	
packaging_airtight_with_lid	-0.27+ (0.05)	-0.26* (0.05)
packaging_if_container_comfortable	-0.15 (0.18)	-0.09 (0.40)
packaging_if_confidence	-0.29* (0.02)	-0.24* (0.03)
packaging_low_quality	0.84*** (<0.01)	0.88*** (<0.01)
packaging_high_quality	0.37** (<0.01)	0.39** (<0.01)
packaging_quality_dont_know	-0.03 (0.84)	-0.04 (0.81)
packaging_plastic_harmful	0.14 (0.26)	0.11 (0.35)
store_original_packaging	0.17 (0.15)	
gender_rather_not_say	0.05*** (<0.01)	
gender_Male	-0.18 (0.12)	
year_of_birth	0.02*** (<0.01)	0.02*** (<0.01)
residence_location	-0.06 (0.29)	
household_members	0.05 (0.18)	
household_income	0.00 (0.97)	
income_change	0.03 (0.57)	
education	0.13 (0.21)	0.15 (0.14)
country_ES	-0.21+ (0.08)	-0.20+ (0.09)
country_GR	-0.47*** (<0.01)	-0.54*** (<0.01)
country_HU	-0.54*** (<0.01)	-0.62*** (<0.01)
country_NL	-0.25* (0.03)	-0.31** (<0.01)
Num.Obs.	1163	1163
AIC	2733.1	2701.3
BIC	2965.8	2812.6
RMSE	2.42	2.42

Table A11: OL regression for food waste levels by food type in CS 6

	Food Waste Bread	Food Waste Potatoes	Food Waste Meat	Food Waste Fruits	Food Waste Dairy	Food Waste Beverages	Food Waste Other
1|2	32.14*** (<0.01)	39.57*** (<0.01)	24.24*** (<0.01)	32.68*** (<0.01)	81.34*** (<0.01)	41.08*** (<0.01)	60.38
2|3	33.70*** (<0.01)	41.48*** (<0.01)	25.60*** (<0.01)	34.23*** (<0.01)	83.03*** (<0.01)	43.08*** (<0.01)	62.50
3|4	34.75*** (<0.01)	42.65*** (<0.01)	26.99*** (<0.01)	36.47*** (<0.01)	84.37*** (<0.01)	43.79*** (<0.01)	64.18*** (<0.01)
check_dates_room_temperature	-0.14 (0.12)	-0.08 (0.46)	-0.24* (0.01)	-0.30** (<0.01)	-0.19+ (0.07)	-0.09 (0.39)	-0.09 (0.46)
check_dates_fresh_food	0.03 (0.66)	-0.01 (0.91)	0.11 (0.19)	0.09 (0.33)	0.06 (0.50)	0.07 (0.42)	0.08 (0.51)
check_dates_meat_fish	-0.02 (0.84)	0.00 (0.99)	-0.11 (0.20)	-0.05 (0.63)	-0.09 (0.35)	-0.01 (0.93)	-0.16 (0.14)
check_expiration_dates_perception	0.57*** (<0.01)	0.22 (0.21)	0.27+ (0.08)	0.28+ (0.09)	0.53** (<0.01)	0.29+ (0.09)	0.66** (<0.01)
safe_until_disease	0.51** (<0.01)	0.57** (<0.01)	0.23 (0.22)	0.47* (0.02)	0.75*** (<0.01)	0.48* (0.02)	0.38 (0.10)
safe_until_taste_bad	-0.11 (0.61)	-0.02 (0.93)	0.23 (0.24)	-0.28 (0.21)	0.14 (0.51)	0.06 (0.78)	0.24 (0.35)
safe_until_regulatory_reasons	0.07 (0.68)	-0.15 (0.47)	-0.01 (0.93)	0.03 (0.85)	-0.01 (0.94)	-0.08 (0.69)	-0.34 (0.15)
safe_until_quality_deteriorates	0.17 (0.30)	-0.21 (0.31)	-0.29+ (0.10)	-0.51** (<0.01)	0.09 (0.65)	-0.52** (<0.01)	-0.32 (0.17)
best_before_disease	-0.04 (0.86)	0.24 (0.34)	0.28 (0.20)	0.30 (0.22)	-0.15 (0.53)	-0.01 (0.96)	0.75** (<0.01)
best_before_taste_bad	-0.01 (0.97)	-0.13 (0.57)	-0.09 (0.64)	-0.03 (0.89)	0.10 (0.66)	0.26 (0.24)	0.61* (0.01)
best_before_regulatory_reasons	-0.09 (0.61)	-0.28 (0.16)	-0.05 (0.75)	0.05 (0.77)	-0.30+ (0.09)	-0.29 (0.11)	-0.11 (0.62)
best_before_quality_deteriorates	-0.36* (0.04)	-0.66*** (<0.01)	-0.49** (<0.01)	-0.32+ (0.08)	-0.50** (<0.01)	-0.47* (0.01)	-0.46* (0.04)
marking_dates_clear	-0.12 (0.39)	0.20 (0.22)	0.03 (0.84)	0.06 (0.66)	-0.14 (0.40)	-0.11 (0.46)	0.17 (0.31)
food_waste_frequency_marking_date	-0.02 (0.82)	-0.08 (0.52)	-0.08 (0.44)	-0.15 (0.17)	-0.03 (0.80)	0.10 (0.38)	-0.19 (0.13)
food_waste_frequency_best_before	0.49*** (<0.01)	0.47*** (<0.01)	0.45*** (<0.01)	0.62*** (<0.01)	0.47*** (<0.01)	0.27* (0.02)	0.67*** (<0.01)
marking_dates_more_or_less	-0.25* (0.04)	0.31* (0.02)	-0.14 (0.25)	0.40** (<0.01)	0.23+ (0.10)	-0.09 (0.52)	0.32+ (0.06)
marking_dates_compulsory_before	0.07 (0.66)	0.50** (<0.01)	0.15 (0.33)	0.08 (0.61)	0.07 (0.68)	-0.13 (0.43)	0.14 (0.48)
marking_dates_suggestion	-0.05 (0.73)	0.51** (<0.01)	0.33* (0.02)	0.72*** (<0.01)	0.56*** (<0.01)	0.36* (0.02)	-0.09 (0.63)
leftovers_no	0.13 (0.50)	-0.05 (0.79)	0.50** (<0.01)	0.16 (0.38)	0.27 (0.16)	0.39* (0.04)	0.73*** (<0.01)
leftovers_yes	0.00 (0.98)	0.06 (0.76)	0.30+ (0.10)	0.03 (0.86)	0.50* (0.01)	0.16 (0.45)	0.60* (0.01)
leftovers_None	0.18 (0.46)	-0.64** (<0.01)	-0.21 (0.19)	-0.37* (0.02)	0.19 (0.40)	0.02 (0.91)	0.35 (0.19)
leftovers_Other	-0.22** (<0.01)	-0.13*** (<0.01)	0.43*** (<0.01)	0.17*** (<0.01)	-0.45* (<0.01)	0.57*** (<0.01)	0.42*** (<0.01)

	Food Waste Bread	Food Waste Potatoes	Food Waste Meat	Food Waste Fruits	Food Waste Dairy	Food Waste Beverages	Food Waste Other
packaging_airtight_with_lid	0.08 (0.67)	-0.38* (0.02)	-0.26 (0.11)	-0.66*** (<0.01)	-0.45** (<0.01)	-1.36*** (<0.01)	-0.79*** (<0.01)
packaging_if_container_comfortable	0.51** (<0.01)	0.12 (0.59)	0.03 (0.86)	-0.40* (0.03)	-0.14 (0.49)	-0.19+ (0.09)	-0.56* (0.01)
packaging_if_confidence	0.38* (0.03)	-0.25 (0.27)	-0.49** (<0.01)	-0.70*** (<0.01)	-0.31 (0.15)	-0.67*** (<0.01)	-0.95*** (<0.01)
packaging_low_quality	0.59** (<0.01)	0.64** (<0.01)	0.59** (<0.01)	0.42* (0.05)	0.62** (<0.01)	0.49* (0.03)	0.33 (0.21)
packaging_high_quality	0.57*** (<0.01)	0.67*** (<0.01)	0.44** (<0.01)	0.38* (0.03)	0.21 (0.25)	0.18 (0.34)	0.31 (0.19)
packaging_quality_dont_know	0.26 (0.28)	0.15 (0.51)	0.05 (0.80)	0.30 (0.16)	-0.20 (0.36)	-0.57** (<0.01)	-0.72*** (<0.01)
packaging_plastic_harmful	-0.04 (0.78)	0.66** (<0.01)	0.25 (0.13)	0.79*** (<0.01)	0.26 (0.30)	0.33 (0.20)	-0.01 (0.91)
store_original_packaging	0.04 (0.79)	0.10 (0.58)	-0.15 (0.31)	0.03 (0.87)	0.12 (0.47)	0.15 (0.34)	0.34+ (0.07)
gender_rather_not_say	-0.46*** (<0.01)	0.66*** (<0.01)	1.02*** (<0.01)	-12.60*** (<0.01)	-12.64*** (<0.01)	0.50*** (<0.01)	1.80
gender_Male	-0.04 (0.77)	0.16 (0.35)	0.21 (0.16)	0.24 (0.14)	0.08 (0.63)	0.30+ (0.07)	0.48* (0.02)
year_of_birth	0.01*** (<0.01)	0.02*** (<0.01)	0.01*** (<0.01)	0.02*** (<0.01)	0.04*** (<0.01)	0.02*** (<0.01)	0.03
residence_location	-0.09 (0.22)	-0.22* (0.02)	-0.11 (0.15)	-0.08 (0.31)	-0.12 (0.20)	-0.11 (0.22)	-0.03 (0.73)
household_members	0.05 (0.26)	-0.01 (0.85)	0.02 (0.61)	0.09+ (0.07)	-0.04 (0.50)	-0.02 (0.72)	-0.06 (0.31)
household_income	0.14 (0.21)	0.00 (0.98)	-0.06 (0.62)	0.01 (0.93)	0.08 (0.54)	-0.01 (0.94)	-0.03 (0.82)
income_change	-0.02 (0.78)	0.08 (0.35)	0.15* (0.04)	-0.05 (0.50)	0.10 (0.24)	0.10 (0.21)	0.04 (0.69)
education	-0.17 (0.21)	-0.31* (0.04)	-0.30* (0.03)	-0.01 (0.94)	-0.25 (0.10)	-0.42** (<0.01)	-0.22+ (0.10)
country_ES	0.85*** (<0.01)	-0.56** (<0.01)	-0.38* (0.04)	0.37* (0.04)	0.18 (0.37)	0.06 (0.77)	0.92*** (<0.01)
country_GR	0.16 (0.35)	-0.76*** (<0.01)	-0.31+ (0.08)	0.15 (0.43)	0.13 (0.53)	0.43* (0.02)	0.53* (0.02)
country_HU	0.30+ (0.09)	-0.49* (0.03)	-0.66*** (<0.01)	-0.61*** (<0.01)	-0.67*** (<0.01)	-0.40* (0.04)	-0.32 (0.11)
country_NL	0.34* (0.02)	-0.12 (0.55)	-0.27+ (0.09)	0.17 (0.31)	0.25 (0.15)	0.66** (<0.01)	0.58** (<0.01)
Num.Obs.	1163	1163	1163	1163	1163	1163	1163
AIC	1613.1	1187.7	1620.9	1387.7	1267.9	1267.0	915.9
BIC	1840.7	1415.4	1848.5	1615.4	1495.6	1494.7	1143.6
RMSE	1.30	1.16	1.37	1.23	1.20	1.21	1.08

The model on the left of table A10 is the full specification, and as it can be seen it has numerous parameters. The problem when having an excessive number of regressors is that the model can lead to overfitting, where it captures noise rather than genuine relationships in the data. Therefore, the model on the right of the table, **Food Waste Frequency with Stepwise Selection**, was employed to address this issue. Automatic stepwise selection, combines forward and backward steps, allowing regressors to enter or leave the model based on statistical criteria improvement (AIC and BIC), resulting in a more parsimonious specification. As a result, the final model only includes the most influential variables which makes it more effective and generalizable to new data.

It can be seen that all the statistically significant parameters in the full specification are also included in the reduced model.

In building a separate model for each food type (Table A11), it was deliberately chosen not to employ a reduction in specifications through stepwise selection, as it was done for the aggregate model. The decision stems from the observation that each food type yields distinct sets of parameters, and enforcing a consistent reduction across all models would overlook the inherent characteristics of each category. However, it is acknowledged here that there is an increased potential for overfitting due to the large number of regressors.

10.2 Appendix B: Clustering Analysis

This Appendix contains the following:

- **Elbow Plots for CS 1 (Figures B1 and B2)**: Visual representations illustrating the selection of the optimal number of clusters using the elbow method, a key step in the k-modes clustering technique applied in Chapter 5.
- **Cluster Profiles for CS 1 (Figures B3 and B4):** Detailed tables presenting the average values of all variables within each of the five clusters, providing insight into the distinctive characteristics of each cluster. The yellow box in these figures highlights the categorical variables that were used for the cluster generation.
- **Statistical Validation for CS 1 (Tables B1 and B2):** A section describing the statistical tests employed to validate the difference in means for the demographics of the five clusters, ensuring the robustness and reliability of the clustering outcomes.
- **Elbow Plot for CS 3 (Figure B5)**: Visual representation illustrating the selection of the optimal number of clusters using the elbow method, a key step in the k-modes clustering technique applied in Chapter 5.
- **Cluster Profiles for CS 3 (Figure B6):** Detailed tables presenting the average values of all variables within each of the six clusters, providing insight into the distinctive characteristics of each cluster. The yellow box in this figure highlights the categorical variables that were used for the cluster generation.
- **Statistical Validation for CS 3 (Tables B3 and B4):** Statistical tests employed to validate the difference in means for the demographics of the six clusters, ensuring the robustness and reliability of the clustering outcomes.
- **Elbow Plot for CS 6 (Figure B7)**: Visual representation illustrating the selection of the optimal number of clusters using the elbow method, a key step in the k-modes clustering technique applied in Chapter 5.
- **Cluster Profiles for CS 6 (Figure B8):** Detailed table presenting the average values of all variables within each of the five clusters, providing insight into the distinctive characteristics of each cluster. The yellow box in this figure highlights the categorical variables that were used for the cluster generation.
- **Statistical Validation for CS 6 (Tables B5 and B6):** Statistical tests employed to validate the difference in means for the demographics of the five clusters, ensuring the robustness and reliability of the clustering outcomes.

Software/Programming language

For the clustering analysis in Chapter 5, we have used:

- the "kmodes" package in Python for generating the clusters.
- the "kruskal" method in the "scipy.stats" package in Python to conduct the Kruskal-Wallis test.
- the "posthoc_dunn" method in the "scikit_posthocs" package in Python to conduct Dunn's test with Bonferroni correction.

