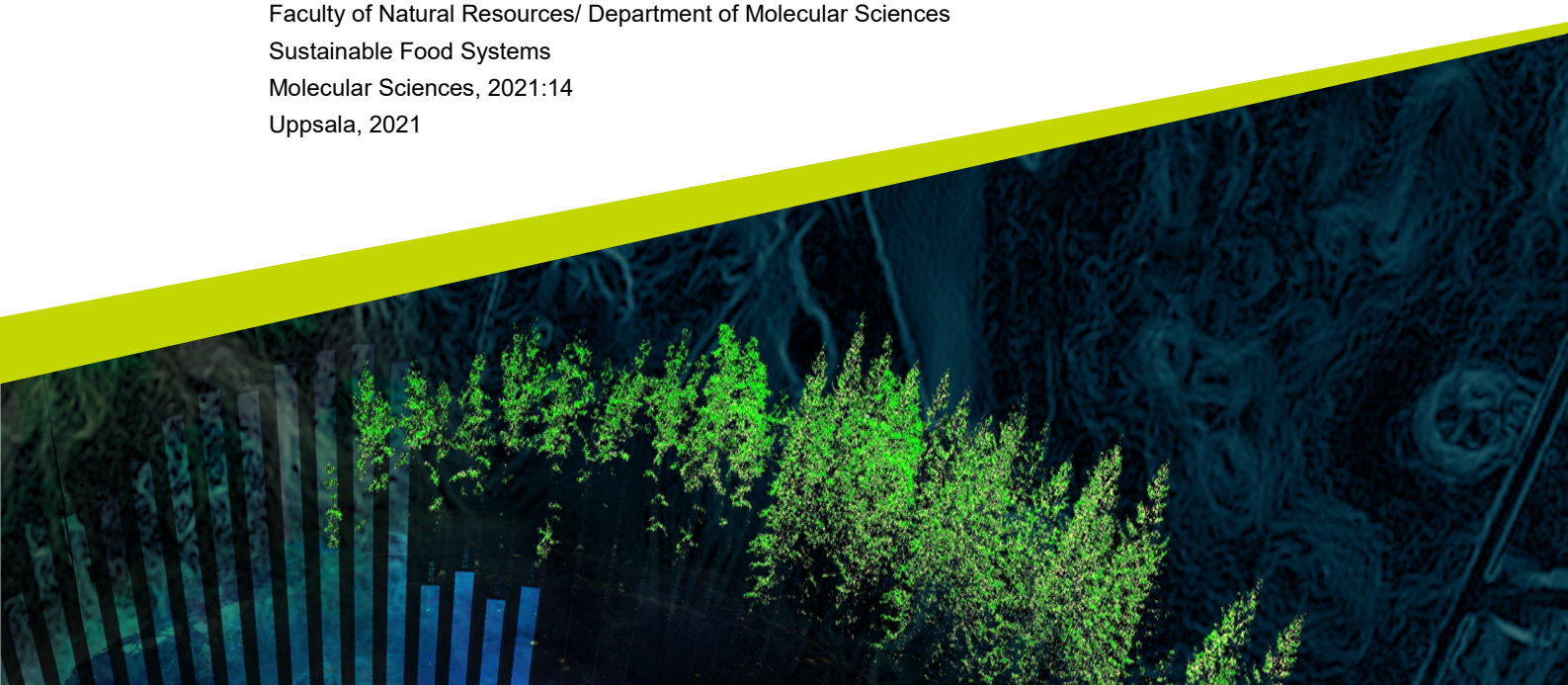
Deligate's role and impact in the food system

– A case study of a Swedish company's multifaceted approach to tackle avoidable food waste in the retail sector

Chelsea Hoegberg and Amanda Olsson

Degree project 30 hp
Swedish University of Agricultural Sciences, SLU
Faculty of Natural Resources/ Department of Molecular Sciences
Sustainable Food Systems
Molecular Sciences, 2021:14
Uppsala, 2021



Deligate's role and impact in the food system – A case study of a Swedish company's multifaceted approach to tackle avoidable food waste in the retail sector

Chelsea Hoegberg and Amanda Olsson

Supervisor:	**Louise Bartek, SLU, Department of Energy and Technology**
Examiner:	Mattias Eriksson, SLU, Department of Energy and Technology

Credits:	30 hp
Level:	A2E
Course title:	**Master Thesis in Food Science**
Course code:	**EX0875**
Programme/education:	**Sustainable Food Systems**
Course coordinating dept:	**Department of Molecular Sciences**
Place of publication:	**Uppsala**
Year of publication:	**2021**
Title of series:	**Molecular Sciences**
Part number:	**2021:14**

Keywords: Circularity Broker, Consumer Behavior, Consumer Engagement, Food System, Food Waste, Price Reduction, Retail Sector

Swedish University of Agricultural Sciences
Faculty of Natural Resources and Agricultural Sciences
Department of Molecular Sciences

Publishing and archiving

Approved students' theses at SLU are published electronically. As a student, you have the copyright to your own work and need to approve the electronic publishing. If you check the box for **YES**, the full text (pdf file) and metadata will be visible and searchable online. If you check the box for **NO**, only the metadata and the abstract will be visible and searchable online. Nevertheless, when the document is uploaded it will still be archived as a digital file.
If you are more than one author you all need to agree on a decision. Read about SLU's publishing agreement here: https://www.slu.se/en/subweb/library/publish-and-analyse/register-and-publish/agreement-for-publishing/.

☒ YES, I/we hereby give permission to publish the present thesis in accordance with the SLU agreement regarding the transfer of the right to publish a work.

☐ NO, I/we do not give permission to publish the present work. The work will still be archived and its metadata and abstract will be visible and searchable.

Abstract

Food waste is occurring at all stages of the food supply chain and leading to environmental, economic, and social costs and injustices. While some actors are responsible for greater degrees of waste, every actor is being called upon to take action. The retail sector is one potential leverage point for reduction measures, but there currently exists insufficient data capturing abilities to fully track and resolve the inefficiencies leading to retail food waste.

Upon recognizing this problem, the Swedish start-up company Deligate has created a program for retailers to track the best before dates of their inventory and take action before food expires, primarily by price reducing expiring items. Additionally, with a pilot self-service price reduction station, called Datum-Rabatten, Deligate is seeking to engage consumers in the issue of retail food waste. This paper set out to define the role Deligate is playing in the food system, what environmental impact the resulting potential reduction in food waste amounts to and finally to understand what factors may influence a consumer's likeliness to engage with the self-service price reduction station.

Utilizing the concept of circularity brokerage as a means to close gaps in the food system leading to waste, Deligate's role has shown to be critical in tackling avoidable retail food waste. Most importantly, Deligate is providing tools for measuring and monitoring grocery store inventories in addition to modifying existing retailer consumer relationships.

Data including the top price reduced expiring items was extracted from Deligate's program, categorized based on past environmental impact studies and the carbon footprint was calculated. It was shown that an average retailer can reduce its annual carbon footprint attributable to food waste by 4 641 $kgCO_2eq$ if they sell 100% of price reduced items. This study contributes to the growing body of food waste research by providing an estimation tool in the form of scenarios of sold price reduced food, which retailers can use to create or gauge alignment with food waste reduction goals. Trends in price reduced items also revealed key product categories which should be targeted and researched for re-evaluation, potentially involving retailers, other upstream actors and academia.

In an effort to investigate consumer motivation to try Datum-Rabatten, an online survey was conducted to uncover consumer awareness, attitudes and shopping habits in regards to retail food waste. The results, framed in the Extended Theory of Planned Behavior, revealed that the main driver for trying Datum-Rabatten was economic incentive, followed by desire to prevent food waste. Despite feeling external pressure to personally act on the issue of food waste, results indicated that consumers view retail food waste as the retailers' burden. The awareness of retail food waste and living environment showed very little effect on willingness to try Datum-Rabatten. Overall, respondents were receptive to the concept, indicating some willingness to accept a role in reducing retail food waste.

The results of this study are intended to be used in the further development of Datum-Rabatten and other future initiatives to reduce retail food waste. May this thesis serve as an example of how external actors can join the food system, create novel connections to resolve inefficiencies and create a more robust and sustainable food system for the future.

Keywords: Circularity Broker, Consumer Behavior, Consumer Engagement, Food System, Food Waste, Price Reduction, Retail Sector

Table of contents

List of tables

List of figures

Abbreviations

CEO	Chief Executive Officer
CF	Carbon Footprint
CO_2eq	Carbon Dioxide equivalents
ECR	Efficient Consumer Response
ETPB	Extended Theory of Planned Behavior
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FSC	Food Supply Chain
FW	Food Waste
GHG	Greenhouse Gas
LCA	Life Cycle Assessment
RFW	Retail Food Waste
SMART	Specific, Measurable, Achievable, Relevant, Time-Bounded
TPB	Theory of Planned Behavior
WRAP	Waste and Resources Action Program

1. Introduction

The global food system has been under a continuous state of evolution to adapt to increasing population needs and technological advancements, from small scale subsistence farming to the green revolution to name a couple. The current era of global trade offers a large variety of readily available food products from all over the world, but not without consequences. As summarized by Priefer et al. (2016), under the current state of affairs, vast amounts of food are lost or wasted at all stages of the food supply chain (FSC). This is not solely economic waste, but it also largely affects the environmental and social outcomes of the food system as well. It was stated by the Food and Agricultural Organization (FAO) of the United Nations in 2011 that one third of all food produced for human consumption is wasted or lost each year, globally (Gustavsson et al. 2011). According to the organization WRAP (2021), this equals 1.3 billion tonnes of wasted food, that otherwise could have fed 3 billion people (FAO 2013). Wasted food is also a major contributor to climate change. In fact, after China and the USA, global food waste (FW) is the third largest producer of greenhouse gas (GHG) emissions in the world (FAO 2015). When the entire European food chain is considered, 15% of the environmental impact is due to FW when Global Warming Potential, Acidification Potential and Eutrophication Potential are used as indicators (Scherhaufer et al. 2018).

Food waste is a complex issue, intertwined with and caused by actions, policies and decisions along the FSC. In high income countries, such as Sweden, this is occurring notably at later stages such as at the retailer and consumption level (Andersson & Stålhandske 2020; Gustavsson & Stage 2011). Due to the wasteful culture that exists in distribution and consumption in high income countries, the carbon footprint (CF) per capita is on a global average greater than double the CF in low-income countries (FAO 2015). It has been suggested that some excess is necessary to maintain food security in food secure regions, but that the surplus should either be limited or redirected to regions experiencing food poverty rather than contributing to FW (Papargyropoulou et al. 2014). According to the waste hierarchy, a guide for waste prevention, waste should preferably be prevented or reused (European Commission n.d. a). But when it comes to food, at later stages of the FSC, prevention seems to be unattainable. Ultimately, this intentional *vastogenic* design of the food system, as labelled by Reynolds et al. (2020), means that waste is a built-in side effect of current production and distribution methods.

During the last decade, the issue of food loss and waste has been brought to the attention of a growing segment of the Swedish population (Rosenlund et al. 2020). In 2018, the total amount of FW in Sweden was 1 300 000 tonnes. This equals 133 kg per person, out of which 95 kg was wasted in the household (Andersson & Stålhandske 2020). Even though multiple campaigns have successfully highlighted the consequences of FW, it remains a problem. The definitions of FW range from expressing it as "post-harvest loss" (e.g. Hodges et al. 2011) to "spoilage" (e.g. Lundquist et al. 2008) and "avoidable" or "possibly avoidable" FW (EC 2010; WRAP 2011). The vast collection of definitions can make comparisons between FW research difficult (Eriksson 2015). Therefore, the chosen definition should be clearly stated. This study specifically focused on retail food waste (RFW) and for that purpose, definitions have been selected which encompass the later stages of the FSC, which point to the actions of key players in the system and mishandling of food as the root of the problem. FAO (2021) describes food waste as the "decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers". Livsmedelsverket (n.d), the Swedish food agency, goes on to include the distinction between avoidable and unavoidable food waste, where avoidable waste could have been sold or eaten if it had been handled differently.

1.1. Problem background

From the general presentation of food waste as a vast problem, this section is focused on FW at the retail level. Challenges and solutions already known is presented, as well as the introduction to the company Deligate, which this case study was based on.

1.1.1. Retail food waste

In comparison to household waste, the retail sector's FW contribution might initially appear rather small. According to Andersson and Stålhandske (2020), per capita household food waste is nearly ten times that which occurs at the retail level. They continue that the total amount of edible and non-edible retail food waste (RFW) in Sweden was 100 000 tonnes in 2018 (ibid.). This generated amount is still significant and poses as a major contributor to environmental, social and economic costs. A study on FW from Swedish retail found that the FW from six stores during three years caused 2500 t of carbon dioxide equivalents (CO_2eq) with an average of 1.6 tCO_2eq per tonne of FW (Scholz et al. 2015).

The food categories most wasted in terms of mass in Swedish grocery stores are fruits, vegetables and bread (Svensk dagligvaruhandel n.d.; Scholz et al. 2015).

Fresh food products are commonly wasted due to aesthetic flaws or spoilage (Andersson & Stålhandske 2020). Inefficient routines, poor planning regarding ordering and difficulty to predict sales can lead to overstocking of items and thereby cause FW (Andersson & Stålhandske 2020; Rosenlund et al. 2020). Furthermore, retailers often feel pressure from consumers to keep the shelves fully stocked (Rosenlund et al. 2020). Overstocking can cause products to come too close to the assigned expiration date and thereby risk being wasted (Andersson & Stålhandske 2020). Broekmeulen & Van Donselaar (2016) further suggest that FW could be considered a choice rather than just an outcome. Scholz et al. (2015) emphasized that for retailers to reduce the CF associated with FW, the focus should not only be on the quantity of waste, but also the products with the highest climate impact.

Food is required by law to be labelled with expiration dates including either a best before and/or a use by date. The best before date indicates the expected time for best quality of the product and after this date the product is still edible. On the other hand, the use by date specifies how long the product is safe to consume, after which the product should not be eaten (Livsmedelsverket 2020a). The date is set by the manufacturer and based on the European Union (EU) Food Law which largely consider the food safety aspect to protect consumers (European Parliament and the Council 178/2002). Grocery stores have the legal right to sell food items that have passed the best before date, as long as the labelling is free from misleading information (Eriksson et al. 2020). However, standard procedures typically lead to wastage of products before they ever reach the best before date, even if the products show no other sign of deterioration (Cicatiello et al. 2017; Lebersorger & Schneider 2014). According to the European Commission (n.d. b), about 10% of the total annual amount of FW in the EU is related to date labelling. In addition, the difference between best before and use by dates are often misinterpreted by consumers, leading to further rejection of often fully edible products (Aschemann-Witzel et al. 2017). A better comprehension of these common date labels, among consumers and other actors, has the potential to reduce and prevent FW (European Commission n.d. b). In summary, overstocking and misinterpretation of best before dates are two key contributors to RFW.

1.1.2. Challenges and solutions to retail food waste

The United Nations' (UN) Sustainable Development Goal 12.3 calls for action along the whole FSC to reduce the per capita global FW by 50% by 2030 (UN n.d.). Every actor carries the responsibility to reach the goal. Measures to reduce in-store FW are not necessarily targeting the source of the problem, but rather handling the symptoms of a series of actions throughout the FSC. Still, at the retail level, FW reduction and prevention efforts have shown to be highly effective (Teller et al. 2018). Retailers already work with small margins and are therefore often driven to

reduce FW since it also represents an economic loss (Cicatiello et al. 2017). Efforts to reduce RFW are therefore often focused on categories with the highest waste potential. The largest retail companies in Sweden, Coop, ICA, Axfood, Lidl and Bergendahls, account for 97% of the market (Svensk Dagligvaruhandel n.d.) and many of them have internal goals to halve the RFW by 2025 (Willys n.d.; Hemköp n.d.; Icagruppen n.d.; Lidl n.d.). Common initiatives to reduce the waste include improved purchasing routines to avoid overstocking, repurposing expiring food products to warm dishes or new products, donations to charity, and price reduction of products approaching best before or use by dates (Svensk Dagligvaruhandel n.d.).

Price reduction to reduce FW is a common practice in food retail (Cicatiello et al. 2017) even though it is a time consuming and labor intensive task often monitored manually by retail employees. On average, large stores spend around 15 hours per week on price reductions, while medium size stores spend around 8 hours per week and small stores around 2 hours per week[1]. However, it is an important part of the daily routines in terms of avoiding FW, since products nearing expiration can be identified and assigned a lower price to potentially increase the likelihood of it being sold before it expires[2]. From a retailer's perspective, items which are either discarded or sold at a reduced price are both classified as waste in their tracking system[3]. Due to the lack of resources, retail employees often focus on price reducing products either with a high economic value, such as meat, or products that generally have shorter shelf life, such as dairy products[4]. Additionally, since product barcodes only have capacity to store limited information about the product and do not include information about the date of manufacture or expiration, the manual approach is the only way to keep track of products' shelf life[4]. Efficient markdown routines require training and committed employees which is challenged by the frequent turnover of staff in retail (Lebersorger & Schneider 2014). Some grocery chains have taken action to make their price reduction routines more efficient by employing date management tools provided by an external actor, such as Deligate. But time is still a scarce resource in retail, because even with the assistance of a date management tool, all products will not be price reduced in time to be sold.

Livsmedelsverket's (2018) action plan for tackling sources of FW includes investigating the benefits of FW reduction incentives, increasing consumer knowledge, understanding consumer decision making behaviors and translating these factors into innovative solutions.

[1] Efficient Consumer Response (ECR) Retail Loss, discussion meeting on food waste and markdown 2021-01-27
[2] ECR Retail Loss, discussion meeting on food waste and markdown 2021-01-27
[3] Adam Vikström, CEO Deligate, video conference 2021-03-17
[4] Adam Vikström, CEO, Deligate, video conference 2021-01-21

1.1.3. Deligate

Under existing practices among retailers for inventory control, about 25% of expiring items with barcodes are thrown away without being identified and price reduced[5]. This led the Swedish start-up company Deligate to develop a program for retailers to make date tracking easier and more efficient. Utilizing Deligate's system, the associated application gives retail employees digital support to keep track of items that are approaching the best before date. By using this program, more expiring items can be identified, price reduced and sold instead of being wasted. Deligate is an external actor, as represented in Figure 1, that found a solution to reduce RFW that saves both time and money for retailers.

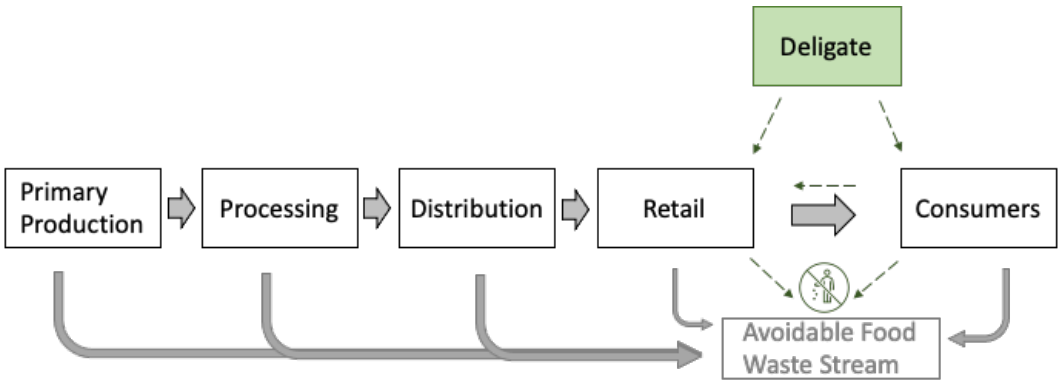


Figure 1. Deligate's position in the Food Supply Chain. Deligate is joining retailers and consumers in a novel way, facilitating information flow and impacting the extent of retail food waste. (Authors' own illustration)

Retailers report that using Deligate's digital system has made their date tracking more efficient and effective (Deligate n.d.). The system is easy to use but requires a start-up period to install the program. Incoming items need to be registered manually, which requires employees to update the digital lists in the application whenever the store takes in new items (Deligate n.d.). But once the new routines are implemented, the date checking becomes more efficient compared to when not using Deligate's application. This program captures and stores information that was previously not collected by retailers, including exactly which items, brands, size and quantity have been price reduced. Previously, retailers only had the data capturing ability to record the economic value of price reduced items, grouped into generalized categories. This meant that detailed adjustments to ordering and stocking practices could not be made, nor process improvement measures realized and implemented.

Taking a step further, Deligate plans to explore consumer engagement in the price reduction process. In April 2021, Deligate launched a pilot for a self-service price

[5] ECR Retail Loss, discussion meeting on food waste and markdown 2021-01-27

reduction station, *Datum-Rabatten,* to further help retailers reduce FW. The aim of the Datum-Rabatten station is to expand the scope of price reduced items and improve the ability to sell a greater variety of such items through consumer involvement, rather than to replace the regular price reduction routines. The first stations were installed in supermarkets in Älmhult and Örebro, Sweden. The Datum-Rabatten station was conveniently placed in the store for easy access from several departments (Figure 2). To use the station, consumers pick food items nearing expiration and bring them to the station to scan them. The program calculates the new price depending on the remaining time until expiration, where the closer to the best before or use by date the greater the price reduction.

Figure 2. Datum-Rabatten in a grocery store provided by Adam Vikström, CEO of Deligate (2021).

Research shows that greater FW reduction can only be accomplished when store employees, managers, parent organizations and consumers work together towards the same goal (Teller et al. 2018). FAO's (2018) vision of a sustainable food system includes aspects such as behaviors among actors, improving performance and knowledge exchange via multi-stakeholder partnerships, and creating positive

feedback loops which naturally increase long term sustainability. Deligate's solutions address these goals.

1.1.4. Consumer perception of price reduced food

It has been shown that strategies to reduce FW and give it a second chance for human consumption is appreciated by consumers and can improve the image of the store in the eyes of the consumers (Cicatiello et al. 2017). Consumer acceptance of price reduced items does not always align with the findings by Cicatiello et al. (2017) though, and is therefore worth exploring further. How consumers perceive and value price reduced food revolves around several different factors. Products with an appearance lower than the cosmetic demands from both retail and consumers, are often perceived as being hard to sell (Rosenlund et al. 2020). Studies on consumer acceptance and perception of suboptimal food have found that younger consumers, consumers with higher education and those who were more concerned about the price had a higher interest in buying food that had been price reduced due to suboptimal appearance or quality (Aschemann-Witzel 2018). In addition, the study showed that women could be more positive towards FW avoidance than men in general, and that men tend to focus more on the price (ibid.). Consumers in general tend to avoid buying price reduced food when they feel there's a risk that the food might just lead to waste at home and not be consumed in time (Aschemann-Witzel 2018; Aschemann-Witzel et al. 2017). It is not only perceived as a waste of food but also as a waste of money, despite the price reduction (Aschemann-Witzel et al. 2017). The concern about food safety is strong among some consumers and can be another reason to choose not to buy products nearing its expiration date. To this background, the pilot launch of Datum-Rabatten hopes to find out if and how this innovation can help retailers succeed to price reduce and sell expiring food, that also has a high chance of being consumed at home.

1.2. Aim and research questions

There are many initiatives and companies working to address the issues and challenges related to retail food waste (RFW). This thesis explored Deligate's unique contributions to the food system. Using this case as our unit of study, the aim was to identify and evaluate Deligate's role and impact in the food system in terms of food waste reduction and associated reduction of carbon footprint (CF). Further, the aim was to analyze their innovative solution for consumer engagement with the issue of RFW, and to illuminate where this innovation has the highest

potential to lead to food waste (FW) reduction. These aims have been addressed by asking the following research questions:

- How can Deligate's role in the food system be positioned and defined?
- What is the potential reduction in CF of avoidable FW at the retail level when using Deligate's program?
    - What trends among commonly price reduced items can be identified and utilized?
- What factors could influence a consumer's likeliness to engage in the price reduction of soon to expire food items utilizing Datum-Rabatten?

2. Conceptual framework

This chapter sets out to create a conceptual framework in which to organize and understand the case study at hand. It lays the foundation for the analysis of Deligate's role in the food system as well as their future prospects, recognizing the complicated network of actors, influences and drivers that emerged during the research process. One useful approach to begin to break down and understand a system is to consider each of these actors, or stakeholders, and the role they play in the system. *Stakeholder Theory,* the concept of circularity brokerage and the *Extended Theory of Planned Behavio*r (ETPB) have been explored and applied. With these conceptual tools the *who*, *how* and *why* of this case study are addressed.

2.1. Actors in a system

Presented by Freeman (1984), Stakeholder Theory suggests that each stakeholder, or actor, within a system is important for the success of a business. Relevant stakeholders can be found both internal and external to the company or system and can exert various pressures or influences. Important to this study is that stakeholder theory goes beyond the means in which shareholders' profits can be increased, but rather draws focus to how the organization's objectives can be bolstered or prevented by internal and external stakeholders (Phillips et al. 2003). The authors continue that it is the interests and well-being of these stakeholders which are critical to the theory, even those stakeholders who fall outside of the profiting shareholder realm (ibid.).

In this study the Stakeholder Theory is applied to Deligate and their role in food waste reduction at the retail stage in the food supply chain (FSC). The introduction of this novel type of actor near the end of the FSC has the potential to create value for those stakeholders directly involved and those external to their direct operation. The involvement of consumers in a slightly new role via the introduction of a self-service price reduction station will also be discussed through the lens of the Stakeholder Theory and complemented by additional concepts which can explain how and why they may adopt this new role.

2.2. Bridging gaps

The global food system is a complicated network of actors and the relationships and activities which link them. The varying degree of waste along an entire FSC is a symptom of inefficiencies of these relationships and activities. Such inefficiencies can be identified as *circularity holes,* which describes the discarded products of the supply chain and can arise due to actors on either side of the hole not recognizing the value of the waste or lacking the connections to transfer it to other actors in a feasible manner (Ciulli et al. 2019). Such circularity holes, which lead to disposal of edible food, contribute to the well documented issues of FW in the food system. To resolve circularity holes, a *circularity broker* can enter the system and either form new connections or bolster existing connections by fostering new relationships or coordination on the basis of access or trust (ibid.).

By analyzing numerous FW reduction platforms, Ciulli et al. (2019) identified the six ways in which circularity brokers can help bridge these gaps: *connecting, informing, protecting, mobilizing, integrating, measuring* as visualized in Figure 3. Some organizations achieve their mission by specifically fulfilling one of these roles while others create solutions by accomplishing multiple roles.

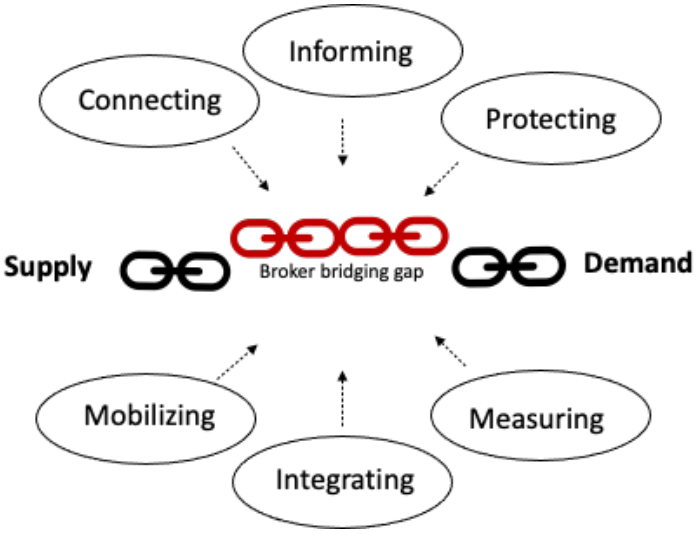


Figure 3. Authors' own visualization of the key roles fulfilled by circularity brokers based on Ciulli et al. (2019).

Clearly, the role of connecting is the most common feature of the studied circularity broker models by virtue of creating new linkages or modifying existing relationships. The nature of information exchange has the power to transform relationships via the role of informing, by either filling knowledge voids or correcting misinformation. Particularly meaningful is the way waste is framed in economic, environmental and social contexts to improve perceptions and connections. Due to the uncertainties or perceived liabilities that come with opening

FW recovery channels, the role of protecting can be adopted by the broker for either the sake of the provider or receiver of discarded items. Next, depending on the circularity broker's model, they may serve to mobilize in the form of recruiting volunteers, partners or other stakeholders in the equation. For those circularity brokers which are projecting their model onto an existing supply chain, which are the majority, they are actively integrating new methods, tools or approaches into existing logistics and processes. Ciulli et al. (2019) offer two key concepts here, *co-creating* and *combining*, to explore how the platforms are weaving the new concept with the existing technologies and processes, primarily on the supply side of the circularity holes. This integration, rather than complete overhaul, creates more feasible solutions that can function in reality. Lastly, measuring is a function provided by some platforms and can be in the form of environmental or social impact, financial terms or the amount of waste saved. This accomplishes several functions and importantly motivates actors on both sides of the bridge to sustain and even increase the work being done to save food from being wasted (ibid.).

2.3. Understanding consumer intentions and predicting behavior

Despite best efforts to understand consumers' values and motives, there still often exists an attitude-behavior gap, which could derail a well-intentioned concept or marketing strategy. Certain consumer awareness or attitudes surrounding sustainability issues, for example, do not always lead to expected consumer action which reflect their knowledge or set of values (Belz & Peattie 2012). Belz & Peattie provide several potential reasons for this disconnect, including biased research results due to social enthusiasm surrounding an attitude, exaggeration of self-reported performance of behaviors compared to reality, stubborn habits, and constraints inhibiting follow through, such as budget or life circumstances (ibid.). While this may be an obstacle for the implementation of the new shopping concept presented in this case study or attempting to reform consumer shopping habits regarding best-before dates, there are tools available to better understand the factors which influence intentions and behaviors. Belz and Peattie (2012) say "there is no substitute for getting to know your consumers" (p. 105), thereby highlighting the importance of including consumer perception when evaluating Deligate's role.

In order to explore how Deligate engages stakeholders, primarily consumers, in a new and innovative manner, the Extended Theory of Planned Behavior (ETPB) has been employed. Based on the original Theory of Planned Behavior (TBP) by Ajzen in 1991, Tommasetti et al. (2018) proposed an extended model which is argued to be useful in predicting behaviors in given scenarios based on several factors. This

model, detailed in Table 1, outlines the five key variables which influence a person's intentions which in turn will motivate a given behavior. Attitude, subjective norm and perceived behavioral control are the original basis of the TPB with perceived usefulness and curiosity creating the extended model (ibid.). Due to the generic nature of these variables, this model has been deemed appropriate to apply to many different contexts. While this model aims to pinpoint and isolate these factors, completely isolating a given variable from other social contexts or the population average, visible or invisible, cannot be done with absolute certainty (Manski 1993). Nonetheless, this model is a useful tool for exploring the cause behind behaviors in a meaningful way.