Figure B1: Elbow method to find optimal number of clusters for Belgium in CS 1
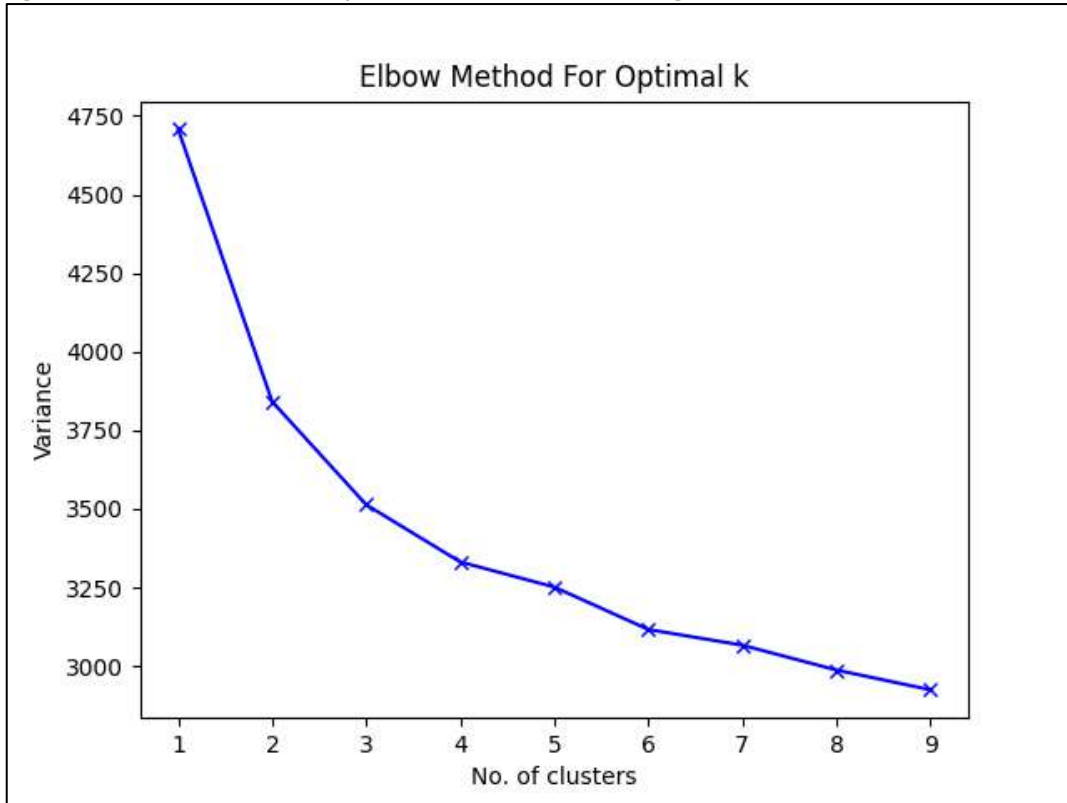
Figure B2: Elbow method to find optimal number of clusters for Spain in CS 1
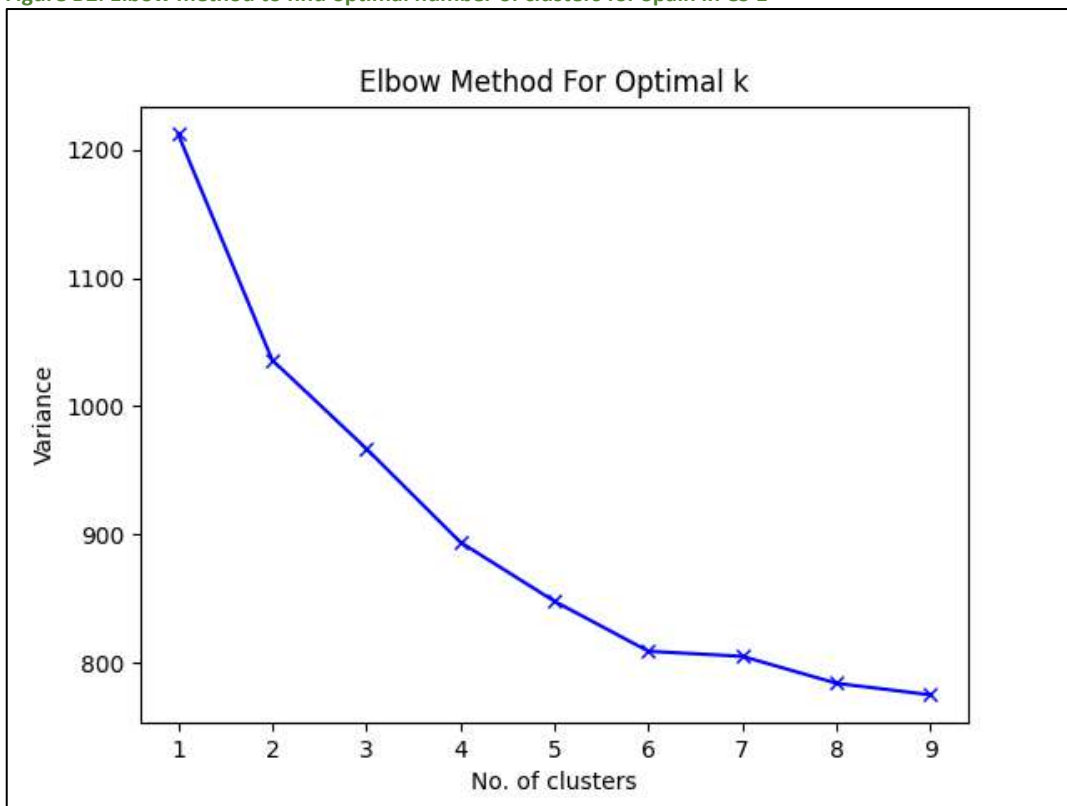
Figure B3: Food Waste Cluster Profiles in Belgium in CS 1

Cluster	0	1	2	3	4
FW	-2.023256	-1.502146	0.128571	-0.500000	-0.750000
Bread	1.262458	1.708155	2.628571	2.137500	1.904762
Fruit	1.299003	1.592275	2.842857	3.000000	2.559524
Potatos	1.225914	1.459227	2.042857	2.225000	1.750000
fish_and_meat_substitutes	1.073090	1.107296	1.885714	1.550000	1.392857
eggs	1.053156	1.072961	1.442857	1.262500	1.166667
FW_Freq_completely_unused_long_shelf_life	1.182791	1.798283	2.657143	2.675000	2.119048
FW_Freq_partly_used_long_shelf_life	1.269103	1.918455	3.314286	3.012500	2.452381
FW_Freq_completely_unused_perishable	1.518272	2.081545	3.671429	3.375000	2.833333
FW_Freq_partly_used_perishable	1.794020	2.364807	4.614286	3.912500	3.797619
FW_Freq_leftover_ingredients	1.717608	2.283262	4.685714	4.137500	3.916667
FW_Freq_meal_leftovers_on_plates	2.504983	2.944206	5.800000	5.687500	5.404762
FW_Freq_meal_leftovers_after_storage	2.149502	2.686695	5.414286	5.025000	4.892857
HH_size	2.285714	2.339056	3.057143	2.887500	2.845238
no_of_people_in_HH_with_special_case	1.076412	1.055794	1.228571	1.112500	1.154762
HH_Income	1.870432	1.854077	2.085714	1.887500	1.821429
Unemployed	0.023256	0.034335	0.028571	0.025000	0.011905
Student	0.036545	0.038627	0.171429	0.087500	0.083333
Stay_at_home_parent	0.049834	0.017167	0.014286	0.025000	0.000000
Part_time_work	0.099668	0.072961	0.128571	0.137500	0.107143
Full_time_work	0.308970	0.437768	0.514286	0.512500	0.607143
Retired	0.428571	0.343348	0.085714	0.112500	0.178571
Employment_Other	0.053156	0.055794	0.057143	0.100000	0.011905
Hometown	-0.129568	-0.158798	-0.214286	-0.162500	-0.119048
gender_male	0.524917	0.527897	0.671429	0.625000	0.607143
Age	54.827243	51.227468	40.285714	41.487500	44.476190
Frequency_grocery_shopping	2.730897	2.480687	2.500000	2.600000	2.619048
Cooking_role	2.282392	2.287554	2.728571	2.612500	2.678571
portion_size_perception	0.109635	0.236052	0.257143	0.175000	0.285714
eating_quantity_perception	-0.196013	-0.025751	0.371429	0.050000	0.261905
Frequency_guests	2.152824	2.437768	2.385714	2.137500	2.380952
Frequency_eating_home	2.617940	2.553648	2.585714	2.375000	2.452381
eating_home_with_others	1.837010	1.909871	1.900000	1.937500	1.904762
Frequency_eating_work	1.242525	1.278970	1.314286	1.425000	1.440476
Frequency_cooking	4.681130	4.510730	4.442857	4.487500	4.333333
Frequency_ordering	1.475083	1.746781	2.200000	2.175000	2.071429

Cluster	0	1	2	3	4
Frequency_food_rescue_apps	1.388704	1.442060	1.728571	1.537500	1.488095
Frequency_eating_out	2.096346	2.244635	2.371429	2.400000	2.404762
Frequency_ordering_food_boxes	1.129568	1.158798	1.271429	1.350000	1.309524
weights	1.060782	0.970524	0.939201	0.921669	0.966273
MealPrepping	4.884477	4.602740	4.135593	4.388889	4.973684
CheckStock	6.000000	5.607306	4.881356	5.125000	5.407895
GroceryList	5.812274	5.611872	4.898305	5.333333	5.776316
ImpulseBuying	4.350181	4.589041	5.152542	5.000000	5.065789
LongerShelfLife	5.754513	5.652968	5.610169	5.569444	5.618421
Cooking_EstimateAmounts	5.971429	5.572864	4.446429	4.828125	5.164179
Cooking_UseTools	4.289796	4.035176	3.285714	3.734375	3.791045
Cooking_ShorterShelfLifeFirst	6.367347	6.120603	5.464286	5.312500	5.910448
Cooking_ReuseIngredientsLeftovers	6.269388	5.879397	4.785714	4.765625	5.388060
Cooking_Pleasing	4.836735	4.788945	4.410714	4.437500	4.388060
Cooking_ServeLargePortions	3.575510	4.015075	4.750000	4.562500	4.492537
Cooking_DecidePortionSize	5.567347	5.613065	5.267857	5.406250	5.820896
LastMinuteChanges	2.634551	2.815451	3.142857	2.850000	2.571429
AlwaysLeftovers	3.514950	3.884120	5.100000	4.812500	4.357143
FoodSpoiled	2.182724	2.841202	4.585714	4.162500	3.797619
ForgetLeftovers	2.624585	3.313305	5.214286	4.737500	4.345238
FollowDateMarking	2.870432	3.296137	4.100000	3.950000	3.190476
FreezeFood	5.501661	5.480687	5.242857	4.925000	5.440476
guests_knowledge_in_advance	6.324551	6.034653	5.666667	5.765625	5.986486
guests_strict_food	4.916667	4.955446	5.300000	4.921875	5.297297
guests_different_food_types	3.986842	4.163366	4.416667	4.109375	4.202703
guests_large_portions	4.250000	4.490099	4.900000	4.781250	4.824324
guests_desired_portion	5.311404	5.504950	4.966667	5.031250	5.540541
guests_give_leftovers	4.070175	3.965347	4.016667	3.515625	4.108108
guests_throw_leftovers	2.175439	2.381188	3.333333	3.359375	2.810811
HeadofFamily_Pleaser	5.348837	5.193133	4.971429	4.750000	4.916667
HeadofFamily_FoodAffluence	6.029900	5.849785	5.571429	5.550000	5.738095
headofFamily_0FW	6.328904	6.090129	5.228571	5.087500	5.547619
HeadofFamily_MonetaryM	6.425249	6.193133	5.357143	5.287500	5.726190
FamilyMember_FinishPlate	5.647841	5.386266	4.785714	4.737500	5.000000
Males_LargerPortion	3.627907	3.549356	3.657143	3.550000	3.297619
Females_Skinny	2.315615	2.154506	2.542857	2.400000	2.083333

Cluster	0	1	2	3	4
Parent_FoodAffluence	6.129568	5.987124	5.700000	5.637500	6.142857
Parent_FinishPlate_A	4.930233	5.141631	5.171429	5.287500	5.238095
Parent_FinishPlate_O	4.166113	4.326180	4.785714	4.625000	4.559524
Parent_FinishPlate_injSN	3.468439	3.309013	2.671429	3.137500	2.928571
Mothers_EatLeftovers	2.086379	1.905579	1.971429	2.250000	1.904762
Fathers_EatLeftovers	2.209302	1.974249	1.900000	2.412500	1.928571
Guest_FinishPlate1	5.112957	4.811159	4.542857	4.337500	4.559524
Host_FoodAffluence	4.518272	4.540773	4.871429	4.487500	4.642857
Cook_FreshIngr	5.222591	4.914163	4.771429	4.537500	4.630952
Cook_VariedMeal	5.112957	4.759657	4.528571	4.787500	4.964286
Cook_DateMarking	4.734219	4.763948	4.700000	4.750000	4.369048
PortionSize	3.770764	3.914163	4.042857	4.225000	3.728190
Guest_FinishPlate2	2.714286	2.699571	2.985714	3.137500	2.869048
FreshMealsvsLeftovers	4.345515	4.257511	3.985714	4.300000	3.904762
FinishPlate	3.528239	3.364807	2.757143	3.250000	3.035714
injSN_Stingy	2.631229	2.974249	2.871429	3.062500	2.690476
injSN_0FW	4.541528	4.184549	3.885714	3.850000	4.202381
descrSN_M_0FW	4.438538	4.377682	4.328571	3.987500	4.440476
descrSN_FW	4.029900	4.103004	3.971429	4.187500	4.202381
good_parent_importance	5.914141	5.858108	5.804878	5.812500	5.923077
good_cook_importance	4.836735	4.793970	4.821429	4.812500	5.089552
good_guest_importance	5.496324	5.270642	5.602941	5.281690	5.602410
good_host_importance	5.574561	5.430693	5.533333	5.312500	5.513514
good_head_of_house_importance	5.070922	5.026667	5.015385	4.813333	5.075949
FWattitude1	6.232563	5.965665	4.985714	4.925000	5.166667
FWattitude2	6.146179	5.815451	5.200000	5.112500	5.488095
AbilityGroceriesAmount	3.602888	4.210046	5.389831	4.625000	4.671053
AbilityCookingAmount	3.453061	4.035176	5.053571	4.578125	4.462687
AbilityCookingFoodSafety	4.959184	4.874372	4.339286	4.500000	4.880597
FWAttitude3	5.594684	5.210300	4.971429	4.912500	5.309524
Motivation_Monetary	2.857143	3.141631	3.200000	3.762500	3.428571
Motivation_Environmental	3.029900	3.210300	3.471429	3.950000	3.559524
Motivation_Needy	3.179402	3.283262	3.442857	3.637500	3.559524
Motivation_Planning	5.664452	5.536481	5.014286	5.412500	5.428571
chaotic_nature	5.724252	5.313305	4.614286	4.950000	5.202381

Figure B4: Food Waste Cluster Profiles in Spain in CS 1

Cluster	0	1	2	3	4
FW	-1.055556	-1.946429	-2.300000	-0.343750	-1.685714
Bread	1.685185	1.410714	1.150000	2.500000	1.542857
Fruit	2.277778	1.803571	1.400000	3.093750	1.657143
Potatos	1.462963	1.303571	1.100000	1.781250	1.314286
fish_and_meat_substitutes	1.333333	1.160714	1.050000	1.843750	1.171429
eggs	1.111111	1.053571	1.050000	1.343750	1.085714
FW_Freq_completely_unused_long_shelf_life	2.333333	1.357143	1.100000	2.593750	1.971429
FW_Freq_partly_used_long_shelf_life	2.222222	1.285714	1.150000	3.093750	2.028571
FW_Freq_completely_unused_perishable	3.296296	2.267857	1.150000	4.062500	2.000000
FW_Freq_partly_used_perishable	3.685185	2.553571	1.750000	4.937500	2.371429
FW_Freq_leftover_ingredients	3.444444	2.303571	1.400000	4.750000	2.342857
FW_Freq_meal_leftovers_on_plates	4.055556	2.750000	1.850000	5.500000	2.400000
FW_Freq_meal_leftovers_after_storage	3.833333	2.589286	1.650000	5.375000	2.485714
HH_size	3.277778	2.732143	2.700000	3.406250	2.942857
no_of_people_in_HH_with_special_case	1.018519	1.035714	1.000000	1.031250	1.000000
HH_Income	1.833333	1.678571	1.350000	1.781250	1.685714
Unemployed	0.037037	0.000000	0.050000	0.000000	0.114286
Student	0.037037	0.071429	0.100000	0.062500	0.057143
Stay_at_home_parent	0.000000	0.017857	0.000000	0.000000	0.000000
Part_time_work	0.111111	0.107143	0.100000	0.093750	0.142857
Full_time_work	0.796296	0.750000	0.600000	0.843750	0.657143
Retired	0.000000	0.035714	0.150000	0.000000	0.000000
Employment_Other	0.018519	0.017857	0.000000	0.000000	0.028571
Hometown	1.092593	1.482143	1.350000	1.562500	1.285714
gender_male	0.259259	0.357143	0.300000	0.406250	0.285714
Age	40.111111	44.089286	43.100000	42.781250	47.971429
Frequency_grocery_shopping	2.666667	2.678571	2.600000	2.500000	2.600000
Cooking_role	2.518519	2.071429	2.650000	2.593750	1.657143
portion_size_perception	0.333333	0.160714	0.250000	0.406250	0.257143
eating_quantity_perception	0.370370	0.303571	-0.200000	0.875000	-0.057143
Frequency_guests	2.592593	2.250000	2.860000	2.500000	2.485714
Frequency_eating_home	2.648148	2.714286	2.800000	2.625000	2.657143
eating_home_with_others	1.685185	1.625000	1.750000	1.687500	1.685714
Frequency_eating_work	1.907407	1.696429	1.300000	2.125000	1.800000
Frequency_cooking	4.574074	4.625000	4.600000	4.531250	4.714286
Frequency_ordering	2.129630	1.821429	1.950000	2.562500	2.114286