Table 1. Collection of definitions for the five variables of ETPB. Authors' own compilation based on Tommasetti et al. (2018).

Variable	**Explanation**
Attitude toward the behavior	A developed state of mind, complex and multifaceted, which influences a person's response. This is molded over a lifetime by life circumstances, social cues, etc.
Subjective Norm	Perceived pressure or expectation from others within one's social group which carries enough influence to change their thoughts, opinions and behaviors.
Perceived Behavioral Control	Whether a person believes they have the ability and freedom to partake in a behavior.
Perceived Usefulness	Extent to which a person believes the behavior will provide them benefit.
Curiosity	An innate stimulus behind behavior making decisions.

As a complement to the above behavior predictors, the *Ikea effect* has been shown to illustrate another source of influence regarding how consumers value a given product. Consumers increased the valuation of a product if they invested labor into it, for example assembling a piece of furniture from Ikea (Norton et al. 2012). This effect stems from the will to create some desired outcome in one's environment. Further, this effect has been shown to be applicable to the "mundane and utilitarian", implying the application of the concept has broad implication when it comes to forming a consumer's perceived value of something. This value, or in other words perceived usefulness, was shown to be a strong factor predicting behavior in the ETPB.

3. Methods

The case was deployed from a system's perspective, recognizing the complicated network of actors, influences and drivers that emerged during the research process. In order to facilitate the understanding of this paper, a project outline has been mapped to provide an overview of the structure (Figure 4). The project followed two parallel paths where first Deligate's role and impact was evaluated, which was supported by the second path focusing on consumers' perceptions of retail food waste (RFW) and their likeliness to use Datum-Rabatten. The two paths used quantification and surveys, respectively, as the main methods. Findings from each path will be harmonized in a synthesis after the analysis and discussion.

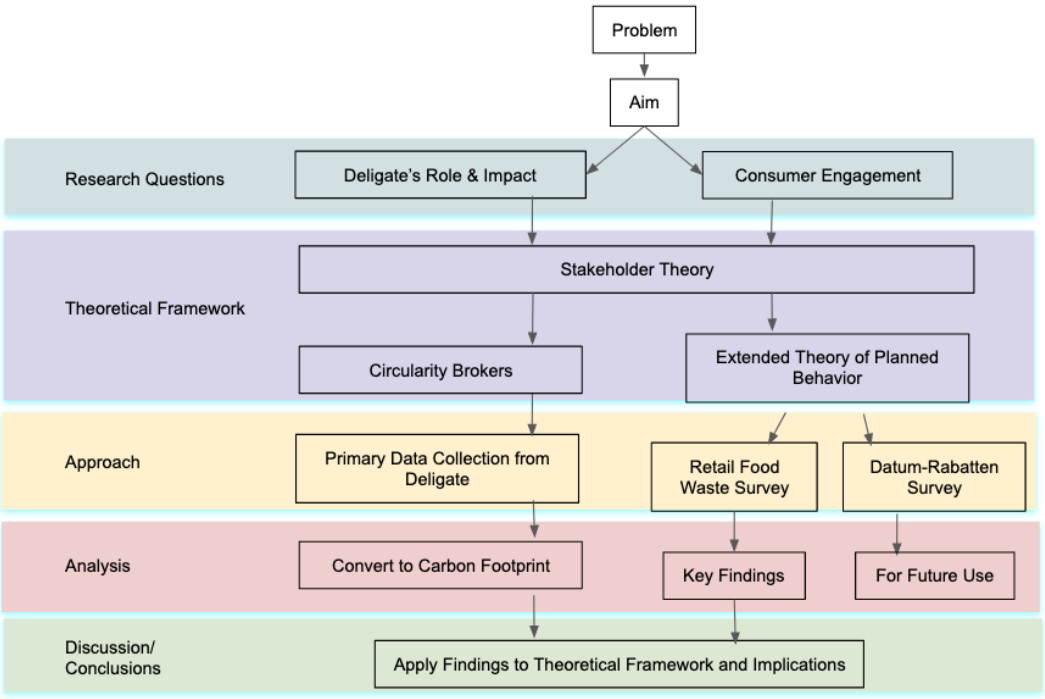


Figure 4. Project outline illustrating the two paths the study navigates.

3.1. Deligate's role

In order to define Deligate's role regarding how they are addressing inefficiencies which are leading to RFW, the concepts of stakeholders and circularity brokerage

roles was found to be applicable. With information gathered about Deligate's operations from direct communication with the Chief Executive Officer (CEO) of Deligate, Efficient Consumer Response (ECR) working group meetings and Deligate's website, each of the brokerage roles was assessed to see how Deligate's actions align within the circularity brokerage framework.

3.2. Quantification

The next part of the study consisted of a quantification based on Deligate's current program. The dataset was analyzed in terms of Carbon Footprint (CF) attributable to potential RFW. Finally, sensitivity analyses of the results were carried out.

3.2.1. Data collection

The data obtained from the CEO of Deligate contained monthly reports of the top 100 price reduced items pooled from a group of retailers in 2020. These 82 retailers belonged to the same parent company and consisted of stores of varying sizes and throughput. Data was not broken down to each individual retailer.

The monthly reports only included barcoded food items, due to the nature of Deligate's system. The reports held information about the name of the item, brand, weight or volume, the number of occasions for price reduction, and total number of units in which that item was price reduced across the retailers for any given month.

3.2.2. Categorization of price reduced food and potential climate impact

Life Cycle Assessment (LCA) is a valuable tool to account for the input resources and resulting impacts of food production, which go to waste when food does not reach its intended end consumer. Although the LCAs that provided the foundation for categorization in this study originated from previous studies and were not calculated by the authors of this thesis, a short introduction to the structure for conducting a LCA here follows. The International Organization for Standardization's LCA standard allows for flexibility in the creation of studies with different goals and provides a general framework for how to structure a LCA study, including four mandatory phases (Röös 2013). In the first phase, the aim, scope and definition, as well as system boundaries are defined. Phase two is the inventory analysis where data of flows in and out from the defined system are collected, such as input of resources, and output of environmentally damaging emissions. The third phase is the impact assessment where the impact of these flows are categorized into impact categories. In the impact category Global Warming, greenhouse gas (GHG)

emissions are converted into one common unit, CO_2eq. The fourth phase is the interpretation of the results, which leads to conclusions and recommendations (ibid.).

To assess the potential avoided climate impact from using Deligate's system, the dataset containing the top 100 price reduced items were categorized according to its primary ingredient and then multiplied with a characterization factor to assess the climate impact. The food categories selected were based on Mat-Klimat-Listan by Röös (2014) which in turn was based on literature reviews of LCA of various food products. Mat-Klimat-Listan provides a list of calculated CO_2eq for common food categories. These categories are broad, including a wide variety of products from different production systems, therefore, a range of possible minimum and maximum CO_2eq for each food category are provided. The list accounts for the climate impact from primary production and processing of food until delivery to retailers (Röös 2014), other environmental impacts are excluded in this list. Röös (2014) encourages the list to be used in research and businesses to generate comparable results for the CF within the food sector. It should be noted that the list's expected durability was until 2015, but the decision to use it in this study was motivated by the extensive literature review and LCAs that led to the compilation of CF values, and the fact that the work by Röös, to our knowledge, is the most current one of its kind.

In the categorization process, products that contained multiple ingredients or did not fit into an existing category were placed in generalized categories, such as "other pantry". These multi-ingredient items, where it was difficult to identify the main ingredient, were either low in quantity or degree of impact was ambiguous. Next, the CF per category was calculated to show monthly and yearly total CO_2eq of price reduced items. This was calculated by multiplying the average CF/kg derived from Röös (2014) with the cumulative category weight (normalized to kg) to generate the CO_2eq per category. These total CF values per category were collected into a total annual CF, and then further broken down to an annual average over the 82 retailers.

3.2.3. Sensitivity analysis

The assumptions for the CF from each category over the course of 2020 were entirely based on the average values for climate impact from Röös (2014). Some categories used in the current study, such as minced meat, beef and fish/seafood had an average CF based on large intervals, indicating a dramatic difference in climate impact depending on origin and agricultural practices. To evaluate how this assumption influenced the result, a sensitivity analysis was conducted where the average CF value was replaced with either the published minimum or maximum

value and a percent change was calculated. For the high impact meat categories beef, chicken and pork, conversion factors from Scholtz et al. (2015) were used to reflect either entirely Swedish or imported goods since Röös (2014) did not explicitly provide these variables. Livsmedelsverket (2020b) reports that there are not substantial differences in CO_2eq between organic and conventional animal rearing systems, excluding chicken, so these assumptions were not selected for analysis. For all other items, the low and high end of the intervals published by Röös (2014) were used.

Additionally, the data lacked confirmation of the number of sold price reduced items and was therefore another source of uncertainty when projecting the potential impact of avoided food waste. To generate any result of CO_2eq reduction due to the use of Deligate's program, four sale scenarios were developed that each proposed a percentage of either 25, 50, 75 and 100% sold price reduced items. This analysis serves as an additional perspective and application of the results of Deligate's price reduction tool.

3.3. Surveys

In the next part of the study, two surveys were created, the *Retail Food Waste* survey and the *Datum-Rabatten* survey, targeting prospective and actual users of the Datum-Rabatten station. The surveys were designed to gain insights into consumers' attitudes towards RFW in general, as well as their likeliness to try Datum-Rabatten. Furthermore, the surveys intended to benefit Deligate regarding their current program and future developments. Both surveys were created in Netigate, a survey tool accessed through the Swedish University of Agricultural Sciences (SLU). For the sake of secrecy, the name Datum-Rabatten was not presented to the respondents in the Retail Food Waste survey but coded as a Self-Service Price Reduction Station.

The Extended Theory of Planned Behavior (ETPB) was utilized in the creation of the structure and content of the surveys. The use of ETPB was motivated by the fact that possible information and trends identified in the surveys could function as control mechanisms to help convince a desired consumer group that choosing a given behavior is in line with their way of thinking. Questions were created which would allow for analysis with the theoretical frameworks selected. Ajzen's (2013) guide, which provides examples of appropriate question structure and language to align with the ETPB, was consulted to design questions which uncover consumer drivers in decision making. Please review appendices A and B to see the intended measures, questions and answer structure of each question of the Retail Food Waste survey and the Datum-Rabatten survey respectively.

3.3.1. Sampling

The exploratory Retail Food Waste survey was intended to gauge awareness and attitudes regarding FW in the retail sector, including likeliness to engage with the Datum-Rabatten station in retail stores. With the goal of reaching the widest respondent population possible, the Retail Food Waste survey was launched via social media channels (Facebook, Instagram, LinkedIn) and respondents were encouraged to share the survey with others. This could be considered a convenience sampling, aiming to engage those who were exposed to the survey via these networking channels and were willing to take the survey with no other qualifiers factored in. Participation in the survey was voluntary and participants were informed that the results would be used for research purposes.

Due to time constraints and delayed launch of Datum-Rabatten, results from the Datum-Rabatten survey were not included in this thesis. However, it is still a tool available to Deligate for the future evaluation and development of the concept. It is intended to only be available to people who use the Datum-Rabatten pilot station and volunteer to participate. After using the station, each user will have the option to enter their email address to have the survey sent to them.

3.3.2. Statistical analysis

The survey tool Netigate was used to generate visual outputs of the result. As a complement to these results, it was desirable to investigate whether a significant relationship existed between different answers. Therefore the statistical tool SPSS, commonly used for analysis of survey data, was used for further analysis. The survey answers selected for analysis were of ordinal type, therefore Spearman's rho correlation test was applied. The possible correlation coefficient lies between -1 and 1, where 0 equals no relationship, -1 equals a perfect negative relationship and 1 equals a perfect positive relationship between the variables (Bryman 2015). A positive relationship is when one variable changes, the other variable follows the same trend. In a negative relationship, when one variable changes, the other variable moves in the opposite direction. The scale indicates the strength of this relationship.

3.4. Synthesis of findings

In order to bring together the findings from this study and evaluate Deligate's approach, the findings were put in the context of a food waste reduction assessment framework. Caldeira et al. (2019) have reviewed multiple FW assessment studies and the authors have composed a FW assessment tool which provides several focal

points to consider when evaluating FW prevention measures: Quality of the action design, Effectiveness, Efficiency, Sustainability Over Time, Transferability and Scalability, and Intersectorial Cooperation.

3.5. Delimitations

A flexible study design allowed a unique study structure, as outlined in Figure 4. While a systems perspective has been adopted, the scope of the food supply chain (FSC) was limited to focus on those actors relevant to this case study. One driver for utilizing a flexible study design was that access to data, from both Deligate and retailers, was limited by: lack of data on price reduced food items sold, access to data from only one food retail company, limited to the top 100 price reduced items, from only 2020, and lacking baseline data from retailers prior to using Deligate. While considered limitations, it also offered the unique focus of this thesis compared to past RFW research.

The chosen survey sampling method for the Retail Food Waste survey entailed an acknowledged sampling bias, as the nature of the authors' social networks could risk getting more responses from people with similar demographic attributes and attitudes regarding these issues. Additionally, the Datum-Rabatten survey was not conducted due to time constraints, which in turn prevented the authors from comparing the attitudes revealed in the Retail Food Waste survey with actual consumer behaviors.

Lastly, the ongoing Covid-19 pandemic created additional challenges and potential unforeseen effects on the results. In-person meetings with Deligate were not possible, therefore reducing the efficiency of communication and possibly preventing a more hands-on approach. Due to the pandemic, shopping habits have changed among consumers which possibly could influence survey responses.

4. Results and analysis

Continuing with the two study paths outlined in Figure 4, the results of Deligate's role are presented first, followed by the quantification portion which is organized into sections by climate impact calculations and sensitivity analysis. Second, the results from the survey are described and key findings highlighted.

4.1. Deligate's role

To understand if Deligate is acting to address circularity holes in the FSC, an examination of which circularity broker functions the company has adopted and taken action to resolve in relation to other stakeholder groups, namely retailers and consumers, is outlined in Table 2.

Table 2. Description of how Deligate fulfils circularity brokerage roles. Application of Ciulli et al. (2019).

Role	**Retailer via Deligate's program**	**Consumers via Datum-Rabatten**
Connecting	Helping more food reach final consumption stage.	Modifying existing retailer-consumer relationships.
Measuring	Quantity and identification of items which are price reduced.	Quantity and identification of items sold which were at risk of expiring, possibly undetected.
Mobilizing	n/a	Engaging this existing stakeholder group in a novel way.
Integrating	Modifying existing inventory checking procedures to include Deligate's new system.	n/a
Informing	Reminding retailers when items are nearing expiration and require action.	Communicating the need for FW action via presence of Datum-Rabatten. Education possibly leading to behavior change.
Protecting	n/a	n/a

4.2. Climate impact and trends of price reduced items

Based on the sampling of 82 retailers described in section 3.2, the top 100 price reduced items were analyzed (Appendix C). Some food items that were frequently price reduced and therefore appeared in the top 100 list every month were beef, charcuterie, chicken, cheese, cream, egg, milk, pork and vegetarian ready meals. Since being the most frequently price reduced food categories, these food items could be considered most likely to have otherwise ended up as FW. However, this is just a piece of the retail food waste (RFW) picture since items which are not dated or barcoded are not included, such as many fruits and vegetables. The result of 214 490 items marked for price reduction from the 82 retailers added up to 115 tonnes of food with a total annual CF of 380 tCO_2eq. This value corresponds to potential avoided climate impact due to Deligate's program.

Of the top 100 price reduced items, very different impressions can be inferred depending on whether the CF or mass is used as a unit of measure, as shown in Figures 5 and 6 respectively. If CF is considered, beef accounted for 43% of the top categories while milk and yogurt was responsible for 20%. However, if mass is considered, beef accounted for only 5.4% of the total mass of price reduced items. Milk and yogurt dominated the items most frequently price reduced and were responsible for 64% of the total mass when the same categories are considered. Regarding quantity of price reduced items, the milk and yogurt category stood out in that it represented on average 42%. This is a brief subset of data to show how the unit of measure influences the story the data tells.

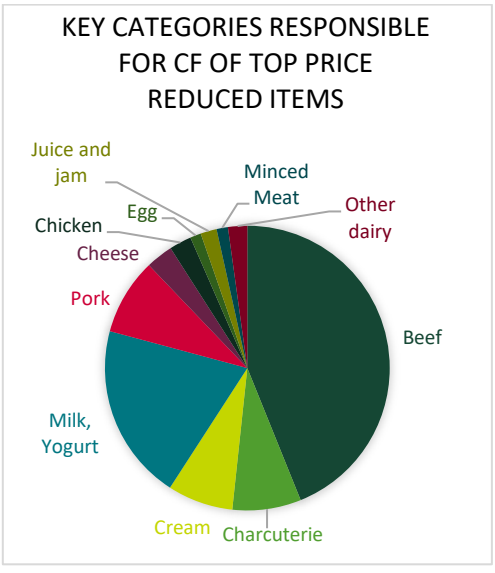


Figure 5. Carbon footprint of potential retail food waste, illustrating the key categories represented in the top 100 price reduced items.

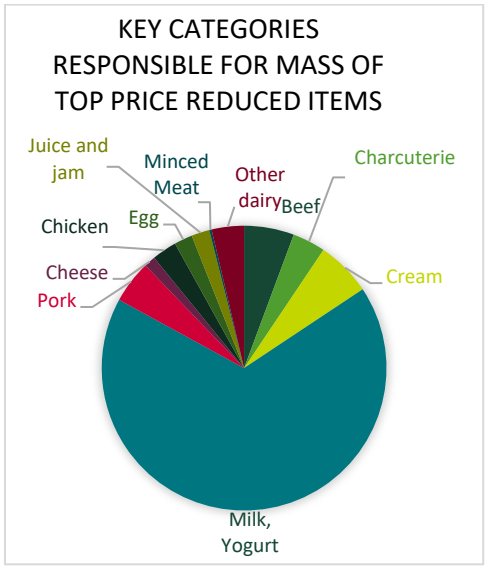


Figure 6. Mass of potential retail food waste, illustrating the key categories represented in the top 100 list of price reduced item.

4.2.1. Sensitivity analysis of carbon footprint estimations

Since the top price reduced items contain some of the most CO_2eq intensive products, a sensitivity analysis was performed to explore the degree to which the assumptions behind the original calculation methods can impact the results. Meat products, depending on whether they were produced in Sweden or were imported, resulted in the greatest range of possible CF, with beef contributing up to 25% more CO_2eq if it is assumed that it was all sourced abroad. Additionally, dairy products could potentially be responsible for up to 29% more CO_2eq if more intensive production systems are relied upon. The tested assumptions were limited to exclusively Swedish or imported production scenarios for meats and the extremes of the range provided by Röös (2014) for all other product categories. Table 3 shows which products are most sensitive to the assumption of this paper, where the result for beef, milk and yogurt showed the highest sensitivity to changed CF values while the remaining categories were not as impacted.

Table 3. Sensitivity analysis testing assumptions of carbon footprint (CF) estimations. Reporting the percent change of the categories' share of total CF when the end values of literature CF range are used in place of the average.

Category	Low end value (% change)	High end value (% change)
Beef*	5	25
Butter	0	0
Candy	0	0
Charcuterie	-3	3
Cheese	-1	1
Chicken*	0	1
Cream	-4	4
Egg	0	2
Fish and seafood	0	0
Juice and Jam	-1	2
Margarine	0	0
Milk and yogurt	-4	29
Minced meat	-1	1
Other dairy	-1	3
Other pantry	0	0
Fresh yeast	0	0
Pasta	0	0
Pork*	0	1
Potato	0	0
Ready Meal fish	0	0
Ready Meal meat	0	1
Ready Meal veg	0	1
Roots, onions, cabbage	0	0
Salad vegetables Scand.	0	0
Sauces and spices	0	0
Soda	0	0

Range values from Röös (2014), unless indicated with * then values are from Scholtz et al. (2015).

Data was not obtained regarding the amount of price reduced food which was actually sold. This type of data does not feed back into Deligate's system and would have required more cooperation from retailers. To account for this uncertainty, the total calculated impact was divided equally between the 82 retailers, despite awareness that the data was obtained from stores of various sizes. Considering the lack of confirmed sale of price reduced products, Table 4 illustrates four scenarios where if a given percentage of the top price reduced items are sold, then an average retailer can potentially reduce the annual amount of CO_2eq which is attributable to FW by the amounts listed.

Table 4. Potential CO_2 eq reduction for four scenarios of avoided food waste.

Percentage sold	Average annual reduction kgCO_2eq attributable to retail food waste
100	4 641
75	3 481
50	2 320
25	1 160

4.3. Retail food waste survey

Over 18 days, 248 respondents participated in the survey on RFW awareness and likeliness to engage with Datum-Rabatten, with 225 completing all questions. Table 5 shows the demographic distribution of the respondents. Answers were obtained from participants living in 14 countries, with Swedish and American residents dominating the sample pool with 51% and 36% respectively. Of note, respondents were primarily female, educated at university level, and living in a household of 2-4 people.

Table 5. Sociodemographic sample characteristics.

Variable	Sample Description (n=248)
Age	
18-30	43%
31-45	34%
46-60	13%
>61	10%
Gender	68% Female, 31% Male, 1% prefer not to say
Living environment	48% Urban, 36% Suburban, 16% Rural
Household Size	15% Single, 77% 2-4, 8% 5+
Highest Education Level	3% Compulsory School, 9% High School, 5% Trade School, 83% University (any level)

4.3.1. Awareness and attitudes

When asked about their impression of the amount of discarded food at grocery stores, due to passing the expiration date, none of the respondents had the impression that the amount is negligible (Figure 7). The majority thought it was too much (43%) or excessive (36%), while 14% admitted they were not aware of the issue.

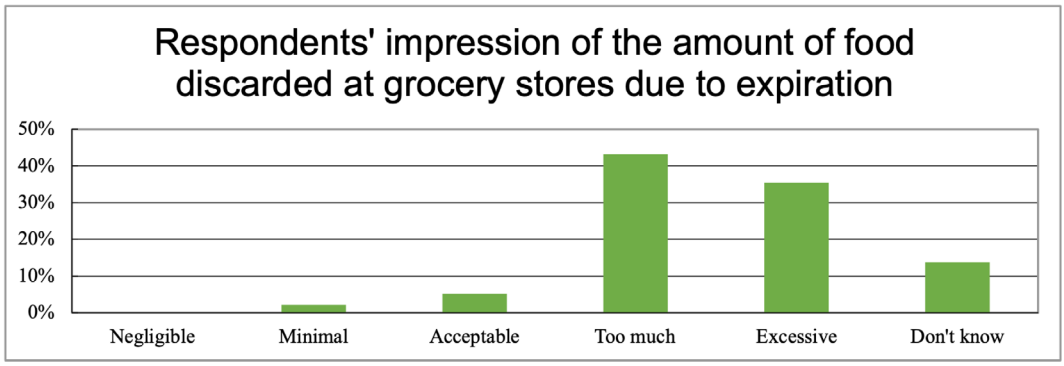


Figure 7. Food waste awareness. Respondents were answering according to their own impression of the amount of wasted food in grocery stores, not according to actual facts.

When asked about the urgency of RFW, the majority agreed and 39% strongly agreed that RFW is in need of an urgent solution (Figure 8). Additionally, when asked about their opinion about the best way to handle unsold expired food, none of the respondents thought that wasting food was the best solution, presented in Figure 9. The result rather suggests that donation (49%), avoidance (32%) and repurposing into new products (19%) were preferred solutions regarding handling unsold expired food. When asked if they felt external pressure or expectancy from others to do something to reduce FW, 60% said they did and only 2% strongly disagreed.

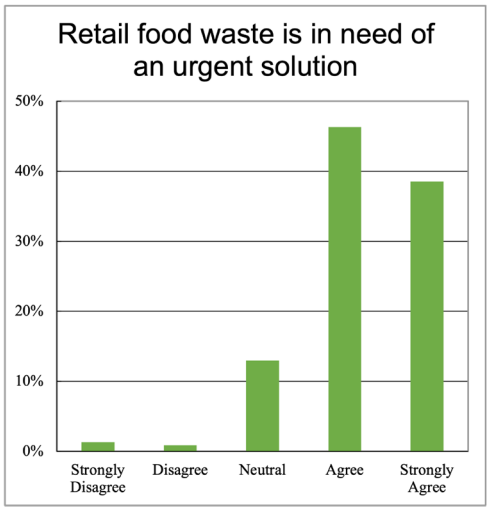


Figure 8. Respondents were answering according to their own impression of the urgency to handle retail food waste.

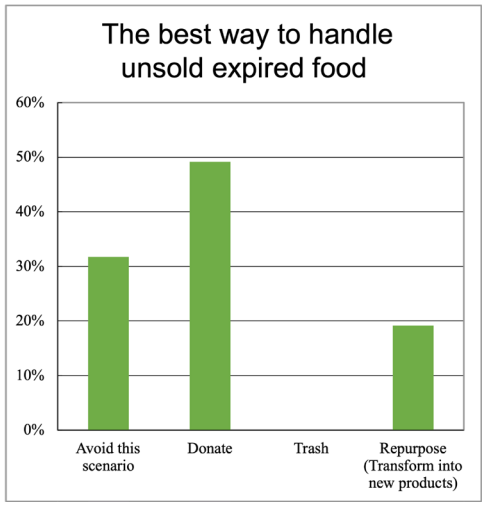


Figure 9. Respondents were answering according to what they thought was the best way to handle unsold expired food.

Further, Figure 10 shows how the respondents' impression of RFW translated into what they thought was the best way to handle unsold expired food. Their FW awareness had little effect on their preferred FW mitigation measure. All alternatives for RFW awareness were represented relatively evenly in every alternative for RFW mitigation that had responses.

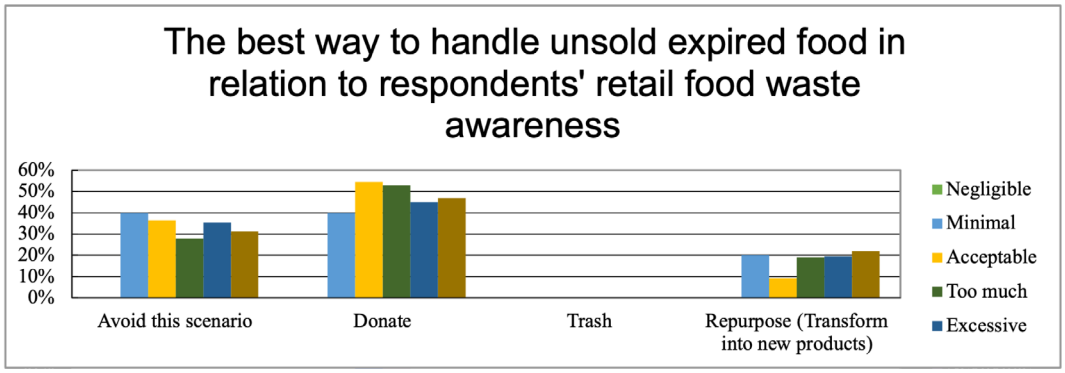


Figure 10. Within a group of respondents who answered to their impression of the degree of retail food waste, the distribution of their opinion of the best way handle unsold expired food is shown by the colored bars.

Respondents were then introduced to questions regarding expiration dates. When asked if they thought it was safe to consume food that has passed its best before date, 90% believed it was safe while 10% thought it was unsafe. The greater part (84%) usually consider the expiration date when grocery shopping, almost half of the respondents who did consider the expiration date mainly did so to find the

freshest product on the shelf. Another 40% wanted to make sure the product had not expired while 11% looked to find products nearing the expiration date. Only 16% of respondents did not consider the expiration date when shopping.

When asked whether they usually purchase price reduced food items close to expiration, 63% answered that they indeed buy such products and 37% responded that they did not. Out of the respondents who were positive to buying price reduced food, 52% did it because it is cheaper, for 26% the reason was to prevent FW. The most common reason for not wanting to buy price reduced products was that it was not believed to be worth the effort and that it would not be consumed in time. The least common reason, expressed by 29%, was that they would rather buy fresh products. For another 29% the reason was that the products they like are usually not price reduced.

4.3.2. Likeliness to engage with Datum-Rabatten

The following questions focused on the respondents' thoughts about the idea of Datum-Rabatten. After an introduction to the concept, the majority of respondents were either likely (38%) or very likely (43%) to try Datum-Rabatten in the future. Only 13 out of 227 respondents were either unlikely or very unlikely to try it, where the most common reasons not to try it were the time-consuming aspect or unwillingness to consume items close to expiration. On the other hand, the most common reason to try it was the opportunity to save money, tightly followed by the fact that it prevents FW. The likeness to try Datum-Rabatten is summarized in Figure 11.

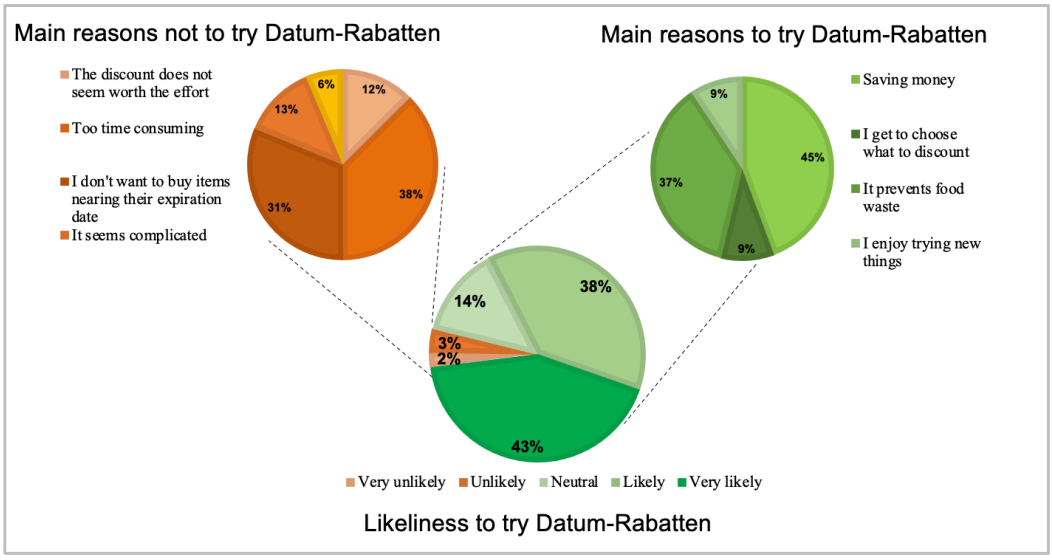


Figure 11. Summary of respondents' likeliness to try Datum-Rabatten. Reasons to try Datum-Rabatten are presented in green. Reasons not to try Datum-Rabatten are presented in orange.