Cluster	0	1	2	3	4
Frequency_food_rescue_apps	1.722222	1.607143	1.650000	1.812500	1.800000
Frequency_eating_out	2.518519	2.482143	2.400000	2.781250	2.571429
Frequency_ordering_food_boxes	1.277778	1.142857	1.150000	1.468750	1.428571
weights	0.850552	0.963969	1.222404	0.997352	1.172503
MealPrepping	3.893617	4.703704	4.473684	4.032258	4.742857
CheckStock	5.446809	6.203704	6.210526	5.322581	5.800000
GroceryList	5.170213	5.870370	5.789474	5.451613	5.600000
ImpulseBuying	5.170213	4.851852	3.526316	5.483871	4.371429
LongerShelfLife	5.276596	5.611111	4.947368	4.935484	5.114286
Cooking_EstimateAmounts	4.580000	5.452830	5.473684	4.612903	5.514286
Cooking_UseTools	3.220000	3.264151	3.842105	3.322581	4.485714
Cooking_ShorterShelfLifeFirst	6.000000	6.415094	6.526316	5.709677	6.257143
Cooking_ReuseIngredientsLeftovers	5.800000	6.415094	6.368421	5.322581	5.971429
Cooking_Pleasing	4.060000	4.811321	4.263158	3.677419	4.542857
Cooking_ServeLargePortions	3.160000	3.169811	2.789474	4.032258	3.428571
Cooking_DecidePortionSize	5.040000	5.320755	5.105263	4.354839	4.800000
LastMinuteChanges	2.981481	2.750000	2.600000	3.343750	3.171429
AlwaysLeftovers	3.851852	3.714286	3.850000	4.437500	3.828571
FoodSpoiled	2.740741	2.089286	1.700000	4.062500	2.742857
ForgetLeftovers	3.333333	2.428571	2.000000	4.500000	2.771429
FollowDateMarking	3.037037	2.178571	1.850000	3.718750	3.085714
FreezeFood	5.370370	5.732143	5.100000	5.562500	5.485714
guests_knowledge_in_advance	5.759259	6.062500	5.588235	5.120000	5.966667
guests_strict_food	4.703704	5.125000	5.235294	4.360000	5.133333
guests_different_food_types	4.425926	4.604167	4.411765	4.800000	4.600000
guests_large_portions	4.666667	4.479167	4.235294	5.160000	4.666667
guests_desired_food	5.685185	5.812500	6.000000	5.240000	5.366667
guests_give_leftovers	3.259259	2.791667	3.235294	3.680000	3.666667
guests_throw_leftovers	2.092593	2.000000	1.705882	2.520000	2.233333
HeadofFamily_Pleaser	4.333333	4.446429	3.950000	4.000000	4.114286
HeadofFamily_FoodAffluence	5.907407	6.071429	5.500000	5.656250	5.971429
headofFamily_0FW	5.907407	6.482143	6.750000	6.750000	6.314286
HeadofFamily_MonetaryM	6.129630	6.428571	6.400000	6.687500	6.285714
FamilyMember_FinishPlate	4.740741	5.196429	5.150000	5.062500	5.400000
Males_LargerPortion	2.685185	2.660714	1.500000	2.781250	2.800000
Females_Skinny	1.574074	1.642857	1.250000	1.812500	1.971429

Cluster	0	1	2	3	4
Parent_FoodAffluence	5.648148	5.607143	5.300000	5.406250	5.800000
Parent_FinishPlate_A	5.407407	5.678571	5.400000	5.406250	6.285714
Parent_FinishPlate_O	4.666667	4.928571	4.400000	4.718750	4.571429
Parent_FinishPlate_injSN	3.574074	3.285714	3.500000	3.625000	3.942857
Mothers_EatLeftovers	1.777778	1.875000	1.200000	1.843750	2.142857
Fathers_EatLeftovers	1.796296	1.946429	1.200000	1.875000	2.257143
Guest_FinishPlate1	4.962963	4.875000	5.000000	5.031250	5.114286
Host_FoodAffluence	3.685185	4.214286	3.250000	4.187500	3.571429
Cook_FreshIngr	4.314815	4.928571	4.400000	4.781250	4.714286
Cook_VariedMeal	4.611111	5.160714	4.800000	4.843750	4.657143
Cook_DateMarking	5.185185	5.142857	5.150000	5.781250	5.200000
PortionSize	3.537037	3.250000	2.500000	3.625000	2.800000
FreshMealsvsLeftovers	3.462963	3.357143	2.300000	4.125000	4.085714
FinishPlate	3.407407	3.285714	3.300000	3.312500	3.914286
injSN_Stingy	2.870370	2.946429	1.800000	2.468750	3.028571
injSN_0FW	4.685185	4.785714	4.650000	4.906250	5.514286
descrSN_M_0FW	4.537037	4.946429	5.150000	4.718750	5.485714
descrSN_FW	3.944444	3.785714	4.100000	3.656250	3.542857
good_parent_importance	5.629630	5.642857	4.714286	5.960000	6.100000
good_cook_importance	5.020000	4.905660	5.000000	4.903226	5.285714
good_guest_importance	5.759259	5.714286	5.650000	5.750000	5.794118
good_host_importance	6.055556	6.145833	5.823529	6.160000	6.066667
good_head_of_house_importance	5.230769	5.436364	5.500000	5.312500	5.514286
FWattitude1	5.962963	6.607143	6.650000	5.718750	6.200000
FWattitude2	6.296296	6.767857	6.550000	6.093750	6.314286
AbilityGroceriesAmount	3.703704	3.375000	3.650000	5.125000	3.257143
AbilityCookingAmount	3.944444	3.232143	3.200000	4.968750	3.657143
AbilityCookingFoodSafety	4.462963	4.517857	4.850000	4.437500	4.942857
FWattitude3	5.833333	6.232143	5.800000	5.875000	6.771429
Motivation_Monetary	3.629630	3.321429	3.100000	3.625000	4.085714
Motivation_Environmental	3.592593	3.107143	3.250000	3.562500	4.057143
Motivation_Needy	3.759259	3.375000	3.800000	3.656250	4.457143
Motivation_Planning	5.351852	5.696429	5.750000	5.312500	5.542857
chaotic_nature	5.388889	5.909091	6.050000	5.593750	5.885714

Statistical Validation of Clustering

The most prominent test to confirm the difference-in-means between the cluster demographics is ANOVA, but to perform ANOVA, the variable of interest should be continuous, otherwise it is likely to violate the assumptions of normality and homogeneity of variances. When dealing with categorical data and multiple groups, non-parametric tests like the **Kruskal-Wallis** test can be used to determine if there are **significant differences between the groups**.

The main difference that distinguishes this non-parametric test from ANOVA, is that instead of sample means, the sample medians are compared. Medians are in general less sensitive to outliers than means. In the following table (Table B1), if the p-value is less than the chosen threshold, the null hypothesis is rejected, hence there are significant differences between at least two of the clusters for the respective variable.

Table B1: Statistical significance of difference in medians between demographics of the food waste clusters in CS 1

	Belgium	Spain
Household size	0.000***	0.009**
Number of people in HH with special case	0.019*	0.736
Household income	0.519	0.088+
Unemployed	0.843	0.047*
Student	0.000***	0.881
Stay at home parent	0.062+	0.641
Part-time worker	0.427	0.975
Full-time worker	0.000***	0.198
Retired	0.000***	0.003**
Other employment	0.187	0.865
Hometown	0.996	0.822
Male	0.088+	0.631
Age	0.000***	0.022*

Significant at $p < .001$: ***, $p < .01$: **, $p < .05$: *, $p < 0.1$: +

After finding the demographics for which there is a statistically significant difference between the clusters, the next step was to identify which pairs of clusters were causing this. The analysis was done using Dunn's test for pairwise comparisons and Bonferroni correction for p-value adjustments, to account for the increased risk of Type I errors due to multiple comparisons. Table B2 breaks down the pairwise relationships between the clusters and shows the attributes that differentiate each pair.

Table B2: Statistically significant differentiating factors between pairs of clusters in CS1

	Belgium				
	Thoughtful Planner Couples	Welcoming Homemakers	Carefree Consumers	Relaxed Urban Consumers	Insecure Urban Professionals
Thoughtful Planner Couples					
Welcoming Homemakers	1. Full Time Worker				
Carefree Consumers	1. Household Size	1. Household Size			

	Belgium				
	2. Number of people in HH with special case 3. Student 4. Full Time Worker 5. Retired 6. Age	2. Number of people in HH with special case 3. Student 4. Retired 5. Age			
Relaxed Urban Consumers	1. Household Size 2. Full Time Worker 3. Retired 4. Age	1. Household Size 2. Retired 3. Age			
Insecure Urban Professionals	1. Household Size 2. Full Time Worker 3. Retired 4. Age	1. Household Size 2. Age			

	Spain				
	Spontaneous Urban Consumers	Thoughtful Planners	Resourceful Waste Minimizers	Carefree Full Timers	Family Oriented Cooks
Spontaneous Urban Consumers					
Thoughtful Planners					
Resourceful Waste Minimizers	1. Household Income 2. Retired				
Carefree Full Timers		1. Household Size	1. Retired		
Family Oriented Cooks	1. Age	1. Unemployed	1. Retired		

Figure B5: Elbow method to find optimal number of clusters in CS 3
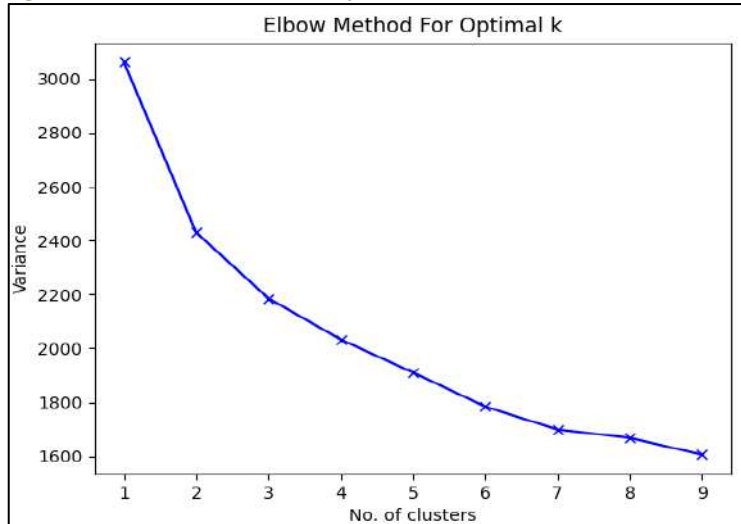
Tables B3 and B4 follow the same logic for the statistical validation of clustering as Tables B1 and B2 for Case Study 1.

Table B3: Statistical significance of difference in median between demographics of the food waste clusters in CS 3

Demographics	p-value
Gender: Male	0.000***
Gender: Female	0.000***
Gender: Prefer not to say	0.361
Income source: Wages or salary	0.000***
Income source: Farming	0.016*
Income source: Investment, savings, insurance, or property	0.004**
Income source: Unemployment/redundancy benefit	0.454
Income source: Self-employment (excluding farming)	0.340
Income source: Pension	0.000***
Income source: Any other social benefits or grants	0.019*
Income source: Other sources	0.668
Education: No education	0.249
Education: Primary education	0.005**
Education: Secondary education	0.007**
Education: Undergraduate	0.000***
Education: Postgraduate	0.000***
Education: Other	0.047*
Slovenian nationality	0.009**
Family income	0.095+
Household size	0.000***
Year of birth	0.000***

Significant at p < .001: ***, p < .01: **, p < .05: *, p < 0.1: +

Figure B6: Food Waste Cluster Profiles for CS 3

Cluster	0	1	2	3	4	5
EAT_OUT_FREQ	3.642857	2.072993	2.267974	3.070312	3.112676	1.838710
FOOD_WASTE_ORDER_AHEAD	2.814286	2.883212	2.405229	2.859375	2.450704	2.881720
ORDER_AHEAD_REASON_1	0.142857	0.306569	0.732026	0.765625	0.154930	0.010753
ORDER_AHEAD_REASON_2	0.185714	0.313869	0.856209	0.914062	0.887324	0.247312
ORDER_AHEAD_REASON_3	0.171429	0.467153	0.954248	0.953125	0.352113	0.086022
ORDER_AHEAD_REASON_4	0.861905	0.284672	0.869281	0.781250	0.098592	1.000000
ORDERING_IMPORTANCE_1	3.573684	2.841121	4.142857	4.250000	3.450000	3.348837
ORDERING_IMPORTANCE_2	4.005128	3.827273	4.362963	4.336538	4.015152	3.853933
ORDERING_IMPORTANCE_3	4.237624	4.677165	4.789855	4.737864	4.542857	4.195652
ORDERING_IMPORTANCE_4	3.791444	3.666667	4.285714	4.446809	3.625866	3.658537
ORDERING_IMPORTANCE_5	3.411043	3.669643	4.278689	4.336957	3.730159	3.101449
RESTAURANT_ATTITUDES_1	2.513369	1.884615	1.876812	2.181818	1.731343	2.441860
RESTAURANT_ATTITUDES_2	2.484375	2.315385	3.151515	3.137255	3.181818	2.261364
RESTAURANT_ATTITUDES_3	2.387435	2.384000	3.114504	3.262136	3.063492	2.159091
RESTAURANT_ATTITUDES_4	2.658065	2.932039	2.857143	3.065217	2.728814	2.710526
RESTAURANT_ATTITUDES_5	3.995098	3.739496	3.514173	4.161616	3.803030	3.910112
RESTAURANT_ATTITUDES_6	2.121693	1.932773	1.808000	1.780000	2.066667	2.209302
RESTAURANT_ATTITUDES_7	2.865169	2.491379	3.661157	3.585106	3.213115	2.729412
RESTAURANT_ATTITUDES_8	3.679558	3.240964	3.378641	3.473684	3.020833	3.666667
RESTAURANT_ATTITUDES_9	3.752809	3.621951	3.423077	3.543478	3.136364	3.750000
RESTAURANT_ATTITUDES_10	2.566879	2.542169	2.564356	2.472527	2.886364	2.520548
RESTAURANT_ATTITUDES_11	2.359551	2.634146	3.401961	3.365854	3.217391	2.273810
RESTAURANT_ATTITUDES_12	3.140845	3.518987	3.575758	3.600000	3.431818	3.203125
RESTAURANT_ATTITUDES_13	2.872483	2.382716	3.712963	3.597561	3.022727	2.803030
PORTION_SIZE_REDUCTION_ATTITUDES_1	3.086667	3.032787	3.782258	3.591837	3.268657	2.970588
PORTION_SIZE_REDUCTION_ATTITUDES_2	3.466799	3.628319	4.416000	4.350000	4.000000	3.500000
PORTION_SIZE_REDUCTION_ATTITUDES_3	3.287582	3.534483	2.635659	2.909091	3.258621	3.184615
SMALL_PORTION_REACTION_1	3.375723	2.946908	3.820312	3.693069	3.442623	3.390244
SMALL_PORTION_REACTION_2	2.161290	1.726562	2.030303	1.930693	1.820896	2.209302
SMALL_PORTION_REACTION_3	2.335135	2.024000	2.557252	2.216495	2.353846	2.348837
SMALL_PORTION_REACTION_4	2.922078	3.376147	3.078740	2.710000	2.819672	2.972973
FINISH_PLATE_ATTITUDES_1	3.561856	3.524194	3.606061	3.594340	3.446154	3.297619
FINISH_PLATE_ATTITUDES_2	3.169399	3.352459	3.286822	3.224299	3.373134	2.888889