When presented with the possibility to use Datum-Rabatten in the future to price reduce items nearing expiration themselves, the respondents were asked to also rank which type of item they were most and least likely to choose (Figure 12). The provided categories were: ready-to-eat fresh meals, fresh fruit and vegetables, fresh meat, pantry goods, dairy and packaged bread. Each item could only occupy one ranking position. The results show that 40% of the respondents selected pantry goods as the item they were most likely to choose for price reduction, while dairy and ready-to-eat fresh meals were rarest in this category. On the other hand, ready to eat fresh meals and fresh meat were least likely to be price reduced by the respondents.

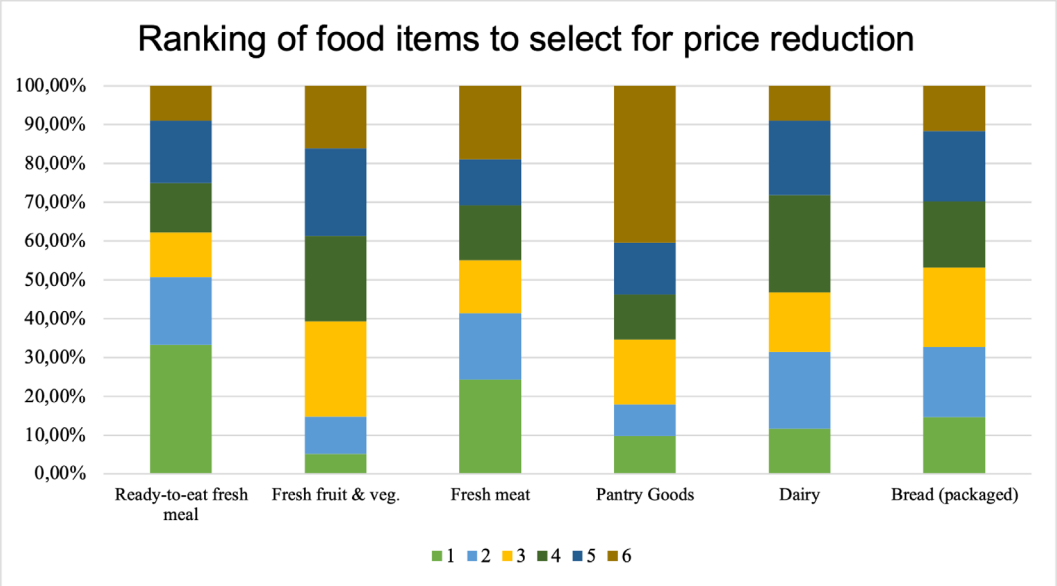


Figure 12. Ranking of food items to select for price reduction on a scale of 1-6. 1 = least likely and 6 = most likely. Each item could only occupy one ranking position when ranked by the respondents. The colors represent the distribution of ranking scores for a given food item.

The Netigate output of the survey results showed a potential for higher consumer awareness regarding RFW to be translated into higher likeliness to try Datum-Rabatten (Figure 13). Out of the respondents who thought the amount of discarded food was excessive, 56% were very likely to try Datum-Rabatten. Spearman's correlation test showed a correlation of only 0.081 between consumers' impression of the amount of RFW and their likeliness to try Datum-Rabatten. While this is a relatively low positive score, it does reflect a positive correlation where some degree of increased RFW awareness possibly led to increased likeliness to try Datum-Rabatten. Among the respondents who either thought the amount of RFW was acceptable or who did not know, the responses were spread more evenly over most of the alternatives. As shown previously in Figure 11, there were several drivers or motivators for wanting to try or not to try the concept.

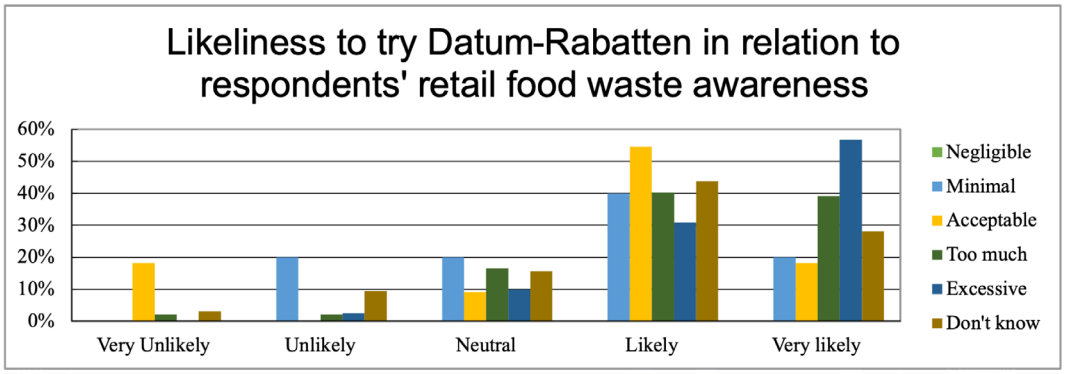


Figure 13. Overlay of respondents' retail food waste awareness on the likeliness to try Datum-Rabatten. For those respondents who selected a degree of perceived awareness of retail food waste, the colored bars show the distribution of likeliness to try Datum-Rabatten.

As shown in Table 5, most respondents came from an urban (48%) or suburban (36%) living environment. Only 16% described their living environment as rural. To facilitate Deligate's decision making process regarding the future placement of Datum-Rabatten, and to investigate a possible link between a key socio-demographic identifier and the likeliness to adopt Datum-Rabatten, living environment in relationship to likeliness to try Datum-Rabatten was analyzed (Figure 14). 50% of the urban respondents, more than 50% of the rural respondents and 46% of the suburban respondents were very likely to try Datum-Rabatten. None of the urban respondents were unlikely or very unlikely to try Datum-Rabatten.

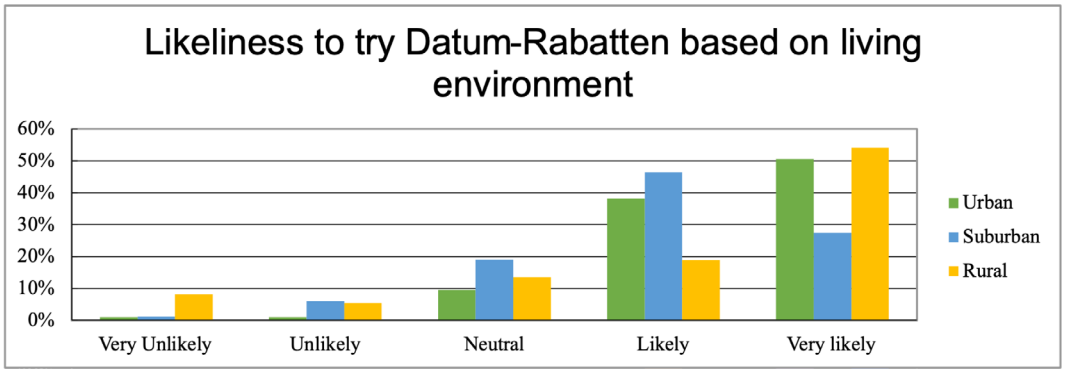


Figure 14. Overlay of respondents' living environment on the likeliness to try Datum-Rabatten. For those respondents who selected a given descriptor of their living environment, the color bars show the distribution of likeliness to try Datum-Rabatten.

5. Discussion

Having presented the results and highlighted the key findings from the study, the following sections apply these findings to the conceptual framework developed earlier in order to answer each research question. As a means to synthesize these findings in terms of looking at the present and future relevance of Deligate, the major findings are placed in the context of a FW reduction evaluation tool.

5.1. Deligate's role

As shown in Figure 1, a simple outline of the food supply chain (FSC) shows physical goods moving from producers to retailers to consumers. A unidirectional stream of waste is produced with little returned to the system. Power and information imbalances have been documented amongst actors (Madichie & Yamoah 2016) in addition to gaps in communication and flow of goods resulting in circularity holes as described by Ciulli et al. (2019). The waste produced is an indicator of these inefficiencies.

Upon recognizing the issue of undetected, expired food being wasted in grocery stores due to lack of efficient inventory monitoring, Deligate joined the food system as an external actor and became a novel stakeholder in this equation. While Deligate is fulfilling several brokerage roles, it is arguable that the role of measuring is the most valuable and providing preliminary solutions to the issues retailers face regarding food passing expiration dates. This aligns with Priefer et al. (2016) who list improvement of data capture capabilities as one of the key leverage points for reducing FW. Once the problem is measurable, goals can be set and progress measured towards achieving such goals. With the extension of Deligate's concept to include Datum-Rabatten, the company can increase the magnitude of their impact and extend their brokerage roles by modifying retailer-consumer relationships and adding value for various stakeholders. First, retailers can start to collect data and form an impression of the food items consumers are most interested in buying with short shelf life. Second, retailers can realize how many items, which are not typically or frequently checked, are nearing expiration and were caught by consumers and registered in Datum-Rabatten. Increasing the number of brokerage

roles performed increases Deligate's relevance and likely sustainability over time by serving multiple valuable functions. In summary, Deligate is indeed working as a circularity broker to help resolve the inefficiencies leading to RFW, primarily via the function of measuring.

5.2. Potential reduction in carbon footprint and price reduction trends

Without Deligate's tracking program, retailers record limited data regarding the quantity of items which are price reduced, and further no visibility to how much of these price reduced items go on to be purchased[6]. Historically, sold price reduced inventory is recorded in terms of monetary units and shed little light on where the key problems lie. Utilizing Deligate's program, retailers now have a valuable tool for tracking such data. The quantification portion of this thesis was performed as a preliminary look into the details of what items are most frequently being price reduced. This unique snapshot of price reduction practices provides valuable perspectives and insights on the issue of RFW.

Deligate's environmental impact was measured in terms of the carbon footprint (CF) of the top 100 price reduced items from 82 stores in Sweden in 2020. As the results in Figures 5 and 6 showed, the amount of price reduced items claimed varying degrees of responsibility when measured in mass versus CF. This agrees with results by Scholz et al. (2015) who showed, for example, that fresh fruit dominated FW when measured in mass but its share decreased by nearly half when measured in terms of CF. In contrast to such previous studies, however, this current study brings a unique approach to the table with its focus on price reduced items instead of the quantified total waste. Price reduction is done to varying degrees of efficiency and the data regarding price reduction is poorly captured by retailers.

The sensitivity analysis in Table 3 revealed potential changes in the results due to the assumption of the previous research this study was based on, where the result for beef, milk and yogurt showed the highest sensitivity to changed CF values while the remaining categories were not as impacted. Of note, the low end CF value of beef also resulted in a positive percent change, indicating the large degree of variability in production methods and how various LCA methods account for these. Contributing to past food waste research, this study demonstrated that if 100% of the top 100 price reduced items were sold, an average size grocery stores could prevent 4 641 $kgCO_2eq$ from being attributable to FW (Table 4). These results have

[6] Adam Vikström, CEO Deligate, video conference 2020-12-21

the possibility to provide a tool for retailers to use in communication and promotion for FW reduction. As the scenarios in Table 4 propose, these average potential CF avoidance calculations could be utilized as an estimation shortcut for retailers.

Such data also has the potential to improve ordering and stocking practices. When retailers have knowledge about the most frequently price reduced items, they can adjust stocking and choice availability to reduce redundancies that lead to waste. Additionally, the list of top 100 price reduced items showed the extent to which different brands of the same items, particularly dairy items, are leading to waste. One trend which stands out is that on average, milk and yogurt products accounted for 42% of the items price reduced each month. This may be a symptom of how retailers are currently under pressure to offer a wide range of products and brands from the same producer in order to secure prices and consumers have become accustomed to these offerings (Priefer et al. 2016). Re-evaluating this practice and using measurements such as the quantity of dairy items which are not selling at full price, this information could be used even further up the FSC by processors and manufacturers to re-evaluate their product line and perhaps limit the number of varieties they offer in order to combat FW. Therefore, achieving further stakeholder involvement could be possible with more sensitive and precise data to motivate better portfolio offerings, something future research could help illuminate further.

5.2.1. Risks and barriers

The potential for this estimation tool to lead to actual climate impact savings is limited if all actors continue with business as usual. These savings need to lead to changes either up or down stream in the FSC – either a shift in demand on the consumer end, or source reduction closer to the producers' end. At the retailer level, this improved capacity to measure the RFW problem must lead to action and adjusting inventory accordingly otherwise such "savings" are simply theoretical.

As with other FW prevention efforts, there is a risk of merely shifting the assignment of waste rather than resolving the source of this problem. One weakness of encouraging increased frequency of price reducing short shelf-life items is exactly this phenomenon of burden shifting. Currently, the greatest amount of FW in happening at the end of the FSC with the consumer, particularly in households. Gustavsson et al. (2011) show promise in reducing this end of chain household waste if retailers are able to coordinate their supply such that there are a greater number of remaining days before expiration. This would give consumers more time to consume the food they purchase. However, a strategy in which the last minute sale of more food at a reduced price could increase the amount of short-shelf life items consumers buy and could potentially end up wasted at the household stage. While this would improve retailer's waste statistics, it is simply shifting this

unfavorable statistic to the consumer. Reducing the amount of RFW is an improvement, so long as the consumer is not simply increasing impulse buys and intends to use or transform the good to extend its life. The Retail Food Waste survey did show that consumers refrain from buying price reduced expiring food if there's a risk it will be wasted in the household, aligning with previous research (Aschemann-Witzel et al. 2017; Aschemann-Witzel 2018), which again would lead to waste in the store. The waste does not disappear until mitigated on several stages simultaneously. Therefore, in order to have the best possible outcome for FW when considering the entire food system, these measures should be accompanied by education or FW awareness goals.

On a similar note, there exists the possibility of a rebound effect. As described by Martinez-Sanchez et al. (2016), if participation in an activity which reduces an individual's CF make economic resources available to participate in other carbon-intense activities, then those initial carbon savings are nullified. According to the Farm Bureau (2019), high income countries spend a significantly smaller portion of their disposable income on food than middle and low income countries and this trend has continued to strengthen over the last few years. Since economic drivers are the main reason for trying Datum-Rabatten, as indicated by the survey results (see Figure 11), then buying more discounted food could further decrease the perceived value of food by requiring fewer economic resources, making it easier to discard or overconsume. Similarly, saved money could potentially be used on other carbon intense activities or purchases. This would in turn void any CF saving intended by the Datum-Rabatten concept. Once again, supporting consumer awareness may be the best path towards avoiding this rebound effect.

5.3. Attitude and consumer engagement

The Retail Food Waste survey revealed factors for consideration in the development on Datum-Rabatten and its future prospects, particularly regarding respondents' awareness of FW. The majority of the respondents were female which could indicate a greater interest in FW among this group due to the voluntary participation in the survey, agreeing with the findings by Aschemann-Witzel (2018). But due to the equality in awareness and the perceived external expectation to reduce FW, as well as the voluntary participation, there is a chance that the overall interest in FW among respondents is greater than in the average population, possibly overstating the portion of the population who would be receptive to such a concept.

To better understand respondents' attitude regarding the best way to handle unsold, expired food items, several FW mitigation alternatives were provided (Appendix

A). More respondents selected donation as the best option rather than avoiding the scenario of unsold expired food. From a waste management and greenhouse gas (GHG) emission perspective, donation is a good option, although it is highly dependable on the type of product (Eriksson et al. 2015). Donation is, however, not always economically or logistically possible. Due to the EU value added tax directive on food donations, retailers often lose more money by donating food than by discarding it (European Commission 2017/C361/01), which makes food donations hard for them to justify. Preventing waste at the source could therefore be argued as the preferable option in retail- something 32% of the respondents in the Retail Food Waste survey agreed with. Interestingly, respondents' impression of RFW are represented evenly in every alternative for RFW mitigation (Figure 10). Therefore, their awareness does not suggest a correlation to their opinion about the best way to handle this issue. The consensus is that food should not be discarded, however, it does not mean that there exists a common understanding or opinion about how this problem should be solved or who is responsible. The preference of donation as the best choice can be interpreted as most consumers viewing the responsibility of resolving food waste as the retailers' burden, rather than their own. On a positive note, even those respondents who felt that the degree of RFW was acceptable, over 70% were likely or very likely to try Datum-Rabatten, indicating some willingness to accept a role in reducing RFW.

Some contradiction was found in the answers regarding attitudes towards expiration dates and price reduced food. Food safety regarding expiring food was over all not a concern for the respondents, but the respondents expressed that they use expiration dates to find the freshest products on the shelf. On the other hand, a preference for fresh products was not the main driver for wanting to avoid buying expiring food that had been price reduced. This may suggest a possible misinterpretation of expiration dates by consumers, as previously shown by Ashemann-Witzel et al. (2017). The result further suggests that these respondents value expiring food less, since the greater part of the respondents buy price reduced expiring products, with the main driver being that it was cheaper. This indicates that these consumers buy expiring food, but only to a reduced price. The price is often used by consumers as an indicator to determine the quality of a product (Völckner & Hofmann 2007), but in this case the expiration itself was perceived as less valuable, since it would only be bought at a reduced price. Furthermore, it is possible that consumer involvement in the price reduction process in fact would increase the likeliness to buy price reduced expiring food since the majority of respondents were positive to trying Datum-Rabatten. Engagement could potentially lead to an *Ikea effect* (Norton et al. 2012) where the consumer perceives the value of the food as greater, due to the investment in making the price reduction themselves. Overall, consumers are not shying away from expiring food, but rather

can be enticed by both reduced prices and adding perceived value via investing their own time and effort.

Insights were gained into which items consumers were most likely to choose for self price reduction. Some respondents expressed that the products they like are usually not price reduced, indicating a misalignment between retail practices and consumer preferences. In addition, pantry goods got the highest ranking when respondents got to choose for themselves what to price reduce (Figure 12), a food category that was on the bottom on the list of top 100 price reduced items. While this might be explained by the preference for the freshest product on the shelf, it is possible that some expiring products never get price reduced due to inefficient price reduction routines, hence hindering consumers from buying them. The food categories least likely to be selected for price reduction by the respondents were ready to eat fresh meals and fresh meat. Due to the outline of the survey, it is not possible to know why these categories got the lowest ranking. Although, a food safety concern cannot be completely excluded, the results from the Retail Food Waste survey suggest that food safety was not the reason, since 90% of the respondents thought it was safe to eat food that has passed the best before date. These food categories are usually sold to a higher price, the lower ranking therefore becomes slightly contradictory to the willingness to try Datum-Rabatten for the main reason of saving money. The ranking question proved to be challenging both to write and to interpret the results, however these preliminary findings were of great value both to this project and the further development of Datum-Rabatten. Some respondents did not understand that the intent was to rank the items amongst each other, and that each preference ranking could only be utilized once. Therefore, there may be some omission or answers that do not reflect the surveyors or respondent intent. Also, for those who would never buy particular items, such as vegetarians avoiding meat, there was not an option to indicate this. Such respondents may have omitted or ranked such items low, giving varying results.

One aim of this study was to illuminate possible links and correlations between consumer attitudes and likeliness to try Datum-Rabatten. As an exploratory measure, a statistical tool was applied to one set of key questions, testing this possibility. Spearman's rho revealed only a low positive correlation of $p=0.08$ between respondents' FW awareness and the likeness to try Datum-Rabatten. While a desired strong and formal correlation was not established by this method, it might indicate that there are several drivers or motivators involved in the decision to try or not to try Datum-Rabatten, such as money, time and the likeliness of the food being consumed at home. Uncertainty regarding the appropriate application of this statistical tool led further links to be investigated by other percentage based calculations. To predict where Datum-Rabatten would be most successful, living environment was compared to likeliness to try Datum-Rabatten and did not reveal

any strong effect. (Figure 14). The broad representation of positivity towards Datum-Rabatten provides a good foundation for the implementation of the station. In addition to best geographical placement, if Datum-Rabatten offered cooking tips or storage advice for various items, there might be a greater chance of more consumers trying Datum Rabatten by increasing confidence in its perceived usefulness from the consumers' perspective.

The surveys conducted provided insights into consumer attitudes and perceptions regarding RFW and Datum-Rabatten, so now the aim shifts to understanding how these results can be used as planning tools for Deligate and retailers by framing the results into the Extended Theory of Planned Behavior (ETPB).

Table 6. Proposed usefulness of ETPB factors as indicators to adopt Datum-Rabatten. Application of Tommasetti et al. (2018).

Variable	**Survey findings**	**Proposed usefulness as a behavior indicator**
Attitude toward the behavior	37% of those willing to try Datum-Rabatten stated desire to reduce FW as a top reason.	Informing and emphasis about RFW could be a powerful motivator.
Subjective Norm	Over half of respondents feel it is expected of them to act on FW.	Potentially useful tool
Perceived Behavioral Control	Freedom to choose which product to self price reduce was a low ranking reason (9%) to try Datum-Rabatten.	Limited impact
Perceived Usefulness	Saving money was ranked as the top reason. Of the few that were not willing to try, one third did not want to buy items nearing expiration.	Strongest motivator- key messaging about Datum-Rabatten should convey this. Education about best before definitions.
Curiosity	Only 9% of those willing to try Datum-Rabatten rated eagerness to try new things as top reason.	Limited impact

The ETPB shows that a person's choice to engage in a behavior is not by chance, but instead regulated by distinct factors which are in turn a powerful and manageable tool for marketing and nudging tactics (Tommasetti et al. 2018). For Datum-Rabatten to be successful, careful consideration will need to be put into how

information about it will be communicated to consumers, particularly how consumer will perceive the potential benefit to them, the likelihood that it can help them achieve their personal desired aims and their ability and freedom to engage. To accomplish this, a solid assumption about the type of consumers the company should target is necessary to condition and influence their behavioral intentions in a positive manner. While results from Table 4 showing the annual saved CF can serve as a estimation tool, they are not necessarily in a digestible form for consumers to grasp the significance. If, for example, these environmental savings are put into the context of emissions from burning gasoline it could serve as a relatable point of reference and trickle down to consumers to fulfil these education goals. A consumer could be encouraged to partake in their local grocery store's efforts to sell 100% of price reduced food throughout the year if they knew that it equalled saving nearly 2 000 liters of gasoline from being burned, calculated from the Environmental Protection Agency (2018).

Perceived usefulness of Datum-Rabatten, particularly economic benefits, was ranked highly and is arguably the strongest motivator for utilizing Datum-Rabatten. Having control of what type of items to select for price reduction did not appear to be a strong motivator. However, over half of respondents felt it was expected of them to act on the issue of FW thus indicating it was felt as a subjective or societal norm. By harnessing this increasing awareness of FW, consumers could be nudged toward utilizing Datum-Rabatten. These motivators answer Belz & Pettie's (2012) prompts about understanding the circumstances and reasons consumers would adopt more sustainable practices.

5.4. Synthesis of findings and practical implications

This study has viewed the company Deligate from multiple perspectives. After positioning Deligate in the food system and performing a preliminary quantification of the program's impact, the next step is to evaluate their approach to reveal the benefits, trade-offs and future implications. In this section, an evaluation tool composed by Caldeira et al. (2019) is used to synthesize this study's findings and gauge Deligate's relevance and success. This tool utilizes the following focal points:

- Quality of the action design
- Effectiveness
- Efficiency
- Sustainability over time

- Transferability and scalability
- Intersectorial cooperation

Key to the findings presented in this study, Deligate has a robust quality of action design. By acting as a circularity broker in the food supply chain to alleviate FW, Deligate is fulfilling the critical brokerage role of measuring when it comes to FW at the retail level. Measuring was found to be a recurring element in the compilation and review of multiple FW reduction assessments by Caldeira et al. (2019) where unsuccessful FW reduction measures have been found to lack SMART (Specific, Measurable, Achievable, Relevant, Time-Bounded) goals and were therefore difficult to evaluate due to gaps in information. By recording more detailed information about price reduced food, this study was able to generate results which can help form such specific and measurable goals. Retailers can harness and utilize this data to better understand exactly which items are frequently price reduced and change product offerings or stocking practices, one of the key leverage points also highlighted by Priefer et al. (2016). The calculated CF and models of the amount of price reduced food that goes on to be sold can create numeric FW reduction goals, to use internally as markers of improvement or communicated to consumers as commitment to sustainability or educational campaigns. Alternatively, retailers could use such data to more accurately check if they are aligning with pre-set FW reduction goals, such as 50% reduction by 2030 set by Sustainable Development Goal 12.3 (U.N., n.d.). While Deligate's initiatives do not create specific goals or associated timeframe to achieve such goals, they do effectively provide a tool and means to create such goals. That being said, it is still up to the users to understand and harness this potential.

The degree of effectiveness relies upon measuring and comparing baseline and periodic progress statistics after the initiative's implementation. Part of the problem with retail FW is the lack of measuring and availability of such data to researchers. As stated above, Deligate is improving the capacity of retailers to collect more detailed information about price reduced food, but data regarding how much is sold is still lacking. Consequently, since baseline data is missing, the degree of effectiveness still remains difficult to evaluate and for future research to illuminate.

Further, according to this assessment tool, the proposed dimensions to consider regarding efficiency are the amount of FW prevented, net environmental savings, net economic benefit, and behavioral change. Without baseline data, additional projections are difficult to calculate but may be made possible by future data sharing. Deligate is clearly laying the foundation for such data to be collected. A unique contribution from this study was converting such raw data into several scenarios of saved CF from avoided FW based on sale of price reduced food nearing expiration. This estimation shortcut to measure net environmental savings has the

potential to add value to Deligate's services and motivate retailers and other upstream actors. The explicit net economic benefit for retailers was not explored as part of this study, but clearly there are gains to be made if less food is discarded. Importantly and innovatively, Deligate is creating the space for consumer behavioral change, in particular date checking and purchasing habits. The Retail Food Waste survey revealed that economic benefit and desire to reduced FW are the most likely drivers to utilize Datum-Rabatten. Within the framework of the ETPB, this falls under perceived usefulness and attitude toward a behavior. By utilizing these powerful motivators behind behavior engagement, further awareness can be promoted and consumers' behavior regarding best before dates improved. Concerning Datum-Rabatten's relevance and potential to further reduce RFW, consumers are interested in price reducing food items which are not usually covered under existing retailer practices. This improved coverage of different grocery store departments shows that Deligate's services can offer improved FW outcomes, rather than merely redundant solutions.

Evaluating whether Deligate's concepts will be sustainable over time or are scalable is the most difficult, as the results from this study suggest positive indications, but definitive or absolute determinations would be inappropriate to conclude. However, by considering new and innovative avenues to address RFW, Deligate is displaying their acknowledgement of the changing FW environment and evolving needs. If a problem is being addressed and eventually resolved, then the solutions should become obsolete overtime (Caldeira et al. 2019). However, Deligate displays strengths such as re-evaluation and innovation via their new and existing solutions, which indicates a positive forecast for their success and ongoing relevance.

The results show that 63% of consumers were already buying price reduced items due to expiration dates prior to Datum-Rabatten, but that this could increase to up to 81% of consumers who are willing to use Datum-Rabatten. A further 14% who were neutral to the concept could still be captured by tapping into the key motivators such as economic incentives and desire to reduce FW. This potential positive change of consumer shopping habits is a positive sign regarding reducing RFW, but it will need to persist to have a lasting, sustainable impact. As with any theoretical study of consumer behavior, there is the potential of an attitude-behavior gap where respondents may have overstated their interest, intentions or habits (Belz & Peattie 2012). Harnessing the perceived benefit, control and societal pressure, as outlined in the ETPB, will be critical in this mission. This could be done via promotions during the launch of Datum-Rabatten, education campaigns and sharing involvement with peers to harness the power of aligning with the subjective norm, something over half of respondents would be receptive or sensitive to.

Lastly, Deligate is creating a link between stakeholders, thus facilitating intersectorial cooperation. The UN Sustainable Development Goal 12.3 calls for action along the whole FSC to reduce the per capita global FW by 50% by 2030 (UN n.d.), where every actor carries the responsibility to reach the goal. Deligate's actions fall into two FW prevention categories according to Caldeira et al. (2019): Supply chain efficiency and consumer behavior change. The authors evaluated zero FW reduction actions which addressed behavioral change and only three which addressed supply chain efficiency at the retail level (ibid.). This shows need for such attention at the retail level. This study supports this classification by defining which circulatory brokerage roles the company is fulfilling. By allowing retailers to better track their inventory, greater supply chain efficiency can be achieved by reducing the retailer's avoidable waste stream. Also key to this classification is engaging stakeholders in a novel way, particularly by pulling consumers into the arena with the Datum-Rabatten initiative. Therefore, it is reasonable to rate the degree of intersectorial cooperation achieved by Deligate as essential and needed, but will it endure? Even if the results show that RFW awareness is high and indicates a tendency to try Datum-Rabatten, there were still 14% who said they did not know how much food was wasted. When that figure is taken into account with the bias among respondents, who likely care or are interested enough in FW to answer the survey, it could still be argued that an effective education campaign would complement and enhance the success of Datum-Rabatten. Increased awareness of RFW and how consumers can help retailers lower the amount of waste has the potential to gain effect further down the FSC and potentially decrease over consumption and household FW. Such extensions from this study require further attention from researchers.

While the goal of utilizing this tool was to aide in providing a fair assessment of Deligate's actions and resulting impact, the data this study was based on was provided exclusively by the company and some unforeseen data censoring may influence the outcomes of this study. An attempt to view the firm from multiple perspectives via an inter-disciplinary approach sought to curb the effects of these limitations. This approach consisted of a toolbox holding this assessment tool, theoretical and conceptual frameworks, and multiple data analyses. While it cannot be known whether this goal was achieved entirely, it is hoped that this acknowledgement and approach strengthens the credibility of the findings. Future research should use identified weaknesses as launching points for further studies.

6. Conclusions

Deligate's role as a circularity broker has shown to be critical in tackling avoidable food waste in the retail sector with a robust quality of design. A recurring theme of measuring was identified in multiple analyses of Deligate's functions. Additionally, their services are modifying existing retailer consumer relationships to reduce inefficiencies which previously contributed to the waste stream.

Considering Deligate's effectiveness and efficiency, there were several outcomes of the quantification portion of this study. With data extracted from Deligate's program, it was shown that an average retailer can reduce its annual carbon footprint (CF) attributable to food waste (FW) by 4 641 $kgCO_2eq$ if 100% of the price reduced items are sold. While these emissions would no longer belong to the FW category, it would only lead to actual positive change in the food system if this sold food is responsibly consumed and leads to changed practices throughout the food supply chain (FSC). This might be just a small dent in a retailer's overall CF, but it is still an improvement and a step the in the right direction if complementary actions are taken such as inventory adjustments and modified consumer demand. When comparing the mass and CF of FW, different problem areas are illuminated. While not the focus of this paper, these findings align with past research on the topic, and show the need to use the appropriate unit of measure and target high impact categories. This study contributes to the growing body of FW research by providing an estimation tool in the form of scenarios of sold price reduced food, for retailers to create or gauge alignment with FW reduction goals. Trends in price reduced items also revealed key product categories which should be targeted and researched for re-evaluation, involving retailers, other upstream actors and academia. While Deligate's tools can help more food reach consumers before expiration, we must acknowledge a risk for merely shifting the burden of waste to consumers or a potential rebound effect where consumers could use saved financial resources on other climate intense purchases, effects which could potentially be mitigated by education and awareness campaigns.