Cluster	0	1	2	3	4	5
FINISH_PLATE_ATTITUDES_3	3.238579	2.669421	2.913386	2.542857	3.292308	2.927711
FINISH_PLATE_ATTITUDES_4	2.829032	2.190083	2.238095	1.959596	2.546875	2.365854
FINISH_PLATE_ATTITUDES_5	3.212121	3.886957	4.303030	4.230000	3.984615	2.907895
NOT_FINISH_PLATE_ATTITUDES_1	3.893939	3.714286	3.735294	3.990291	3.312500	3.847826
NOT_FINISH_PLATE_ATTITUDES_2	3.994898	3.902439	3.977099	4.275510	3.923077	3.966667
NOT_FINISH_PLATE_ATTITUDES_3	2.427835	2.388889	2.550388	2.500000	2.218760	2.220690
NOT_FINISH_PLATE_ATTITUDES_4	2.327778	1.952381	1.909091	1.938144	1.833939	2.271605
NOT_FINISH_PLATE_ATTITUDES_5	2.020619	1.672000	1.952756	2.098901	1.921875	1.953488
NOT_FINISH_PLATE_ATTITUDES_6	2.340426	2.371901	2.311475	2.360465	2.442623	2.197674
NOT_FINISH_PLATE_ATTITUDES_7	3.763736	3.570175	3.048780	3.333333	3.469719	3.611765
NOT_FINISH_PLATE_ATTITUDES_8	1.942857	1.621053	1.793103	1.738636	1.770833	1.939024
NOT_FINISH_PLATE_ATTITUDES_9	2.221519	1.780220	1.745763	1.829545	1.760000	2.039474
LEFTOVERS_AMOUNT	4.276190	4.189781	4.013072	3.851563	4.169014	4.150538
TAKE_HOME_MEAL	2.233333	1.824818	1.816993	1.781250	1.745479	1.709677
LEFTOVERS_MOTIVES_1	3.505376	2.838710	3.649485	3.410256	3.132075	3.662162
LEFTOVERS_MOTIVES_2	3.712766	4.145833	4.269231	4.207317	4.100000	3.322034
LEFTOVERS_MOTIVES_3	4.200000	4.281250	4.438776	4.512500	4.087719	4.157895
LEFTOVERS_MOTIVES_4	2.521277	2.063158	2.178947	2.275000	2.000000	2.540541
LEFTOVERS_MOTIVES_5	3.978261	3.483146	3.479167	3.309859	3.563636	4.106667
SOLO_DINING_EFFECT_1	3.079710	2.932039	3.323810	3.320988	2.946429	2.904762
SOLO_DINING_EFFECT_2	2.961538	3.011236	3.072917	3.109756	2.812500	2.933333
SOLO_DINING_EFFECT_3	3.075188	3.036585	3.290000	3.140845	3.187500	2.970149
SOLO_DINING_EFFECT_4	3.037594	2.894118	2.968750	2.902778	2.893617	2.984615
DISCOURAGEMENT_REASONS_1	4.107843	3.031746	4.237037	4.339450	3.730159	3.943820
DISCOURAGEMENT_REASONS_2	3.958763	2.943580	3.890511	4.009434	3.135593	3.943182
DISCOURAGEMENT_REASONS_3	3.744318	3.271186	4.362963	4.298077	3.491803	3.452055
DISCOURAGEMENT_REASONS_4	2.790698	2.318966	2.701613	2.867347	2.839286	2.833333
DISCOURAGEMENT_REASONS_5	2.304094	2.120690	2.099237	1.929293	2.622642	2.500000
DISCOURAGEMENT_REASONS_6	4.586387	4.507937	4.688000	4.643564	4.462687	4.564706
YEAR_OF_BIRTH	1976.433333	1980.328467	1976.921569	1981.828125	1980.338028	1972.473118
HOUSEHOLD_SIZE	2.847619	3.240876	3.189542	2.953125	2.788732	2.989247
FAMILY_INCOME	2.395238	2.598540	2.457516	2.601562	2.436620	2.387097
nationality_Slovenian	0.995238	0.985401	0.993464	0.992188	0.943662	1.000000

Cluster	0	1	2	3	4	5
eat_alone	0.314286	0.014599	0.058824	0.257812	0.169014	0.000000
eat_with_family	0.028571	0.839416	0.758170	0.085938	0.126761	1.000000
eat_with_friends_colleagues	0.657143	0.145985	0.183007	0.656250	0.704225	0.000000
leftovers_glad_not_waste	0.885714	0.824818	0.849673	0.867188	0.788732	0.892473
leftovers_do_not_care	0.090476	0.138686	0.045752	0.031250	0.098592	0.032258
leftovers_person_poor	0.014286	0.007299	0.019608	0.007812	0.028169	0.043011
leftovers_acceptable_food_on_plate	0.009524	0.029197	0.084967	0.093750	0.084507	0.032258
not_take_home_saves_little_money	0.804762	0.204380	0.660131	0.625000	0.140845	0.946237
not_take_home_food_not_good	0.147619	0.759124	0.300654	0.351562	0.802817	0.000000
not_take_home_leftovers_unhealthy	0.019048	0.000000	0.026144	0.007812	0.000000	0.021505
not_take_home_not_allowed	0.014286	0.036496	0.013072	0.007812	0.056338	0.010753
not_take_home_cook_better_at_home	0.004762	0.000000	0.000000	0.007812	0.000000	0.010753
not_take_home_look_poor	0.009524	0.000000	0.000000	0.000000	0.000000	0.010753
gender_male	0.619048	0.423358	0.450980	0.421875	0.549296	0.602151
gender_female	0.376190	0.576642	0.549020	0.578125	0.436620	0.397849
gender_prefer_not_say	0.004762	0.000000	0.000000	0.000000	0.014085	0.000000
income_source_benefits	0.000000	0.007299	0.052288	0.031250	0.028169	0.021505
income_source_farming	0.042857	0.036496	0.006536	0.046875	0.014085	0.096774
income_source_investment_savings_insurance_property	0.000000	0.007299	0.039216	0.039062	0.000000	0.000000
income_other_sources	0.014286	0.007299	0.026144	0.015625	0.000000	0.010753
income_source_self_employment	0.047619	0.051095	0.026144	0.023438	0.014085	0.010753
income_source_pension	0.214286	0.065693	0.183007	0.125000	0.084507	0.290323
income_source_unemployment	0.033333	0.036496	0.052288	0.015625	0.042254	0.010753
income_source_wages_or_salaries	0.647619	0.788321	0.614379	0.703125	0.816901	0.559140
education_no	0.014286	0.000000	0.000000	0.000000	0.000000	0.010753
education_other	0.028571	0.007299	0.000000	0.015625	0.014085	0.053763
education_post_graduate	0.147619	0.197080	0.045752	0.062500	0.140845	0.053763
education_primary_education	0.133333	0.051095	0.143791	0.054688	0.070423	0.172043
education_secondary_education	0.452381	0.321168	0.509804	0.445312	0.394366	0.548387
education_undergraduate	0.223810	0.416058	0.300654	0.421875	0.380282	0.161290
PAY_FOR_CONTAINOR_-99 - Missing	0.485714	0.182482	0.209150	0.210938	0.056338	0.172043
PAY_FOR_CONTAINOR_I don't bring food home	0.004762	0.000000	0.000000	0.000000	0.000000	0.000000
PAY_FOR_CONTAINOR_I don't know	0.057143	0.124088	0.045752	0.062500	0.197183	0.043011
PAY_FOR_CONTAINOR_No.	0.033333	0.094891	0.045752	0.015625	0.154930	0.129032
PAY_FOR_CONTAINOR_Yes.	0.419048	0.598540	0.699346	0.710938	0.591549	0.655914

Table B4: Statistically significant differentiating factors between pairs of clusters in CS 3

	Frequent Diners	Discerning Customers	Opportunity takers	Moderate Eaters	Deal Hunters	Efficient Retirees
Frequent Diners						
Discerning Customers	1. Gender 2. Income source: Pension 3.Education: Undergraduate 4.Household size					
Opportunity takers	1. Gender 2. Income Source: - Benefits - Investments, savings, insurance, or property 3. Education: Postgraduate 4. Household size	1. Income source: Wages or salary 2. Education: Postgraduate Secondary education				
Moderate Eaters	1. Gender 2. Education: Undergraduate 3. Year of birth	1. Education: Postgraduate	1. Year of birth			
Deal Hunters	1. Slovenian nationality		1. Income source: Wages or salary 2. Slovenian nationality	1. Slovenian nationality		
Efficient Retirees		1. Income source: - Pension - Wages or salary 2. Education - Postgraduate - Primary education - Secondary education Undergraduate 3. Year of birth	1. Income source: Farming 2.Education: Other	1. Income source: Pension 2. Education: - Primary education - Undergraduate 3. Year of birth	1. Income source: - Pension - Wages or salary 2. Education: Undergraduate 3. Slovenian nationality 4. Year of birth	

Figure B7: Elbow method to find optimal number of clusters in CS 6
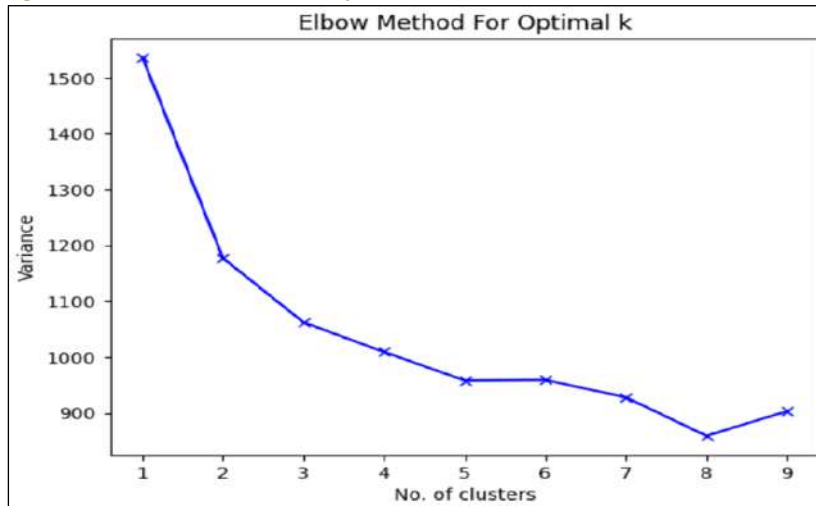
Table B5: Statistical significance of difference in medians between demographics of the food waste clusters in CS 6

Demographics	p-value
Gender: Female	0.012*
Gender: Rather not say	0.856
Gender Male	0.008**
Year of birth	0.000***
Residence location	0.029*
Number of household members	0.656
Household income	0.650
Income change within the last 3 years	0.230
Education	0.417
Country: Estonia	0.826
Country: Spain	0.000***
Country: Greece	0.364
Country: Hungary	0.024*
Country: Netherlands	0.000*

Significant at p < .001: ***, p < .01: **, p < .05: *, p < 0.1: +

Table B6: Statistically significant differentiating factors between pairs of clusters in CS 6

	Eco-Affluent Individuals	Urban Over-buyers	Conscious Consumers	Status-Driven Wasters	Ethical Moderates
Eco-Affluent Individuals					
Urban Over-buyers	1. Residence location				
Conscious Consumers	1. Year of birth				
Status-Driven Wasters	1. Gender 2. Year of birth 3. Country: Spain		1. Gender 2. Country: Netherlands		

Horizon Europe

	Eco-Affluent Individuals	Urban Over-buyers	Conscious Consumers	Status-Driven Wasters	Ethical Moderates
	4. Country: Netherlands				
Ethical Moderates					

Figure B8: Food Waste Cluster Profiles in CS 6

10.3   Appendix C: Factor Analysis and Structural Equation Modelling (SEM)

This Appendix contains the following:

- **Selection of Number of Factors in CS 1 (Figure C1):** Eigenvalues plots were utilized to determine the optimal number of factors for the EFA model, providing insights into the underlying structure of the data.
- **Assessment of data suitability for EFA in CS 1:** This section includes descriptions of Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) test, which were employed to evaluate the suitability of the dataset for conducting EFA.
- **Results of EFA in CS 1 (Tables C1-C3):** Detailed tables presenting the results of the EFA, along with explanations of Cronbach's alpha values, which assess the internal consistency reliability of the derived factors.
- **Adjustments and Results of CFA in CS 1 (Tables C4 and CS):** Detailed tables presenting the results of the CFA models, along with explanation of the modifications made to the model to increase model fit, as well as the final values of the evaluation metrics.
- **Adjustments and Results of SEM in CS 1 (Tables C6 and C7):** Detailed tables presenting the results of the SEM models, along with explanation of the modifications made to the model to increase model fit (or even to make model fitting possible in the presence of identification problems), as well as the final values of the evaluation metrics.
- **Selection of Number of Factors in CS 6(Figure C2):** Eigenvalues plot was utilized to determine the optimal number of factors for the EFA model, providing insights into the underlying structure of the data.
- **Assessment of data suitability for EFA in CS 6:** This section includes descriptions of Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) test, which were employed to evaluate the suitability of the dataset for conducting EFA.
- **Results of EFA in CS 6 (Table C8):** Detailed table presenting the results of the EFA, along with explanations of Cronbach's alpha values, which assess the internal consistency reliability of the derived factors.
- **Adjustments and Results of CFA in CS 6 (Table C9):** Detailed table presenting the results of the CFA model, along with explanation of the modifications made to the model to increase model fit, as well as the final values of the evaluation metrics.
- **Adjustments and Results of SEM in CS 6 (Table C10):** Detailed table presenting the results of the SEM models, along with explanation of the modifications made to the model to increase model fit (or even to make model fitting possible in the presence of identification problems), as well as the final values of the evaluation metrics.

Software/Programming language

Explanatory factor analysis was conducted with Python's package *"factor_analyzer".* Both CFA and Structural Equation Models were estimated with the *"lavaan"* package in R. The reason for shifting from Python to R for this part of the analysis is the flexibility that the lavaan package gives in a) customizing the model and optimizing the parameters, b) building complex specifications with simple syntax and c) visualizing the results.

Explanatory Factor Analysis for CS 1

Figure C1: Eigenvalues for EFA number of factors selection for Belgium (left) and Spain (right) in CS 1
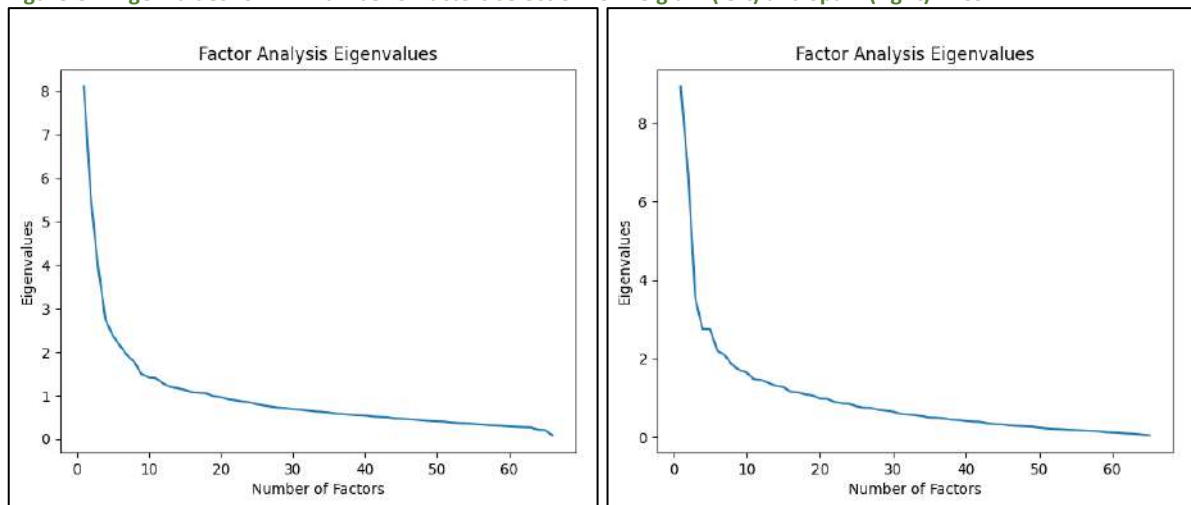
To assess if our data are suitable for conducting factor analysis, we are evaluating two metrics: **Bartlett's test of sphericity** and the **Kaiser-Meyer-Olkin (KMO) test**. For both tests to converge, missing values had first to be removed. Bartlett's test assesses whether the observed variables in the dataset are interrelated and in our case is equal to 9536 (*p=0.00)* for Belgium and 4319 (p=0.00) for Spain*,* supporting the suitability for factor analysis. KMO that tests for sampling adequacy is equal to 0.8 for Belgium, also indicating excellent suitability for factor analysis. For Spain a KMO equal to 0.4 suggests that the sample size might be smaller than required for performing EFA, however since the nature of the analysis at this point is exploratory and comparative between the two subsamples it was decided to proceed with caution on interpreting the results.

The latent constructs' reliability for the ten factors ranged between 0.68-0.85 for Belgium (Table C1) and 0.67-0.88 for Spain (Table C2), thus all the values are above the recommended threshold of 0.6 that is encountered in the literature (Nunnally, 1978). These high Cronbach's alpha values suggest a good internal consistency of the sample data, for all the 10 factors that were generated.

The threshold for factor loadings was set on 0.40 as suggested by Hair et. al. (2006). Therefore, all the items with a lower loading are not presented in the results. The variables that are excluded with this approach are 19 out of 66 and 20 out of 66 for Spain (Table C3).

Table C1: Summary of EFA results for Belgium in CS 1

Factor	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Factor Loading	Reliability Analysis (Cronbach's α)
Food Waste Attitudes	CB3										0.51	0.85
	CB4										0.60	
	FR3										0.61	
	FR4										0.61	
	AA1										0.69	
	AA2										0.59	
	M1										0.47	0.83
Ability in shopping, cooking and eating		SP4									0.43	
		CB6									0.53	
		AA3									0.75	
		AA4									0.71	
		EB2									0.51	
		EB3									0.56	
		EB4									0.56	
Finishing Plate			CB6								0.57	0.78
			FR1								0.64	
			HG1								0.58	
			HG9								0.58	
Good Provider				FR1							0.46	0.71
				HG3							0.56	
				HG4							0.55	
				HG5							0.59	
				HG8							0.54	
Good Eating Behaviour					FR12						0.90	0.77
					FR13						0.88	
					HG7						0.41	
Planning and Organization						SP1					0.65	0.76
						SP2					0.59	
						SP3					0.72	
						CB1					0.45	
						CB2					0.44	
						M5					0.44	
Public Picture							PP1				0.53	0.81
							PP2				0.54	
							PP3				0.69	
							PP4				0.58	
							PP5				0.66	
Hosting Affluence								HG2			0.43	0.71
								HB2			0.67	
								HB3			0.52	
								HB4			0.61	
Food Waste Motives									M2		0.57	0.78
									M3		0.75	
									M4		0.73	
Good Family Provider										FR9	0.45	0.68
										FR8	0.48	

Table C2: Summary of EFA results for Spain in CS 1

Factor	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Factor Loading	Reliability Analysis (Cronbach's α)
Head of Family	FR2										0.68	0.86
	FR3										0.86	
	FR4										0.81	
	FR4										0.42	
	AA1										0.47	
	AA2										0.42	
	PP5										0.47	0.79
Gender Norms		FR6									0.44	
		FR7									0.61	
		FR12									0.81	
		FR13									0.84	
		SN1									0.57	
Good Cook and Portion Size			CB6								0.41	0.80
			FR1								0.49	
			HG1								0.60	
			HG2								0.60	
			HG3								0.60	
			HG6								0.54	
			HG8								0.41	
			HB4								0.40	
Ability in shopping, cooking and eating				SP4							0.45	0.77
				CB6							0.43	
				AA3							0.74	
				AA4							0.71	
				EB2							0.51	
				EB3							0.41	
Planning and Organization					SP1						0.61	0.76
					SP2						0.68	
					SP3						0.60	
					CB1						0.53	
					CB3						0.41	
					M5						0.45	
Cooking Behaviour						CB3					0.42	0.67
						CB4					0.53	
						HB2					0.44	
Public Picture							PP1				0.58	0.82
							PP2				0.43	
							PP3				0.69	
							PP4				0.80	
							PP5				0.42	
Food Waste Motives								M2			0.73	0.88
								M3			0.90	
								M4			0.83	
Finishing Plate									FR5		0.68	0.81
									FR11		0.61	
									HG1		0.70	
									HG9		0.66	
Parent Norms										FR9	0.42	0.77
										FR10	0.48	

Table C3: Variables that are excluded from the factors in EFA in CS 1

Only Belgium	Only Spain	Spain and Belgium
Males_LargerPortion	Cooking_UseTools	LongerShelfLife
Females_Skinny	Cooking_Decide_PortionSize	Cooking_Pleasing
Parent_FinishPlate_A	Parent_FoodAffluence	injSN_OFW
Parent_FinishPlate_O	Cook_DateMarking	decrSN_M_0FW
PortionSize	FWAttitude3	decrSN_FW
injSN_Stingy	ForgetLeftovers	AbilityCookingFoodSafety
	guests_different_food_types	LastMinuteChanges
		FollowDateMarking
		FreezeFood
		guests_knowledge_in_advance
		guests_desired_portion
		guests_give_leftovers
		guests_throw_leftovers

Confirmatory Factor Analysis for CS1

In the initial findings of CFA, the model fit metrics were not satisfactory with respect to the recommended thresholds. As a result, we followed the following steps to improve the model:

- We reviewed the Modification Indices (MI), and we allowed variables with high values (>10) to correlate.
- For the Belgian subsample, we removed the three measurement items with the lowest loadings: MotivationPlanning, Cooking_EstimateAmounts and Cooking_UseTools. All these items were previously assigned to the Planning and Organization factor.

After these changes, the model for **Belgium** was improved from a χ^2 value of 2206.934 (df=994 and p=0.000) to 1310.706 (df=804 and p=0.000). The RMSEA improved from 0.063 to 0.043, the CFI from 0.796 to 0.912 and the TLI from 0.776 to 0.901. The standardized loadings of the measurement items are presented in Table C4, along with the construct composite reliability measures (C.R). C.R is above the recommended threshold of 0.6 for all factors apart from the good eating behaviour factor (0.52) and the Planning and Organization factor (0.57). All the factor loadings are statistically significant at the 0.001 level and range from 0.409 to 0.925, which is above the recommended threshold of 0.4.

The model for **Spain** was improved from a χ^2 value of 1592.851 (df=897 and p=0.000) to 1446.432 (df=887 and p=0.000). The RMSEA improved from 0.094 to 0.085, the CFI from 0.713 to 0.769 and the TLI from 0.683 to 0.742. The standardized loadings of the measurement items are presented in Table C5, along with the construct composite reliability measures (C.R). C.R is above the recommended threshold of 0.6 for all. Most of the factor loadings are statistically significant at the 0.001 level and are above the recommended threshold of 0.4, with the exception of Cooking_ServeLargePortions, Cooking_ShorterShelfLifeFirst and FreshMealvsLeftovers. The RMSEA value of 0.085 indicates a reasonable fit, though it suggests that the model may have some room for improvement. The same applies for the CFI and CLI values.

Table C4: Summary of first-order CFA results for Belgium in CS 1

Items	Standardized Loadings	Factor	Composite Reliability (C.R)
Cooking_ShortShelfLifeFirst	0.609***		
Cooking_ReuseIngredientsLeftovers	0.649***		
headofFamily_0FW	0.665***		
HeadofFamily_MonetaryM	0.757***	Food Waste Attitudes	0.78
FWattitude1	0.798***		
FWattitude2	0.634***		
FWattitude3	0.454***		
ImpulseBuying	0.409***		
Cooking_ServeLargePortions	0.661***		
AbilityGroceriesAmount	0.592***	Ability in shopping, cooking and eating	0.76
AbilityCookingAmount	0.565***		
AlwaysLeftovers	0.661***		
FoodSpoiled	0.716***		
ForgetLeftovers	0.636***		
FamilyMember_FinishPlate	0.554***		
Parent_FinishPlate_injSN	0.608***	Finishing Plate	0.72
Guest_FinishPlate1	0.623***		
FinishPlate	0.865***		
HeadofFamily_Pleaser	0.549***		
Cook_FreshIngr	0.619***		
Cook_VariedMeal	0.723***	Good Provider	0.71
Cook_DateMarking	0.449***		
FreshMealvsLeftovers	0.554***		
Mothers_EatLeftovers	0.541***		
Fathers_EatLeftovers	0.544***	Good Eating Behaviour	0.52
Guest_FInishPlate2	0.710***		
MealPrepping	0.424***		
CheckStock	0.925***	Planning and Organization	0.57
GroceryList	0.549***		
Good_parent_importance	0.616***		
Good_cook_importance	0.618***		
Good_guest_importance	0.744***	Public Picture	0.82
Good_host_importance	0.806***		
Good_head_of_house_importance	0.681***		
Host_FoodAffluence	0.513***		
Guests_strict_food	0.669***		
Guests_different_food_types	0.676***	Hosting Affluence	0.75
Guests_large_portions	0.623***		
Motivation_Monetary	0.641***		
Motivation_Environmental	0.835***	Food Waste Motives	0.79
Motivation_Needy	0.759***		
HeadofFamily_FoodAffluence	0.750***	Good Family Provider	0.65
Parent_FoodAffluence	0.635***		

Standardized loadings, significant p < .001 coefficients: ***, p < .01 coefficients: **, p < .05 coefficients: *

x^2= 1310.706, df = 804, p <.001, RMSEA = 0.043, CFI = 0.912, TLI = 0.901

Table C5: Summary of first-order CFA results for Spain in CS 1

Items	Standardized Loadings	Factor	Composite Reliability (C.R)
HeadofFamily_FoodAffluence	0.806***		
HeadofFamily_0FW	0.940***		
HeadofFamily_MonetaryM	0.881***	Head of Family	0.86
FWattitude1	0.470***		
FWattitude2	0.657***		
Good_head_of_house_importance	0.446***		
Males_LargerPortion	0.422***		
Females_Skinny	0.481***		
Mothers_EatLeftovers	0.953***	Gender Norms	0.78
Fathers_EatLeftovers	0.981***		
injSN_Stingy	0.469***		
Cooking_ServeLargePortions	0.388***		
HeadofFamily_Pleaser	0.554**		
Host_FoodAffluence	0.709**		
Cook_FreshIngr	0.785**	Good Cook and Portion Size	0.81
Cook_VariedMeal	0.689**		
PortionSize	0.651**		
FreshMealvsLeftovers	0.335*		
Guests_large_portions	0.525**		
Impulse_Buying	0.379***		
Cooking_ServeLargePortions	0.229		
Ability_GroceriesAmount	0.906***	Ability in shopping, cooking and eating	0.73
Ability_CookingAmount	0.727***		
AlwaysLeftovers	0.422**		
FoodSpoiled	0.547***		
MealPrepping	0.623***		
CheckStock	0.813***		
GroceryList	0.630***	Planning and Organization	0.77
Cookling_EstimateAmounts	0.638***		
Cooking_ShorterShelfLifeFirst	0.110		
MotivationPlanning	0.458***		
Cooking_ShorterShelfLifeFirst	0.720***		
Cooking_ReusedIngredientsLeftovers	0.903***	Cooking Behaviour	0.71
Guests_strict_food	0.467***		
Good_parent_importance	0.806***		
Good_cook_importance	0.490***		
Good_guest_importance	0.750***	Public Picture	0.85
Good_host_importance	0.960***		
Good_head_of_house_importance	0.415***		
Motivation_Monetary	0.778***		
Motivation_Environmental	0.886***	Food Waste Motives	0.90
Motivation_Needy	0.917***		
FamilyMember_FinishPlate	0.788***		
Parent_FinishPlate_injSN	0.546***	Finishing Plate	0.77
Guest_FinishPlate1	0.676***		
FinishPlate	0.694***		
Parent_FinishPlate_A	0.773***	Parent Norms	0.80
Parent_FinishPlate_0	0.852***		

Standardized loadings, significant p < .001 coefficients: ***, p < .01 coefficients: **, p < .05 coefficients: *

x^2 = 1446.432, df = 887, p <.001, RMSEA = 0.085, CFI = 0.769, TLI = 0.742

Structural Equation Modelling for CS 1

Table C6: Summary of SEM Measurement Model for Belgium in CS 1

Items	Standardized Loadings	Standard Error	Latent Variables
First Level			
Cooking_ReuseIngredientsLeftovers	0.696***	Fixed	
headofFamily_0FW	0.778***	0.043	Food Waste Attitudes
FWattitude1	0.877***	0.046	
FWattitude2	0.792***	0.042	
FWattitude3	0.560***	0.038	
ImpulseBuying	0.352***	Fixed	
Cooking_ServeLargePortions	0.646***	0.138	Ability in shopping, cooking and eating
AbilityGroceriesAmount	0.872***	0.175	
AbilityCookingAmount	0.856***	0.173	
AlwaysLeftovers	0.633***	0.137	
ForgetLeftovers	0.698***	0.148	
FamilyMember_FinishPlate	0.888***	Fixed	
Parent_FinishPlate_injSN	0.535***	0.036	Finishing Plate
Guest_FinishPlate1	0.831***	0.053	
FinishPlate	0.669***	0.039	
HeadofFamily_Pleaser	0.638***	Fixed	
Cook_FreshIngr	0.794***	0.075	
Cook_VariedMeal	0.709***	0.070	Good Provider
Cook_DateMarking	0.313***	0.049	
FreshMealvsLeftovers	0.449***	0.055	
MealPrepping	0.467***	Fixed	
CheckStock	0.887***	0.163	Planning and Organization
GroceryList	0.688***	0.129	
Good_parent_importance	0.693***	Fixed	
Good_cook_importance	0.689***	0.050	
Good_guest_importance	0.801***	0.055	Public Picture
Good_host_importance	0.830***	0.056	
Good_head_of_house_importance	0.737***	0.054	
Host_FoodAffluence	0.507***	Fixed	
Guests_strict_food	0.758***	0.114	Hosting Affluence
Guests_different_food_types	0.611***	0.092	
Guests_large_portions	0.668***	0.098	
Motivation_Monetary	0.680***	Fixed	
Motivation_Environmental	0.854***	0.067	Food Waste Motives
Motivation_Needy	0.810***	0.062	
Second Level			
Finishing Plate	0.435***	Fixed	
Public Picture	0.331***	0.040	
Good Provider	0.522***	0.059	Motivation
Hosting Affluence	0.206***	0.031	
Food Waste Motives	-0.475***	0.055	
Food Waste Attitudes	1.042***	0.113	

Standardized loadings, significant p < .001 coefficients: ***, p < .01 coefficients: **, p < .05 coefficients: *

χ^2= 2647.725, df = 618, p <.001, RMSEA = 0.099,, CFI = 0.910, TLI = 0.908

Table C7: Summary of SEM Measurement Model for Spain in CS 1

Items	Standardized Loadings	Standard Error	Latent Variables
First Level			
HeadofFamily_FoodAffluence	0.688***	Fixed	
FWattitude1	0.546***	0.058	Head of Family
Good_head_of_house_importance	0.327***	0.104	
Males_LargePortions	0.557***	Fixed	
Mothers_EatLeftovers	0.981***	0.177	
Fathers_EatLeftovers	1.015***	0.186	Gender Norms
injSN_Stingy	0.557***	0.126	
Cooking_ServeLargePortions	0.430***	Fixed	
HeadofFamily_Pleaser	0.597***	0.156	
Host_FoodAffluence	0.737***	0.181	
Cook_FreshIngr	0.868***	0.206	Good Cook and
Cook_VariedMeal	0.700***	0.172	Portion Size
PortionSize	0.662***	0.167	
FreshMealvsLeftovers	0.347***	0.111	
Guests_large_portions	0.655***	0.166	
Impulse_Buying	0.408***	Fixed	
Cooking_ServeLargePortions	0.257***	0.134	Ability in Eating,
Ability_GroceriesAmount	0.989***	0.272	Shopping and
Ability_CookingAmount	0.910***	0.247	Cooking
AlwaysLeftovers	0.429***	0.150	
FoodSpoiled	0.621***	0.186	
MealPrepping	0.673***	Fixed	
CheckStock	0.722***	0.098	
GroceryList	0.632***	0.090	Planning and
Cookling_EstimateAmounts	0.648***	0.092	Organization
Cooking_ShorterShelfLifeFirst	-0.139	0.306	
MotivationPlanning	0.631***	0.089	
Cooking_ShorterShelfLifeFirst	0.942***	Fixed	
Cooking_ReusedIngredientsLeftovers	0.767***	0.183	Cooking Behaviour
Guests_strict_food	0.688***	0.161	
Good_parent_importance	0.768***	Fixed	
Good_cook_importance	0.631***	0.069	
Good_guest_importance	0.703***	0.074	Public Picture
Good_head_of_house_importance	0.575***	0.126	
Motivation_Monetary	0.807***	Fixed	
Motivation_Environmental	0.932***	0.073	Food Waste Motives
Motivation_Needy	0.922***	0.066	
FamilyMember_FinishPlate	0.851***	Fixed	
Parent_FinishPlate_injSN	0.464***	0.057	Finishing Plate
Guest_FinishPlate1	0.792***	0.071	
FinishPlate	0.759***	0.069	
Parent_FinishPlate_A	0.909***	Fixed	Parent Norms
Parent_FinishPlate_0	0.801***	0.073	
Second Level			
Finishing Plate	0.602***	Fixed	Motivation

Items	Standardized Loadings	Standard Error	Latent Variables
Public Picture	0.762***	0.116	
Parent Norms	0.662***	0.093	
Gender Norms	-0.205***	0.037	
Head of Family	1.053***	0.112	
Good Cook and Portion Size	0.741***	0.072	
Food Waste Motives	0.287***	0.046	
Cooking Behaviour	1.394***	0.674	

Standardized loadings, significant p < .001 coefficients: ***, p < .01 coefficients: **, p < .05 coefficients: *

x^2= 1877.562, df = 796, p <.001, RMSEA = 0.125, CFI = 0.971, TLI = 0.971

In order to facilitate the estimation of the ordered logit component of the SEM, certain factor items (or even the whole factors) were removed from the previous specification of the CFA. In particular:

- For Belgium the Good Family Provider and Good Eating Behaviour were removed as well as two items from the Food Waste attitudes factor and one item from the Ability in Eating, Shopping and Cooking factor.
- For Spain two items were removed from the Head of Family factor, one item from the Gender Norms factor and one item from the Public Picture factor.