Datum-Rabatten is Deligate's initiative to engage consumers in the price reduction of items nearing expiration. In an effort to understand consumer motivation, the survey revealed that the main driver for trying Datum-Rabatten was economic

incentive, followed by desire to prevent FW. Despite feeling external pressure to personally act of the issue of FW, most respondents believed donation to be the best mitigation strategy thus indicating they view FW as the retailers' burden. The awareness of retail food waste (RFW) and living environment showed very little effect on willingness to try Datum-Rabatten. Overall, respondents were very receptive to the concept, indicating some willingness to accept a role in reducing RFW.

As a young start-up company, Deligate has been an interesting case study of innovators interrupting the FSC to provide a solution to a glaring problem. Their role, while currently critical, should become obsolete over time if it is fulfilling its purpose. However, due to their innovative nature they can persist by adapting to evolving challenges. The results of this study are intended to be used in the further development of Datum-Rabatten and other future initiatives to reduce RFW. The following suggested actions to Deligate could bolster their concepts and provide examples for other FW reduction measures:

- Utilize the Datum-Rabatten survey to understand consumers' experiences and whether there is consistency regarding attitudes among a different survey population. This can help identify potential attitude-behavior gaps and work to address them.

- As an invested stakeholder, Deligate should collaborate with retailers to increase availability of baseline "before" data, in order to evaluate Deligate's effectiveness- a missing gap in our synthesis. This would benefit both parties and help support the research community.

- Increasing consumer awareness was found to be a key element for long term success. This could be accomplished, for example, by sharing the potential CF reduction estimation tool (Table 4), educating consumers that they can be a tangible part of the solution- a powerful motivator appealing to their sustainability goals.

May this thesis serve as an example of how external actors can join the food system, make novel connections to resolve inefficiencies and create a more robust and sustainable food system for the future.

7. Reflections

Difficulty accessing waste statistics from retailers has been an obstacle in RFW research, both logistically and from the perspective of company secrecy. This study was no exception. Even with this third party actor interested in reducing FW, there was hesitation and restriction when it came to information sharing. Ultimately, to get more accurate data, further intersectorial cooperation is needed. The ongoing Covid-19 pandemic made it even more challenging by limiting in person meetings where more data could possibly have been obtained from retailers and extracted from their systems. We were warned of such hindrances and they do in fact exist.

Current shopping habits are likely affected by the ongoing pandemic which may have changed consumers' priorities when shopping. The questions we ask are obviously specific to an in-store shopping experience. Due to the unusual circumstances, the results we obtained may be influenced by either consumers not physically visiting grocery stores or re-prioritizing their shopping needs. The results of this survey reflect this environment and could change if this survey would be conducted again after the world normalized post-pandemic. This element has not explicitly been incorporated into the survey in order to focus on the long-term potential of this new service rather than the peculiarities of this time.

For future students working on their theses and wanting to work with a third party, we offer the following advice based on our experience. Creating and sharing a clear time plan is imperative so that all parties are aware of expectations. Start communicating early and be assertive about expectations and project requirements, while also being sensitive and flexible to their time restraints. Overall, it was a rewarding experience and met with enthusiasm by all parties.

References

Aschemann-Witzel, J. (2018). Consumer perception and preference for suboptimal food under the emerging practice of expiration date based pricing in supermarkets. *Food Quality and Preference.* 63, 119-128. http://dx.doi.org/10.1016/j.foodqual.2017.08.007

Aschemann-Witzel, J., Jensen, J. H., Jensen, M. H., Kulikovskaja, V. (2017). Consumer behaviour towards price-reduced suboptimal foods in the supermarket and the relation to food waste in households. *Appetite.* 116, 246-258. http://dx.doi.org/10.1016/j.appet.2017.05.013

Ajzen, I. (1991) The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*. 50, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2013). Theory of Planned Behaviour Questionnaire . *Measurement Instrument Database for the Social Science*. www.midss.ie

Andersson, T., Stålhandske, S. (2020). *Matavfall i Sverige Uppkomst och behandling 2018.* (ISBN: 978-91-620-8861-3). Stockholm: Naturvårdsverket. https://www.naturvardsverket.se/Documents/publ-filer/978-91-620-8857-6.pdf?pid=26031

Belz, F., Peattie, K. (2012). *Sustainability Marketing*. Second Edition, West Sussex: Wiley.

Broekmeulen, R., Van Donselaar, K. (2016). *Sell More Waste Less Increasing sales and reducing waste in the fresh supply chain.* Brussels: ECR Community.

Bryman, A. (2015). *Social Research Methods.* Oxford: Oxford University Press.

Caldeira, C., De Laurentiis, V., Sala, S. (2019). *Assessment of Food Waste Reduction Actions.* (JRC Technical Reports EUR 29901 EN). Luxembourg: Publications Office of the European Union. doi:10.2760/9773

Cicatiello, C., Franco, S., Pancino, B., Blasi, E., Falasconi, L. (2017). The dark side of retail food waste: Evidences from in-store data. *Resources, Conservation & Recycling*. 125, 273-281. http://dx.doi.org/10.1016/j.resconrec.2017.06.010

Ciulli, F., Kolk, A., Boe-Lillegraven, S. (2019). Circularity Brokers: Digital Platform Organizations and Waste Recovery in Food Supply Chains. *Journal of Business Ethics*. https://doi.org/10.1007/s10551-019-04160-5

Deligate. (n.d). *Turn your food waste into profit.* https://deligate.app/ [2021-24-02]

Environmental Protection Agency (2018). *Greenhouse Gas Emissions from a Typical Passenger Vehicle.* https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle [2021-05-31]

Eriksson, M. (2015). *Supermarket food waste prevention and management with the focus on reduced waste for reduced carbon footprint.* Diss. Uppsala: Sveriges lantbruksuniversitet. https://pub.epsilon.slu.se/12756/1/Eriksson_m_151029.pdf

Eriksson, M., Giovannini, S., Ghosh, R. (2020). Is there a need for greater integration and shift in policy to tackle food waste? Insights from a review of European Union legislations. *SN Applied Sciences.* https://doi.org/10.1007/s42452-020-3147-8

Eriksson, M., Strid, I., Hansson, P-A. (2015). Carbon footprint of food waste management options in the waste hierarchy – a Swedish case study. *Journal of Cleaner Production*. 93, 115-125. https://doi.org/10.1016/j.jclepro.2015.01.026

European Commission 2017/C361/01 Commission notice, EU guidelines on food donations. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017XC1025(01)&from=PL

European Commission. (n.d. a). *Waste prevention and management.* https://ec.europa.eu/environment/green-growth/waste-prevention-and-management/index_en.htm [2021-18-03]

European Commission. (n.d. b). *Date marking and food waste.* https://ec.europa.eu/food/safety/food_waste/eu_actions/date_marking_en [2021-18-02]

European Parliament and the Councel (EC) 178/2002 on January 28 2002 on the general principles and requirements of food law and procedures in matters of food safety (“Food law”). http://data.europa.eu/eli/reg/2016/429/oj

FAO. (2013). Food wastage footprint - Impacts on natural resources. Summary report. Available at: http://www.fao.org/3/i3347e/i3347e.pdf

FAO. (2015). Food Wastage Footprint & Climate Change. Rom: UN FAO. Available at: http://www.fao.org/3/bb144e/bb144e.pdf

FAO. (2018). Sustainable Food Systems - Concept and Framework. Rome. Available at: http://www.fao.org/3/ca2079en/CA2079EN.pdf

FAO. (2021) *Food Loss and Food Waste*. Available at: http://www.fao.org/food-loss-and-food-waste/flw-data [2021-03-24]

Farm Bureau (2019). *U.S. Food Expenditures at Home and Abroad*. https://www.fb.org/market-intel/u.s.-food-expenditures-at-home-and-abroad [2021-04-01]

Freeman, E.R. (1984). *Strategic management: a stakeholder approach*. Cambridge: Cambridge University Press.

Gustavsson, J., Cederberg, C., Sonesson, U., 2011. Global food losses and food waste. Gothenburg, Sweden. http://www.fao.org/docrep/014/mb060e/mb060e.pdf.

Gustavsson, J., Stage, J. (2011). Retail waste of horticultural products in Sweden. *Resources, conservation and recycling.* 55, 554-556. 10.1016/j.resconrec.2011.01.007

Hemköp (n.d.). *Vår resa mot halverat matsvinn.* https://www.hemkop.se/artikel/hallbarhet-svinn [2021-02-16]

Hodges, R., Buzby, J., Bennet, B. (2011). Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. *Journal of Agricultural Science.* 149, 37-45.

Icagruppen (n.d.). *Strategier och mål för hållbarhet.* https://www.icagruppen.se/hallbarhet/#!/vara-utgangspunkter/lb//hallbarhet/vara-utgangspunkter/strategier-och-mal-for-hallbarhet/ [2021-02-16]

Lebersorger, S., Schneider, F. (2014). Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures. *Waste management.* 34, 1911-1919. http://dx.doi.org/10.1016/j.wasman.2014.06.013

Lidl (n.d.). *Hållbarhet*. https://om.lidl.se/hallbarhet [2021-02-16]

Livsmedelsverket (n.d.). Less waste- more food. https://www.livsmedelsverket.se/globalassets/english/food-habits-health-environment/food-environment/slv_faktablad_matsvinn_eng_web.pdf [2021-04-20]

Livsmedelsverket (2018). *More to do more! Action plan for food loss and food waste reduction by 2030 – Summary.* https://www.livsmedelsverket.se/globalassets/publikationsdatabas/rapporter/2018/2018-more-to-do-more-action-plan-for-food-loss-and-food-waste-reduction-by-2030

Livsmedelsverket (2020a). *Vad betyder datummärkningen?*. https://www.livsmedelsverket.se/matvanor-halsa--miljo/matsvinn/vad-betyder-datummarkningen [2021-02-18]

Livsmedelsverket (2020b) Meat – beef, lamb, pork and chicken https://www.livsmedelsverket.se/(X(1)S(tnbuz23d0aysvbgifsut4rqn))/en/food-habits-health-and-environment/food-and-environment/eco-smart-food-choice/meat--beef-lamb-pork-and-chicken?AspxAutoDetectCookieSupport=1 [2021-03-17]

Lundquist, J., de Fraiture, C., Molden, D. (2008). *Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain.* SIWI policy brief, Stockholm International Water Institute, Stockholm.

Madichie, N, Yamoah, F. (2016). Revisiting the European Horsemeat Scandal: The Role of Power Asymmetry in the Food Supply Chain Crisis. *Thunderbird International Business Review*. 59 (6), 663-675. https://doi.org/10.1002/tie.21841

Manski, C.F. (1993). Identification of endogenous social effects: The reflection problem. Rev. Econ. Stud. 1993, 60,531–542. http://hdl.handle.net/10.2307/2298123

Martinez-Sanchez, V., Tonini, D. Moller, F., Astrup, T. (2016). Life-Cycle Costing of Food Waste management in Denmark: Importance of Indirect

Effects. *Environ Sci Technology*. 50 (8). https://doi.org/10.1021/acs.est.5b03536

Norton, M., Mochon, D. Ariely, D. (2012). The "Ikea Effect": When Labor Leads to Love. *Journal of Consumer Psychology*. 22 (3), 453–460. doi:10.1016/j.jcps.2011.08.002

Papargyropoulou, E., Lozano, R., Steinberger, J., Wright, N., Ujang, Z. (2014). The food waste hierarchy as a framework for the management of food surplus and food waste. *Journal of Cleaner Production.*76, 106-115. http://dx.doi.org/10.1016/j.jclepro.2014.04.020

Phillips, R., Freeman, E., Wicks, A. (2003). What Stakeholder Theory Is Not. *Business Ethics Quarterly*. 13(4), 479-502. https://www.jstor.org/stable/3857968

Priefer, C., Jörissen, J., Bräutiga,, K. (2016). Food waste prevention in Europe – A cause-driven approach to identify the most relevant leverage points for action. *Resources, Conservation and Recycling.* 109, 155-165. http://dx.doi.org/10.1016/j.resconrec.2016.03.004

Reynolds, C., Soma, T., Spring, C., Lazell, J. (eds.) (2020). *Routledge Handbook of Food Waste*. Oxon: Routledge.

Rosenlund, J., Nyblom, Å., Matschke Ekholm, H., Sörme, L. (2020). The emergence of food waste as an issue in Swedish retail. *British Food Journal*. 122 (11), 3283-3296. 10.1108/BFJ-03-2020-0181

Röös, E. (2013). *Analysing the Carbon Footprint of Food – Insights for Consumer Communication*. Diss. Uppsala: Sveriges Lantbruksuniversitet. https://pub.epsilon.slu.se/10757/1/roos_e_130821.pdf

Röös, E. (2014). *Mat-klimat-listan version 1.1.* (Report 077, ISSN 1654-9406). Uppsala: SLU, Swedish University of Agricultural Sciences Department of Energy and Technology. https://pub.epsilon.slu.se/11671/7/roos_e_141125.pdf

Scherhaufer, S., Moates, G., Hartikainen, H., Waldron, K., and Obersteiner, G. (2018). Environmental Impacts of Food Waste in Europe. *Waste Management.* 77, 98–113. https://doi.org/10.1016/j.wasman.2018.04.038

Scholz, K., Eriksson, M., Strid, I. (2015). Carbon Footprint of Supermarket Food Waste. *Resources, Conservation and Recycling*. 94, 56-65. http://dx.doi.org/10.1016/j.resconrec.2014.11.016

Svensk Dagligvaruhandel (n.d.). *Matsvinn #Svinnsikt i dagligvaruhandeln.* https://www.svenskdagligvaruhandel.se/matsvinn/ [2021-02-16]

Teller, C., Holweg, C., Reiner, G., Kotzab, H. (2018). Retail store operations and food waste. *Journal of Cleaner Production.* 185, 981-997. https://doi.org/10.1016/j.jclepro.2018.02.280

Tommasetti, A., Singer, P., Troisi, O., Maione, G. (2018). Extended Theory of Planned Behavior (ETPB): Investigating Consumer's Perception of Restaurants' Sustainability by Testing a Structural Equation Model. *Sustainability.* 10. https://doi:10.3390/su10072580.

United Nations (n.d.). *Goal 12: Ensure sustainable production and consumption patterns.* https://www.un.org/sustainabledevelopment/sustainable-consumption-production/ [2021-02-16]

Völckner, F., Hofmann, J. (2007). The price-perceived quality relationship: A meta-analytic review and assessment of its determinants. *Market Lett.* Vol. 18, pp. 181-196. https://doi.org/10.1007/s11002-007-9013-2

Willys (n.d.). *Vår målsättning*. https://www.willys.se/artikel/om-oss/hallbarhet/svinnsmart/var-malsattning [2021-02-16]

WRAP (2011). *Food waste in schools.* Banbury, UK: WRAP.

WRAP (2021) Food and drink. https://wrap.org.uk/taking-action/food-drink [2021-04-22]

Acknowledgements

We extend our thanks to our supervisor, Louise Bartek, who helped us navigate creating our own study design and provided encouragement. We also thank the team at Deligate who invested time in meeting with us over the course of the project and supplying us with valuable data and retail knowledge.