The final composition of the factors can be seen in Tables C6 and C7. Additionally, certain covariances entered the model based on the Modification Indices, similarly to the CFA analysis. The model for Belgium has a χ^2 value of 2647.725 (df=617 and p=0.000). ThedRMSEA is 0.099, the CFI 0.910 and the TLI 0.908. Therefore, the model generally shows a good d to the data, while all the standardized coefficients are statistically significant. Likewise, for Spain the model has a χ^2 value of 1877.562 (df=796 and p=0.000). The RMSEA is 0.125, the CFI 0.971 and the TLI 0.971 so the model fit is similar for the two countries.

Explanatory Factor Analysis for CS 6

Figure C2: Eigenvalues for EFA number of factors selection in CS 6
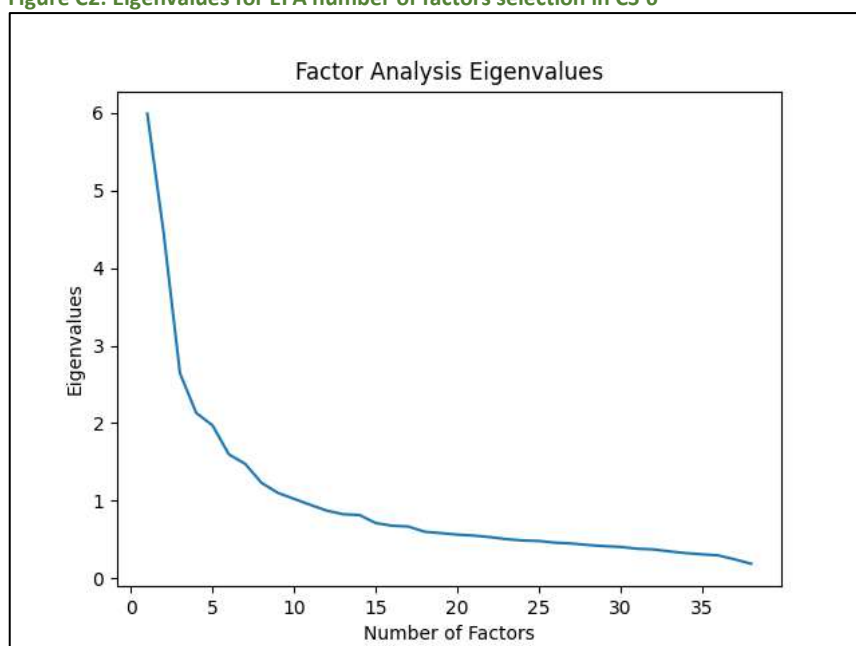
Bartlett's test, described earlier, assesses whether the observed variables in the dataset are interrelated and in our case is equal to 15841 (*p=0.00),* supporting the suitability for factor analysis. KMO that tests for sampling adequacy is equal to 0.84, also indicating excellent suitability for factor analysis. The latent constructs' reliability for the nine factors ranged from 0.71 to 0.89, thus all the values are above the recommended threshold of 0.6 that is encountered in the literature (Nunnally, 1978). These high Cronbach's alpha value suggest a good internal consistency of the sample data, for all the 9 factors that were generated.

The variables that were excluded with the approach followed for Case Study 1 (loading values are below the 0.4 threshold) are only three:

- It seems ethical to throw away food in good condition.
- Companies want to ensure the quality of the products and shorten the dates.
- If new packaging is developed to ensure the durability of the food, what do you think its quality will be?

Table C8: Summary results of EFA in CS 6

Factor	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor Loading	Reliability Analysis (Cronbach's α)
Reasons to NOT throw away expired or out-of-date foods	RNTA1									0.57	0.85
	RNTA2									0.66	
	RNTA3									0.78	
	RNTA4									0.70	
	RNTA5									0.64	
	RNTA6									0.64	
	RNTA7									0.50	
	PB5									0.50	
Reasons to throw away expired or out-of-date foods		RB3								0.42	0.80
		RTA1								0.75	
		RTA2								0.54	
		RTA3								0.70	
		RTA4								0.71	
Perception of longer expiration dates			PLED1							0.57	0.81
			PLED2							0.68	
			PLED3							0.80	
			PLED4							0.77	
Reasons for buying more food than needed/planned				RB1						0.66	0.76
				RB2						0.57	
				RB3						0.42	
				RB4						0.61	
				RB5						0.57	
				RB6						0.59	
Reasons for companies shortening dates					RSED2					0.62	0.75
					RSED3					0.74	
					RSED4					0.69	
Wasting food regulation						PB6				0.87	0.89
						PB7				0.80	
Expiration Dates Meat and Fish							IED1			0.80	0.85
							IED2			0.81	
Expiration date Fruits, Dairy and Pantry								IED3		0.71	0.72
								IED4		0.58	
								IED5		0.66	
Food Waste Feelings									PB1	0.43	0.71
									PB2	0.68	
									PB3	0.65	

Confirmatory Factor Analysis for CS 6

Table C9: Summary of first-order CFA results in CS 6

Items	Standardized Loadings	Factor	Composite Reliability (C.R)
Not_throw_expired_solidarity	0.518***	Reasons to NOT throw away expired or out-of-date foods	0.83
Not_throw_expired_environment	0.633***		
Not_throw_expired_ethics	0.812***		
Not_throw_expired_second_life	0.707***		
Not_throw_expired_economic	0.680***		
Not_throw_expired_health_risk	0.688***		
Not_throw_expired_manufacturer	0.539***		
Throw_expired_important	0.556***		
Food_waste_reason_social_statud	0.432***	Reasons to throw away expired or out-of-date foods	0.80
Throw_expired_social_status	0.799***		
Throw_expired_low_quality	0.534***		
Throw_expired_good_ethics	0.726***		
Throw_expired_economic_level	0.758***		
Long_expiration_additives	0.470***	Perception of longer expiration dates	0.76
Long_expiration_worse_taste	0.744***		
Long_expiration_artificial	0.709***		
Long_expiration_low_quality	0.850***		
Food_waste_reason_time	0.652***	Reasons for buying more food than needed/planned	0.76
Food_waste_reason_discounts	0.562***		
Food_waste_reason_social_status	0.325***		
Food_waste_reason_cook_more	0.639***		
Food_waste_reason_store_for_unforeseen_events	0.573***		
Food_waste_reason_experiment	0.632***		
Companies_no_returns	0.656***	Reasons for companies shortening dates	0.75
Companies_rotate	0.737***		
Companies_minimizing_responsibilities	0.738***		
Throw_expired_fine	0.856***	Wasting food regulation	0.89
Throw_expired_penalty	0.928***		
Expiration_date_meat	0.799***	Expiration Dates Meat and Fish	0.85
Expiration_date_fish	0.924***		
Expiration_date_fruits	0.746***	Expiration date Fruits, Dairy and Pantry	0.72
Expiration_date_dairy	0.616***		
Expiration_date_pantry	0.679***		
Throw_expired_embarassed	0.573***	Food Waste Feelings	0.71
Throw_expired_responsible	0.720***		
Throw_expired_guilty	0.740***		

Standardized loadings, significant p < .001 coefficients: ***
x^2= 1726.441, df = 595, p <.001, RMSEA = 0.045, CFI = 0.919, TLI = 0.907

To achieve a good model fit, we reviewed the Modification Indices (MI), and we allowed variables with the highest values to correlate. The correlations that are included in the model (Table C9) are the following:

- Not throwing expired food because of solidarity to other households vs not throwing expired food to protect the environment.
- Longer expiration dates mean that food has additives vs longer expiration dates mean that food is artificial.
- It is important for people not to waste food vs feeling guilty for throwing expired food.

Structural Equation Modelling for CS 6

Table C10: Summary of SEM measurement model in CS 6

Items	Standardized Loadings	Standard Error	Latent Variables
First Level			
Not_throw_expired_solidarity	0.519***	Fixed	Reasons to NOT throw expired or out-of-date foods
Not_throw_expired_environment	0.633***	0.060	
Not_throw_expired_ethics	0.804***	0.081	
Not_throw_expired_second_life	0.714***	0.080	
Not_throw_expired_economic	0.680***	0.077	
Not_throw_expired_health_risk	0.691***	0.073	
Not_throw_expired_manufacturer	0.547***	0.068	
Throw_expired_important	0.534***	0.065	
Food_waste_reason_social_status	0.403***	Fixed	Reasons to throw expired or out-of-date foods
Throw_expired_social_status	0.786***	0.167	
Throw_expired_low_quality	0.548***	0.140	
Throw_expired_good_ethics	0.738***	0.161	
Throw_expired_economic_level	0.761***	0.177	
Long_expiration_additives	0.577***	Fixed	Perception of longer expiration dates
Long_expiration_worse_taste	0.714***	0.071	
Long_expiration_artificial	0.785***	0.075	
Long_expiration_low_quality	0.797***	0.076	
Food_waste_reason_time	0.507***	Fixed	Reasons for buying more food than needed/planned
Food_waste_reason_discounts	0.470***	0.072	
Food_waste_reason_social_status	0.345***	0.082	
Food_waste_reason_cook_more	0.647***	0.136	
Food_waste_reason_store_for_unforeseen_events	0.572***	0.125	
Food_waste_reason_experiment	0.660***	0.129	
Companies_no_returns	0.650***	Fixed	Reasons for companies shortening dates
Companies_rotate	0.744***	0.062	
Companies_minimizing_responsibilities	0.737***	0.062	
Throw_expired_fine	0.872***	Fixed	Wasting food regulation
Throw_expired_penalty	0.912***	0.059	
Expiration_date_meat	0.880***	Fixed	Expiration Dates Meat and Fish
Expiration_date_fish	0.838***	0.068	
Expiration_date_fruits	0.748***	Fixed	Expiration date Fruits, Dairy and Pantry
Expiration_date_dairy	0.637***	0.056	
Expiration_date_pantry	0.656***	0.055	
Throw_expired_embarassed	0.596***	Fixed	Food Waste Feelings
Throw_expired_responsible	0.721***	0.065	
Throw_expired_guilty	0.714***	0.065	
Second Level			
Reasons for buying more food than needed/planned	0.081***	Fixed	Attitudes
Reasons to throw expired or out-of-date foods	0.098***	0.174	
Reasons to NOT throw expired or out-of-date foods	0.197***	0.479	
Food Waste Feelings	0.795***	Fixed	Social Norms
Wasting Food Regulations	0.476***	0.090	

Standardized loadings, significant p < .001 coefficients: ***

x^2= 2458.400, df = 570, p <.001, RMSEA = 0.053, CFI = 0.876, TLI = 0.863

After adding the correlations, the model was improved from a χ^2 value of 2155.623 (df=523 and p=0.000) to 1726.441 (df=520 and p=0.000). The RMSEA improved from 0.052 to 0.045, the CFI from 0.890 to 0.9129and the TLI from 0.875 to 0.907. The standardized loadings of the measurement items are presented in Table C9, along with the construct composite reliability measures (C.R). C.R is above the recommended threshold of 0.6 for all factors. All the factor loadings are statistically significant at the 0.001 level and range from 0.325 to 0.924, while only the 'wasting expired food for social status' variable is below the recommended threshold of 0.4.

3 of the 9 factors are used as indicators for the **Social Norms** latent variable and 2 of the 9 factors are used for the **Attitudes** latent variable. All these factors are statistically significant at the p<0.001 level. The model has a χ^2 value of 2458.400 (df=570 and p=0.000). The RMSEA is 0.053, the CFI 0.876 and the TLI 0.863. Therefore, the model fit is slightly lower than the recommended thresholds, but all the standardized coefficients are statistically significant.

10.4 Appendix D: Propensity Score Matching (PSM) for CS 2

Software/Programming language

The steps described for the Propensity Score Matching (PSM) in Chapter 5 were implemented in Python with the PsmPy library.

Figure D1 shows the distribution of the propensity scores for two groups (control and treatment) for positive and provocative messaging side by side. The interpretation of this figure is that the nearer the two distributions mimic one another, the better the matching is. It can be seen that the matching process worked better for the positive messaging experiment (left side) compared to the provocative messaging experiment (right side).

Figure D1: Propensity scores for control and treatment groups for positive messaging (left) and provocative messaging (right)
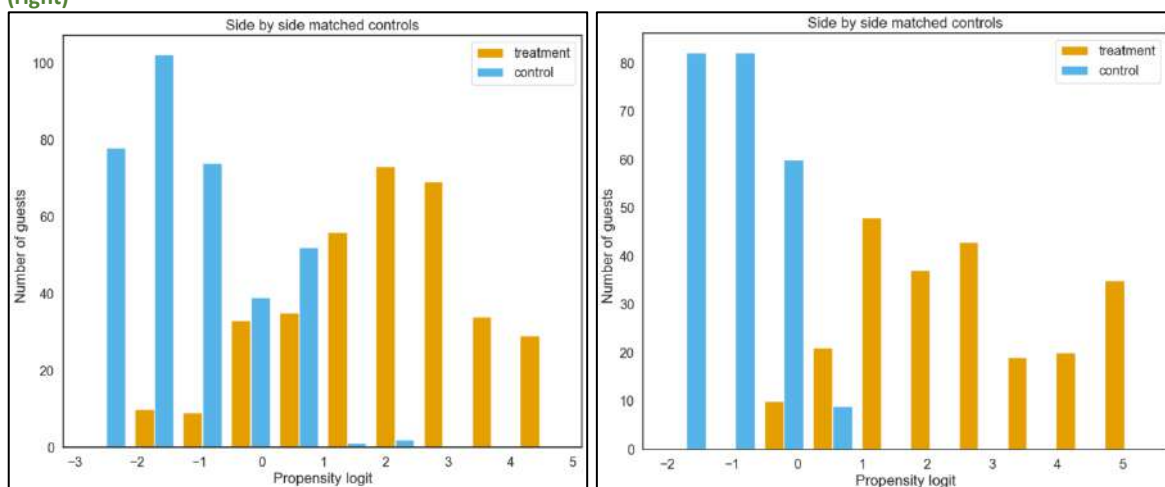
As it was discussed in Chapter 5, it's also crucial to evaluate the effect sizes before and after matching. The effect size in PsmPy is calculated using Cohen's D (Cohen, 1992), which is a modified Chi square test. The changes of the effect sizes are presented in Figure D2 for the positive messaging experiment and in Figure D3 for the provocative messaging experiment.

In general, the thresholds for a small, medium and large effect size as they were characterized by Cohen are:

- *Small*: ≤ 0.2
- *Medium*: ≤ 0.5
- *Large*: ≤ 0.8

The hypothesis for not perfect randomization is validated in the effect sizes figures, i.e. there is a significant differentiation between control and treatment with regards to the month that the various messages (or no messages) were displayed. Moreover, the variations in the strategies that the various hotels followed are also visible, since some of them have values that fall in the medium category (>0.2). The matching process mitigated some of these effects leading to a more balanced dataset. It's interesting that in both cases, the effect size for the business ratio was reduced almost to zero, indicating that the proportion of business and non-business guests that saw one of the two messages was approximately the same to the proportion of those that didn't see any message.

Figure D2: Effect sizes before and after matching for the positive messaging experiment
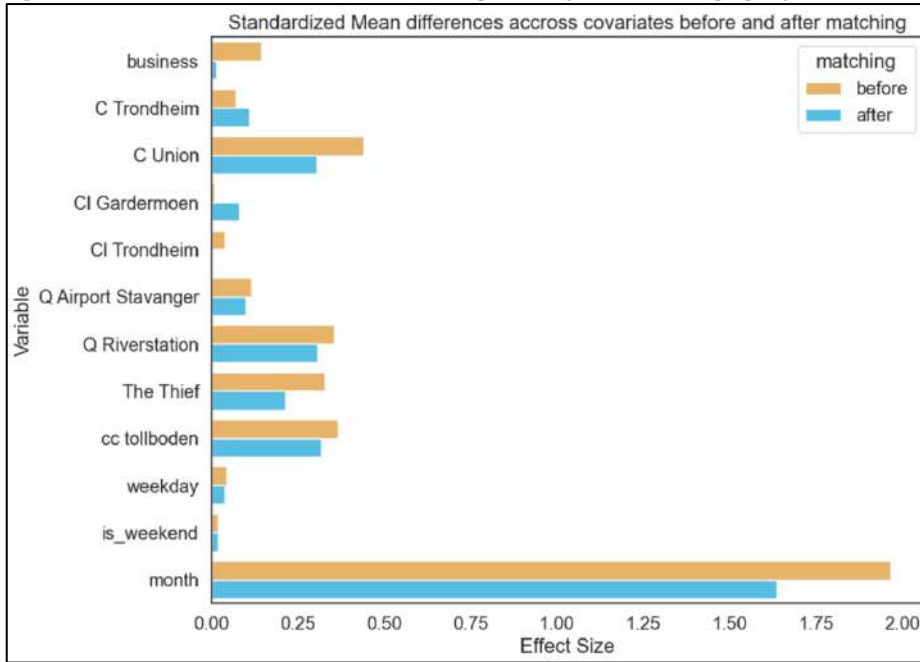
Figure D3: Effect sizes before and after matching for the provocative messaging experiment
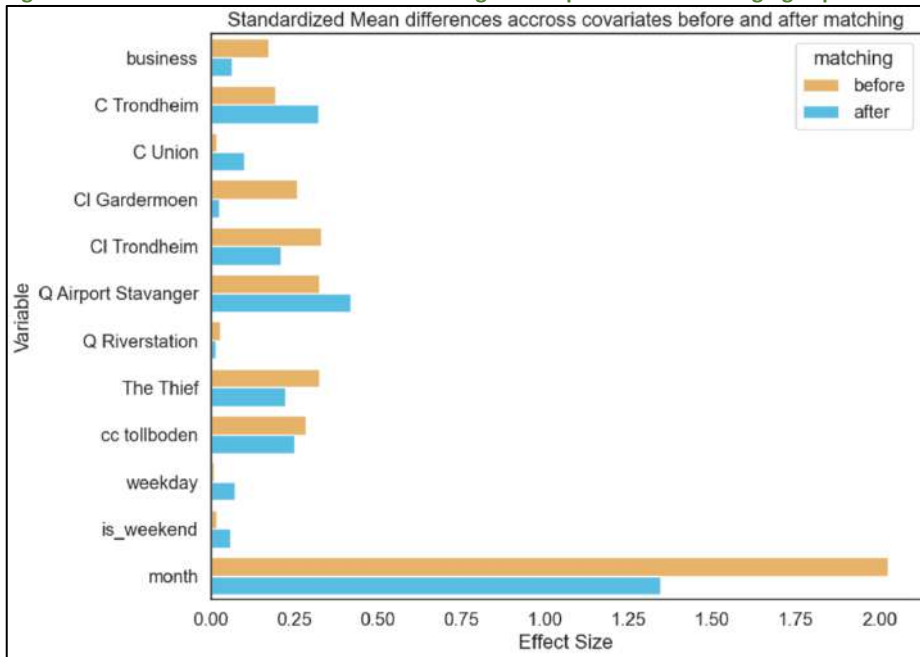
10.5 Appendix E: Cross-tabulation Analysis for CS 3

To delve deeper into potential gender or intersectional variations for Case Study 3, crosstabulation analysis was employed, facilitating a comprehensive exploration of relationships within the dataset. The most interesting relationships that emerged from this analysis are presented in Tables E1-E3.For the quantitative analysis of Case Study 3, Statistical Package for the Social Sciences (SPSS) was utilized as the primary tool.

Table E1: Cross tabulation of the importance factor 'I receive very large portion sizes' for dining out and registered sex

Crosstab					
			Registered Sex		**Total**
			Male	**Female**	
I receive very large portion sizes	Least Important	Count	4	36	40
		Expected Count	20.8	19.2	40.0
		% within Registered Sex	1.1%	10.9%	5.8%
	Less important	Count	29	65	94
		Expected Count	48.8	45.2	94.0
		% within Registered Sex	8.1%	19.7%	13.7%
	Moderately important	Count	68	52	120
		Expected Count	62.3	57.7	120.0
		% within Registered Sex	19.1%	15.8%	17.5%
	Important	Count	167	91	258
		Expected Count	133.9	124.1	258.0
		% within Registered Sex	46.9%	27.6%	37.6%
	Most important	Count	88	86	174
		Expected Count	90.3	83.7	174.0
		% within Registered Sex	24.7%	26.1%	25.4%
Total		Count	356	330	686
		Expected Count	356.0	330.0	686.0
		% within Registered Sex	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	
Pearson Chi-Square	63.036[a]	4	**<.001**	
Likelihood Ratio	67.491	4	<.001	
Linear-by-Linear Association	28.605	1	<.001	
N of Valid Cases	686			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 19.24.

Crosstab			
	Registered Sex		**Total**
	Male	**Female**	
Symmetric Measures			

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Nominal by Nominal	Phi	.303			<.001
	Cramer's V	**.303**			**<.001**
Interval by Interval	Pearson's R	-.204	.036	-5.460	<.001[c]
Ordinal by Ordinal	Spearman Correlation	-.159	.038	-4.210	<.001[c]
N of Valid Cases		686			
a. Not assuming the null hypothesis.					
b. Using the asymptotic standard error assuming the null hypothesis.					
c. Based on normal approximation.					

Table E2: Cross tabulation of the importance factor 'The menu changes seasonally/periodically' for dining out and registered sex

Crosstab			Registered Sex		Total
			Male	Female	
The menu changes seasonality/periodically	Least Important	Count	10	13	23
		Expected Count	11.6	11.4	23.0
		% within Registered Sex	3.2%	4.2%	3.7%
	Less important	Count	31	16	47
		Expected Count	23.7	23.3	47.0
		% within Registered Sex	9.8%	5.2%	7.5%
	Moderately important	Count	111	62	173
		Expected Count	87.2	85.8	173.0
		% within Registered Sex	35.2%	20.0%	27.7%
	Important	Count	94	97	191
		Expected Count	96.3	94.7	191.0
		% within Registered Sex	29.8%	31.3%	30.6%
	Most important	Count	69	122	191
		Expected Count	96.3	94.7	191.0
		% within Registered Sex	21.9%	39.4%	30.6%
Total		Count	315	310	625
		Expected Count	315.0	310.0	625.0
		% within Registered Sex	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	
Pearson Chi-Square	33.773[a]	4	**<.001**	
Likelihood Ratio	34.244	4	<.001	
Linear-by-Linear Association	20.434	1	<.001	
N of Valid Cases	625			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.41.

Crosstab			
	Registered Sex		**Total**
	Male	**Female**	

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Nominal by Nominal	Phi	.232			<.001
	Cramer's V	**.232**			**<.001**
Interval by Interval	Pearson's R	.181	.040	4.593	<.001[c]
Ordinal by Ordinal	Spearman Correlation	.206	.039	5.258	<.001[c]
N of Valid Cases		625			
a. Not assuming the null hypothesis.					
b. Using the asymptotic standard error assuming the null hypothesis.					
c. Based on normal approximation.					

Table E3: Cross tabulation of reason 'I received portion sizes that are too small' for returning to a restaurant and registered sex

Crosstab					
			Registered Sex		**Total**
			Male	**Female**	
I received portion sizes that are too small	Least Important	Count	12	31	43
		Expected Count	22.4	20.6	43.0
		% within Registered Sex	3.1%	8.8%	5.9%
	Less important	Count	39	74	113
		Expected Count	58.7	54.3	113.0
		% within Registered Sex	10.2%	21.0%	15.4%
	Moderately important	Count	19	24	43
		Expected Count	22.4	20.6	43.0

Crosstab			Registered Sex		Total
			Male	Female	
		% within Registered Sex	5.0%	6.8%	5.9%
	Important	Count	116	79	195
		Expected Count	101.4	93.6	195.0
		% within Registered Sex	**30.4%**	22.4%	26.6%
	Most important	Count	195	144	339
		Expected Count	176.2	162.8	339.0
		% within Registered Sex	**51.2%**	40.9%	46.2%
Total		Count	381	352	733
		Expected Count	381.0	352.0	733.0
		% within Registered Sex	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	
Pearson Chi-Square	33.415[a]	4	**<.001**	
Likelihood Ratio	33.914	4	<.001	
Linear-by-Linear Association	28.247	1	<.001	
N of Valid Cases	733			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 20.65.

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Nominal by Nominal	Phi	.214			<.001
	Cramer's V	**.214**			**<.001**
Interval by Interval	Pearson's R	-.196	.036	-5.417	<.001[c]
Ordinal by Ordinal	Spearman Correlation	-.167	.036	-4.589	<.001[c]
N of Valid Cases		733			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

10.6   Appendix F: Pilot Home Survey for CS 6

Figures F1-F13 demonstrate the reported food waste for the individual pilot homes, while the percentages indicate the proportion out of the 5 weeks that the respective option was selected. Apart from the food waste levels, the main findings about the habits of the pilot households with regards to food waste and treatment of leftovers are presented for each household individually below.

Household 1: Home for 2 **elderly people** without dependent children in a **big city**
This household had the **ability to** plan and organize lunch/dinner for 2 out 5 weeks. There were leftovers 2 out of 5 weeks, because one week they didn´t plan the food and the necessary portions well and the other week for other reasons. In terms of their **behaviour** towards leftovers, they disposed of them in all cases. Apart from leftovers, for 2 out of 5 weeks they threw food away because they forgot it in the fridge and it got spoiled, while the other 3 weeks they did not throw it away because their strategy was to throw it only if it was already expired for a few days.

Household 2: Home for 2 **elderly people** without dependent children in a **small town**
This household had the **ability to** plan and organize lunch/dinner throughout the whole pilot. There were leftovers throughout the whole pilot because a) they didn´t plan well the food and the necessary portions, b) they like to cook much more than necessary and c) the food wasn´t in its original packaging and has been damaged. In terms of their **behaviour** towards leftovers, in most cases they disposed of them (80%), while sometimes they used leftovers to prepare new meals or as lunch/dinner for the next day or for other purposes. Moreover, 4 out of 5 weeks they threw food away because they forgot it in the fridge and it got spoiled (100%), while sometimes the reason was that the expiration date has passed, or the food didn't have the expected quality (bad packaging, bad appearance, smell, or taste). For the one week that they did not throw away food, the reason was that their strategy was to throw food only a few days after its expiry date.

Household 3 - Home for 2 **adults** without dependent children in a **big town.**
This household had the **ability to** plan and organize lunch/dinner throughout the whole pilot. There weren't leftovers throughout the whole pilot. Apart from leftovers, they never threw food away because their strategy was to throw away food only a few days after the expiry date and normally, their leftover food was kept in a container and eaten the next day.

Household 4 - Home for 2 **adults** without dependent children in a **small town**
This household had the **ability to** plan and organize lunch/dinner throughout the whole pilot. There were leftovers all throughout the pilot because **they like to cook much more than necessary**. In terms of **behaviour** towards leftovers, they disposed of them in all cases. Apart from leftovers, 3 out of 5 weeks they threw food away because they forgot it in the fridge and it was spoiled, while the other 2 weeks they did not throw it away because it was preserved in its original packaging and lasted longer, but also because their food was not out-of-date or spoiled.

Household 5 - Home for 2 **adults** with **2 children** between **10-18 years old** in a **big city**
This household had the **ability** to plan and organize lunch/dinner for 4 out of 5 weeks. The household had leftovers 3 out of 5 weeks, due to ineffective purchase and meal planning (portions), as well as because a relative sent them several containers of unplanned meals. In terms of their **behaviour** towards leftovers, they typically use the leftover food as lunch/dinner the next day, they dispose of the leftovers, they use leftovers to prepare new meals, and they freeze portions. Apart from leftovers, 3 out of 5 weeks they threw food away either because they forgot it in the fridge, and it got spoiled or because the expiration date has passed. The other 2 weeks they did not throw food away because they either froze it, or they didn't have spoiled leftovers/food in the fridge, or the date of the packaged food had not yet passed.

Household 6 - Home for **2 adults** with **2 children** between **0-9 years old** in a **big city**
This household had the **ability** to plan and organize lunch/dinner for 2 out of 5 weeks. There were leftovers 3 out of 5 weeks, either because the food wasn´t in its original packaging and had been damaged, or for other reasons. In terms of their **behaviour** towards leftovers, they disposed of them in all cases, while in some cases they used the leftover food as lunch/dinner the next day. Apart from leftovers, 1 out of 5 weeks they threw food away because they forgot it in the fridge and it got spoiled. The other 4 weeks they did not throw it away because food was preserved in its original packaging and lasted longer or because of other reasons.

Household 7 - Home for **2 adults** with **2 children** between **0-9 years old** in a **small town**
This household didn´t have the **ability to** plan and organize lunch/dinner throughout the whole pilot, because they did not have enough time for it. They had leftovers 2 out of 5 weeks, because they didn´t plan the food purchase and the necessary portions well, in addition to other reasons. In terms of their **behaviour** towards leftovers, they disposed of them in all cases. Apart from leftovers, 4 out of 5 weeks they threw food away because they forgot it in the fridge, and it got spoiled. The remaining week they did not throw anything away because they ate all the food.

Household 8 - Home for **1 adult** with **1 dependent children** in a **small town**
This household had the **ability to** plan and organize lunch/dinner for 1 out of 5 weeks, because the respondent went shopping on a weekly basis. For the other 4 weeks she didn't plan lunch/dinner because she didn't eat at home. This household had leftovers 1 out of 5 weeks, because the respondent was ill. Apart from leftovers, she didn't throw away food throughout the whole pilot because it was preserved in its original packaging and lasted longer.

Household 9 - Home for **1 adult** without children in a **big city**
This household had the **ability to** plan and organize lunch/dinner for 2 out of 5 weeks. For the remaining 3 weeks that the respondent didn't plan, the reason was travelling. The household didn't have leftovers throughout the whole pilot. Apart from leftovers, 1 out of 5 weeks food was thrown away because the respondent went on a trip without proper planning and the food in the fridge became spoiled. For the remaining 4 weeks she did not throw food away because it was preserved in its original packaging and lasted longer, and because she had organized the week properly.

Household 10 - Home for **1 adult** without children in a **big city**
This household had the **ability to** plan and organize lunch/dinner for 2 out of 5 weeks. Below are some comments of the respondent on the reasons for planning. The household had leftovers 1 out of 5 weeks, because they didn't plan the food and the necessary portions, and also for other reasons. In terms of their **behaviour** towards leftovers, they disposed of them in all cases. Apart from leftovers, 1 out of 5 weeks they threw food away because the food did not have the expected quality (bad packaging, bad appearance, smell, or taste). The remaining 4 weeks they did not throw food away because their strategy was to discard food only if it was a few days after the expiration date and also because food was preserved in its original packaging and lasted longer.

Household 11 - Home with people with **food intolerances** (CELIAC)
This household had the **ability to** plan and organize lunch/dinner for 2 out of 5 weeks.

This household had leftovers 3 out of 5 weeks, because either the respondent liked to cook more than necessary, the food wasn´t in its original packaging, had been damaged, or because the respondent went on vacation and could not take along the food. In terms of **behaviour** towards leftovers, the leftover food was utilized for lunch/dinner the next day, or the leftovers were disposed of or used to prepare new meals. Apart from leftovers, 2 out of 5 weeks he threw food away because either he forgot it in the fridge and it was spoiled, or because the food did not have the expected quality (bad packaging, bad appearance, smell, or taste), or because the food was in its

original packaging and had been damaged. For the remaining 3 weeks the respondent did not throw away food because the strategy was to discard food only if it was a few days after the expiration date, or because planning for the fridge contents was well done so as to not waste any food.

Household 12 - Home with **vegan people**
This household had the **ability** to plan and organize lunch/dinner for 3 out of 5 weeks. There were leftovers 1 out of 5 weeks, because the food wasn´t in its original packaging and had been damaged. In terms of **behaviour** towards leftovers, they used the leftovers to feed animals in all cases. Apart from leftovers, 2 out of 5 weeks they did not throw food away because food was preserved in its original packaging and lasted longer.

Household 13 - Home with **vegetarian people**
This household did not have the **ability** to plan and organize lunch/dinner throughout the whole pilot. There were leftovers 3 out of 5 weeks, because the respondent didn´t plan the food and the necessary portions well and because leftovers were kept but forgotten about in the fridge, and hence the food got spoiled. In terms of **behaviour** towards leftovers, in some cases the leftover food was used for lunch/dinner the next day, while in other cases used to feed animals. Apart from leftovers, 2 out of 5 weeks food was thrown away because it was forgotten in the fridge, and it got spoiled. For the remaining 3 weeks food was not thrown away for the following reasons:

- Strategy was to discard food only a few days after the expiration date;
- Food was only thrown away if it was spoiled; and
- If food was past the expiration date, it usually was not thrown away.

Figure F1: Food waste per category for pilot home (1) with 2 elderly, without depending children in a big city

BREAD

2 slices or less: 0%
3 - 6 slices: 20% of the weeks
7 - 10 slices: 40% of the weeks
A whole loaf of bread or more: 40% of the weeks

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 60% of the weeks
200g - 400g: 40% of the weeks
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 20% of the weeks
1: 80% of the weeks
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 60% of the weeks
50g - 100g: 20% of the weeks
100g - 200g: 0%
> 200g: 20% of the weeks

FRUITS AND VEGETABLES

< 500g: 80% of the weeks
500g - 1kg: 20% of the weeks
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 80% of the weeks
1: 20% of the weeks
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 80% of the weeks
200g - 400g: 20% of the weeks
500g - 1kg: 0%
> 1kg: 0%

Figure F2: Food waste per category for pilot home (2) with 2 elderly, without depending children in small town

BREAD

2 slices or less: 100% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 80% of the weeks
50g - 100g: 20% of the weeks
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 80% of the weeks
200g - 400g: 20% of the weeks
500g - 1kg: 0%
> 1kg: 0%

Figure F3: Food waste per category for pilot home (3) with 2 adults, without dependent children in a big city

BREAD

2 slices or less: 80% of the weeks
3 - 6 slices: 20% of the weeks
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

Figure F4: Food waste per category for pilot home (4) with 2 adults, without dependent children in a small town

BREAD

2 slices or less: 100% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

Figure F5: Food waste per category for pilot home (5) with 2 adults with 2 children between 10-18 years old in a big city

BREAD

2 slices or less: 0%
3 - 6 slices: 80% of the weeks
7 - 10 slices: 20% of the weeks
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

Figure F6: Food waste per category for pilot home (6) with 2 adults with 2 children between 0-9 years old in a big city

BREAD

2 slices or less: 60% of the weeks
3 - 6 slices: 20% of the weeks
7 - 10 slices: 20% of the weeks
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

Figure F7*: Food waste per category for pilot home (7) with 2 adults with 2 children between 0-9 years old in a small town*

BREAD

2 slices or less: 100% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 80% of the weeks
200ml - 400ml: 0%
500ml - 1L: 20% of the weeks
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

Figure F8: Food waste per category for pilot home (8) with 1 adult with 1 dependent children in a small town

BREAD

2 slices or less: 100% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

Figure F9: Food waste per category for pilot home (9) with 1 adult without children in a big city

BREAD

2 slices or less: 100% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)
< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS
0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)
0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES
< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)
< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)
< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)
< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

Figure F10: Food waste per category for pilot home (10) with 1 adult without children in a big city

BREAD

2 slices or less: 80% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 20% of the weeks

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 80% of the weeks
200ml - 400ml: 20% of the weeks
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

Figure F11: Food waste per category for pilot home (11) with people with food intolerances (CELIAC)

BREAD

2 slices or less: 100% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 100% of the weeks
500g - 1kg: 0%
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 20% of the weeks
200ml - 400ml: 80% of the weeks
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 80% of the weeks
200g - 400g: 20% of the weeks
500g - 1kg: 0%
> 1kg: 0%

Figure F12: Food waste per category for pilot home (12) with vegan people

BREAD

2 slices or less: 100% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 80% of the weeks
500g - 1kg: 20% of the weeks
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
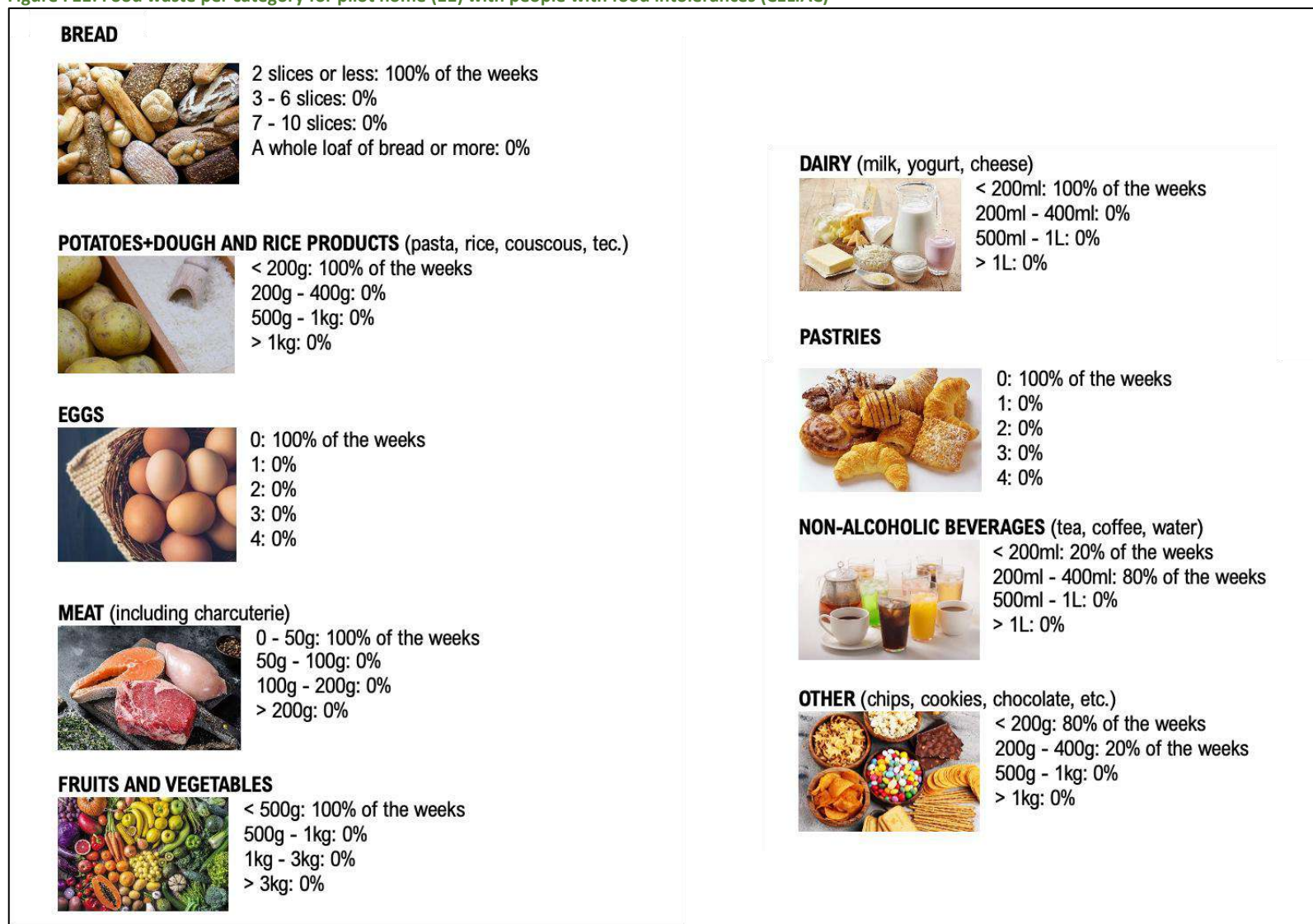> 1kg: 0%

**Figure F13: Food waste per category for pilot home (13) with vegetarian people**

BREAD

2 slices or less: 100% of the weeks
3 - 6 slices: 0%
7 - 10 slices: 0%
A whole loaf of bread or more: 0%

POTATOES+DOUGH AND RICE PRODUCTS (pasta, rice, couscous, tec.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

EGGS

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

MEAT (including charcuterie)

0 - 50g: 100% of the weeks
50g - 100g: 0%
100g - 200g: 0%
> 200g: 0%

FRUITS AND VEGETABLES

< 500g: 80% of the weeks
500g - 1kg: 20% of the weeks
1kg - 3kg: 0%
> 3kg: 0%

DAIRY (milk, yogurt, cheese)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

PASTRIES

0: 100% of the weeks
1: 0%
2: 0%
3: 0%
4: 0%

NON-ALCOHOLIC BEVERAGES (tea, coffee, water)

< 200ml: 100% of the weeks
200ml - 400ml: 0%
500ml - 1L: 0%
> 1L: 0%

OTHER (chips, cookies, chocolate, etc.)

< 200g: 100% of the weeks
200g - 400g: 0%
500g - 1kg: 0%
> 1kg: 0%

10.7   Appendix G: Qualitative Coding Tree

Figure G1: Qualitative coding tree for CHORIZO T2.4 / D2.3 ("a priori")
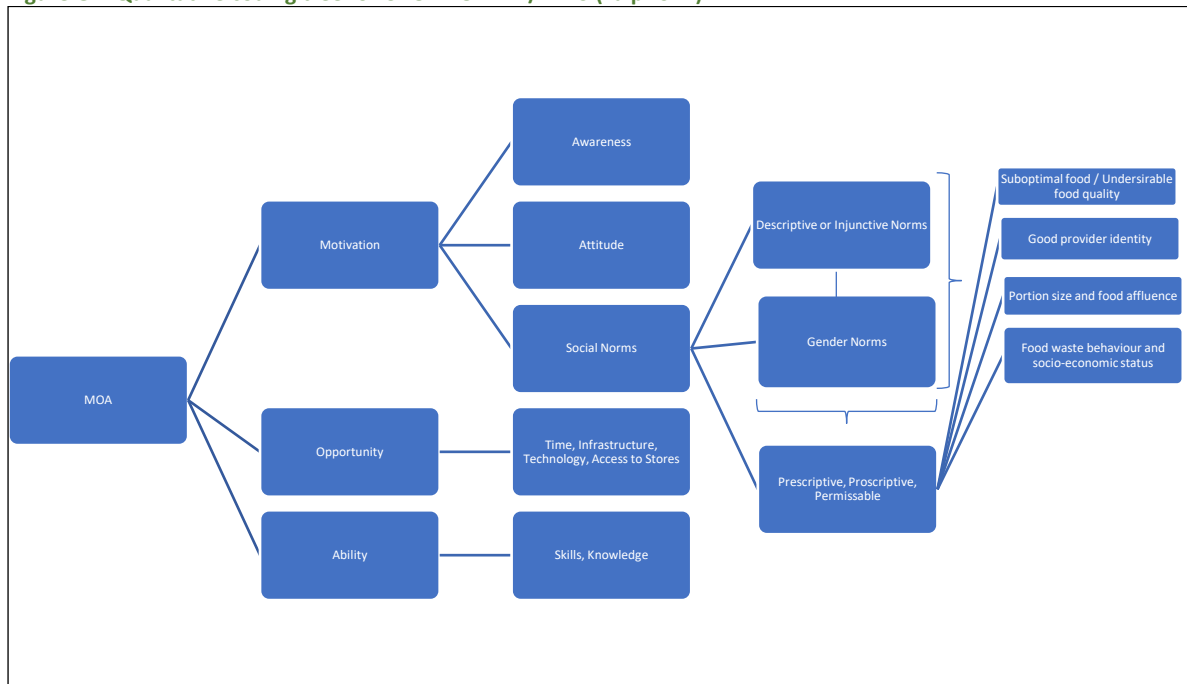
Motivation: A driving force or internal state that energizes, directs, and thus sustains behaviour towards achieving a goal, as avoiding food waste. It is shaped by individual awareness of the environmental impact of food waste, personal attitudes toward waste (including values like environmental concern), and social norms. In the presence of social norms, individuals identifying with the norm's target group believe that certain actions are anticipated of them as members of that group.

Social norms: Rules/guides for actions perceived by individuals aspiring/belonging to the norm's target group as expected by others. In reality, usually either the target in-group or out-group members (or both) accept the social norms as rules/guides and usually do expect the normative action.

Types of social norms:

Descriptive social norm: The normative action is followed by an individual as it is perceived to be effective in a given situation, rather than because of perceived expectations of others. Descriptive social norms refer to prevalent or common behaviour, and they reflect perceptions about the likelihood that others engage in the normative behaviour themselves.

Injunctive social norm: There exists a reinforcing mechanism through which (dis)approval of (non)conformity are expressed. Additionally, observing the members of the target group conforming to the norm (and possibly receiving a reward for conformity) or/and seeing the members of the target group punished for non-compliance provide validation that the norm exists. Injunctive social norms indicate perceptions about normatively appropriate behaviour in a specific context (what kind of behaviour is approved or disapproved by the reference group).

Gender norms: The social rules and expectations that build a gender system – referring to societal expectations and standards regarding behaviour and roles considered appropriate for individuals

based on their perceived gender; engrained into institutions, power relations and in certain cases policies.

Prescriptive: Character of the social norm where the action should be done.

Proscriptive: Character of the social norm where the action should not be done.

Permissible: Character of the social norm where the action is acceptable/allowed to be done, but not obligatory.

Social norms related to the food waste:

Suboptimal Food/Undesirable Food Quality: Not buying, utilizing food in meal preparations, or eating it, due to "sensory deviations" primarily unusual shape or colour.

Good Provider Identity: Desire to be a good parent, host, and therefore emphasis is placed on amount of food provided, often exceeding what is needed.

Portion Size and Food Affluence: Portion size is taken to indicate how much is considered socially acceptable to eat, without being considered excessive (although it might be excessive in reality).

Food Waste Behaviour and Socio-Economic Status: Associations that are made about one's socio-economic status based on their actions regarding food purchase (i.e. if go to food banks might be considered poor for example), preparation, and consumption.

Ability: The knowledge, actual or perceived skills, and individual capacities to solve the problems encountered when changing and sustaining the new behaviour, including breaking well-formed habits and routines. In food waste domain it is related to the capability of planning the purchase and preparation of food, the proficiency with food preparation skills, the knowledge of storing techniques, the capacity to assess food safety (e.g., through the understanding of labelling), and more in general, to the personal level of food literacy.

Opportunity: The availability and accessibility of materials and resources needed to change behaviour such as time, technology, and infrastructures that allow an individual to perform the intended. In food domain it relates to the actual or perceived availability of time for grocery shopping, cooking activities, availability of stocking capacity and kitchen tools, learning new food-related skills (non-material resources), the access to grocery stores, and to purchase affordable and quality food in suitable packs and portions (material resources).

When creating the structure for coding, the final tree should be structured as follows (guidance):

Motivation
1. Awareness
2. Attitudes (values)
3. Social Norms

- Social norm level (Descriptive/Personal or Injunctive/Group/Societal); if injunctive, mark if the norm is gender related.
- Type of social norm (Prescriptive, Proscriptive and Permissible)
- Example of social norm (Suboptimal Food/Undesirable Food Quality, Good Provider Identity, Portion Size and Food Affluence, Food Waste Behaviour and Socio-Economic Status, or other if present).

Ability
1. Planning the purchase of food.
2. Proficiency with food preparation skills (cooking skills).
3. Knowledge of storing techniques.
4. Capacity to assess food safety.

Opportunity
1. Non-material resources
2. Material resources

Resources:

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