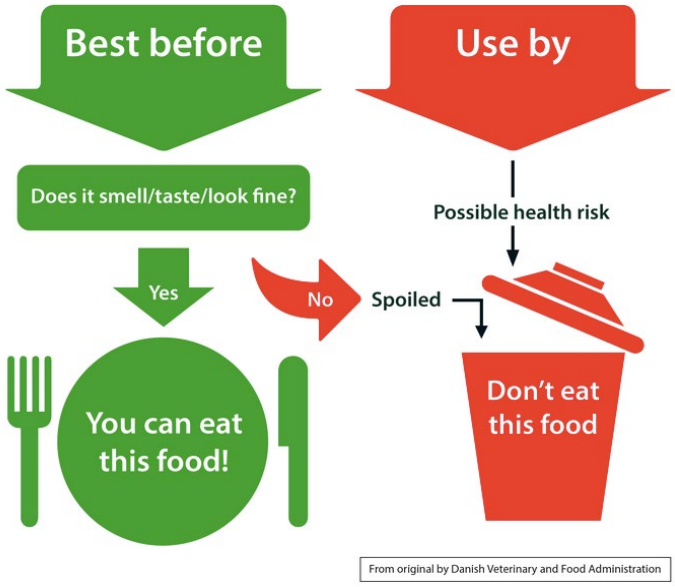
We also want to acknowledge our appreciation for having the opportunity to tackle this project as a team. It was so valuable to have moral support from each other and a great privilege to brainstorm and develop this project as a team.

Appendix A. Retail Food Waste survey

Measure	Question	Structure
About you		
Demographic	1. Age a. 18–30 b. 31–45 c. 46–60 d. >60	Interval
Demographic	2. Gender a. Female b. Male c. Prefer not to say d. Prefer to self-describe_____	Nominal with free response
Demographic	3. Where do you currently live?	Drop down menu by country
Demographic	4. How would you describe your living environment? a. Urban b. Suburban c. Rural	Nominal
Demographic	5. How many people live in your household? a. 1 b. 2-4 c. 5+	Interval
Demographic	6. Choose your highest level of education a. Compulsory school b. High school c. Trade school d. University (any level)	Nominal

This section holds questions about retail food waste and your shopping habits. For clarity, the following definitions of *Expiration date*, *Best before*, and *Use by* from the National Food Agency in Sweden (Livsmedelsverket) have been used.

Expiration date - Indicates either the best before or use by date of a product. When it has passed, the retailers can not sell the product.



From National Food Agency, Sweden

Awareness of food waste issue Attitude	7. What is your impression of the amount of food that is discarded at grocery stores due to passing its expiration date? a. Rare, negligible b. Minimal c. Acceptable d. Too much e. Excessive	Ordinal
Awareness of food waste issue Attitude	8. Retail food waste is in need of an urgent solution a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree	Ordinal
Subjective Norm	9. I feel it is expected of me to do my part to reduce food waste. a. Strongly Disagree	Ordinal

	b. Disagree c. Neutral d. Agree e. Strongly Agree	
Awareness of food waste issue Attitude	10. Do you think it is safe to consume food after it has passed its **best before** date? a. yes b. no	Nominal
Awareness of food waste issue	11. What is the best way to handle unsold items which passed their **best before** date? a. Avoid this scenario b. Donate c. Trash d. Repurpose (transform into new products)	Nominal
Habits Perceived behavioral control	12. When shopping, do you usually consider the expiration date? a. yes b. no	Nominal
Habits	12a. If yes, what are you looking for? a. the freshest product on the shelf b. products nearing its expiration date c. only to make sure it hasn't passed its expiration date	Nominal
Habits	13. Do you typically buy food that has been price reduced due to nearing its expiration date? a. yes b. no	Nominal
Habits → drivers	13a. If yes: What is your main reason? a. It is cheaper b. It is convenient and I can eat it soon c. I want to prevent food waste	Nominal
Habits → drivers	13b. If no: What is your main reason? a. I do not think it is safe to eat b. It is not worth it. I probably wouldn't use it in time. c. The products I like are usually not price reduced d. I would rather buy fresh products	Nominal

Testing a new concept
In the near future, consumers might be given an opportunity to be more involved in reducing retail food waste.

This might be a scanning station where you can bring any product nearing the expiration date.

You scan the product and it will be given a new price depending on how much time is left before it expires.

Then you check out and pay like normal.

Now we will ask about your opinion on such a self-service price reduction station.

Interest in self-service price reduction	14. How likely are you to try the self-service price reduction station? a. Very Unlikely b. Unlikely c. Neutral d. Likely e. Very likely	Ordinal
Perceived Usefulness, Perceived behavioral control	14a. What is your main reason not to try the self-service price reduction station? a. The discount does not seem worth the effort. b. Too time consuming. c. I don't want to buy items nearing its expiration date d. It seems complicated	Nominal
Perceived Usefulness, Perceived behavioral control, Curiosity	14b. What is your main reason to try the self-service price reduction station? a. Saving money. b. I get to choose what to discount c. It prevents food waste. d. I enjoy trying new things.	Nominal
Interest in self-service price reduction	15. How would you rank the following items in terms of your likeliness to choose the product to price reduce: most likely → least likely. Note: Each rating can only be used once. a. Ready-to-eat fresh meal (Ex: sandwich, salad, sushi)__ b. Fresh fruit and vegetables __ c. Fresh meat__	Ranking

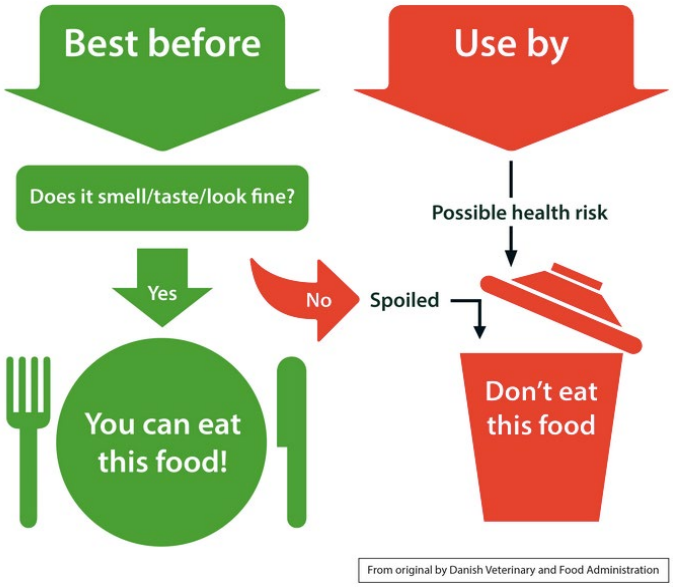
	d. Pantry goods __ e. Dairy __ f. Packaged bread __	

Appendix B. Datum-Rabatten survey

Measure	Question	Structure
About you		
Demographic	1. Age bracket 18–30 31–45 46–60 >60	Interval
Demographic	2. Gender a. Female b. Male c. Prefer not to say d. Prefer to self-describe_____ Free response	Nominal
Demographic	3. How many people live in your household ? a. 1 b. 2-4 c. 5+	Nominal
Demographic	4. How would you describe your living environment? a. Urban b. Suburban c. Rural	Nominal
Demographic	5. Choose your highest level of education a. Compulsory school b. High school c. Trade school d. University (any level)	Nominal
Retail Food Waste		

This section is about retail food waste and your shopping habits. For clarity, the following definitions have been chosen.

Expiration date- product has passed either the best before or use by date and retailers can not sell it**.**



From National Food Agency, Sweden

Retail FW Awareness	6. The amount of food that is discarded at grocery stores due to passing its expiration date is... a. Rare, negligible b. Minimal c. Acceptable d. Too much e. Excessive	Ordinal
Importance/Attitude	7. Retail food waste is in need of an urgent solution a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree	Ordinal
Subjective Norm	8. I feel it is expected of me to reduce food waste. a. Strongly Disagree b. Disagree c. Neutral	

	d. Agree e. Strongly Agree	
Habits	9. When shopping, do you usually consider the best by date? a. Yes b. No	Nominal
Habits	10. Do you typically buy food that has been price reduced due to nearing its expiration date? a. Yes b. No	Nominal
	9a. If yes: What is your main reason? a. It is cheaper b. It is convenient and I will eat it soon. c. I want to prevent food waste.	Nominal
	9b. If no: What is your main reason? a. I do not think it is safe to eat. b. It is not worth it. I probably would not use it in time. c. The products I like are usually not price reduced. d. I would rather buy fresh products	Nominal
Experience with Datum-Rabatten		
Experience Perceived behavioral control, Perceived usefulness	11. Using Datum-Rabatten was a. Very difficult b. Somewhat difficult c. Neutral d. Easy e. Very easy	Ordinal
Engagement Attitude, perceived usefulness, perceived behavioral control	12. Datum-Rabatten is an effective solution to engage consumers in reducing in-store food waste. a. Strongly Disagree b. Disagree c. Neutral d. Agree e. Strongly Agree	Ordinal

Experience	13. Do you like this concept more than buying already discounted products from the "short-date-bin"? a. Yes b. No	Nominal
Future Use	14. What price reduction makes using the station worth your time and effort? a. 0-10% b. 10-20% c. 20-30% d. 30-50% e. 50-75%	Interval
Potential to change habits	15. Now that you know about Datum-Rabatten, how likely are you to choose items closest to their expiration dates? a. Very unlikely b. Unlikely c. Neutral d. Likely e. Very Likely	Ordinal
Item type	16. How would you rank the following items in terms of your likeliness to select for price reduction: 1 least likely, 5 most likely. a. Ready-to-eat fresh meal (Ex: sandwich, salad, sushi)__ b. Fresh fruit and vegetables __ c. Fresh meat__ d. Pantry goods __ e. Dairy __ f. Packaged bread __	Ranking
Future use	17. How likely are you to recommend Datum-Rabatten to a friend? a. Very Unlikely b. Unlikely c. Neutral d. Likely e. Very Likely	Ordinal
Future Use	18. Do you have any suggestions for improvement?	Free Response

Appendix C. Top 100 price reduced items 2020

The three following tables contain manipulated raw data from the top 100 price reduced items from 82 stores in 2020.

Table A: Total quantity of price reduced items per category

Table B: Total CO_2eq per category based on Röös (2014)

Table C: Total mass (kg) per category

Table A. Total quantity of price reduced items per category in 2020

Category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total quantity per category	Annual % per category
Beef	1129	747	848	1452	509,00	1125	1004	1139	1276	1338	1692	1717	**13976**	**6,52**
Butter				113	302,00					120			**535**	**0,25**
Candy						200	758	509	300	390	350	140	**2647**	**1,23**
Charcuterie	606	798	808	323	142,00	657	1707	273	2073	1512	1037	967	**10903**	**5,08**
Cheese	1135	794	793	332	882,00	671	250	710	345	1007	462	912	**8293**	**3,87**
Chicken	564	559	943	668	1025,00	533	448	391	474	963	1092	525	**8185**	**3,82**
Cream	1687	623	2002	3424	2536,00	2956	1297	2006	1112	1121	1399	2079	**22242**	**10,37**
Egg	560	292	129	494	849,00	293	622	561	297	353	180	803	**5433**	**2,53**
Fish/Seafood				162	113,00					170			**445**	**0,21**
Juice and Jam	409		91	175	253,00	540		475	417	204	232	120	**2916**	**1,36**
Margarine		65				161	120						**346**	**0,16**
Milk, fil, yoghurt	7712	3891	6323	10385	7577,00	8184	7089	8954	6095	7069	6792	9498	**89569**	**41,76**
Minced meat				110		112			115	116	180		**633**	**0,30**
Other dairy	964	358	786	1503		1777	1924	1541	896	808	891	736	**12184**	**5,68**
Other pantry										135			**135**	**0,06**
Yeast	132	0			0,00	1021	156	384	408	428	135	531	**3195**	**1,49**
Pasta			282										**282**	**0,13**
Pork	1449	63	1667	2671	0,00	1456	2681	2222	1381	1028	2462	3234	**20314**	**9,47**
Potato							127	121					**248**	**0,12**
Ready Meal fish	120	0											**120**	**0,06**

Ready Meal meat				115		119	622			163			**1019**	**0,48**
Ready Meal veg	820	392	902	290	1580,00	826	985	545	644	1088	542	380	**8994**	**4,19**
Roots, onions, cabbage						145			101				**246**	**0,11**
Salad vegetables import													**0**	**0,00**
Salad vegetables Scand.					115,00	300		155	232		139	255	**1196**	**0,56**
Sauces and spices		97											**97**	**0,05**
Soda							337						**337**	**0,16**
Total	**17287**	**8679**	**15574**	**22217**	**15883**	**21076**	**20127**	**19986**	**16166**	**18013**	**17585**	**21897**	**214490**	**100**

Table B. Total CO_2eq per category. Calculations based on Röös (2014)

Category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total Co_2eq per category	Annual % per category
Beef	11737,7	9869,86	8747,18	20737,34	1314,04	15150,72	9801,48	11706,76	15792,14	14573,52	20187,7	23290,28	**162908,72**	**42,81**
Butter				271,2	52					480			**803,2**	**0,21**
Candy						120	462,128	373,366	100,08	89	140	28,28	**1312,854**	**0,34**
Charcuterie	1464	1852,97	1861,265	960,925	67,2	1508,78	3287,62	1182,3	5879,44	4221	2807,63	3858,295	**28951,055**	**7,61**
Cheese	1597,6	2179,2	815,6	355,6	382,88	1240	365	1542,8	345	1007	433,2	1166,8	**11430,68**	**3,00**
Chicken	611,1	561,3	1054,77	924,54	122,49	973,5	669,9	617,49	791,7	1496,73	1245,09	280,77	**9349,38**	**2,46**
Cream	2508,2	854,8	2897,2	4496,42	590,9	4251,4	1861,6	2478,2	1509,4	1531	1944	2738,2	**27661,32**	**7,27**
Egg	661,902	220,752	97,524	658,566	106,596	332,64	642,6	437,556	224,532	364,392	136,08	702,324	**4585,464**	**1,20**
Fish/Seafood				87,48	6,9					51			**145,38**	**0,04**
Juice and Jam	1227		232,05	36,75	161,1	1620		701,13	1176,15	612	696	360	**6822,18**	**1,79**
Margarine		97,5				72,45	108						**277,95**	**0,07**
Milk, yoghurt	6670,12	3859,59	5620,15	9595,15	1187,72	8160,6	6942,85	8610,99	5637,95	6174,6	5386,67	6521,08	**74367,47**	**19,54**
Minced meat				704		716,8			1472	742,4	1152		**4787,2**	**1,26**
Other dairy	746,6	287,5	515,25	978,1		1250	1347	1024,8	561,55	488,95	469	433,35	**8102,1**	**2,13**
Other pantry										0			**0**	**0,00**
Yeast	4,8444	3,7434			1,468	37,4707	5,7252	14,0928	14,9736	15,7076	4,9545	19,4877	**122,4679**	**0,03**
Pasta			93,92										**93,92**	**0,02**
Pork	1718,73	1740,48	2245,98	3924,57	490,62	1963,98	7020,87	2636,1	2170,08	1223,52	3087,06	3992,28	**32214,27**	**8,46**
Potato							10,16	4,84					**15**	**0,00**

Ready Meal fish	72	66,15											**138,15**	**0,04**
Ready Meal meat				227,7		235,62	1460,22			322,74			**2246,28**	**0,59**
Ready Meal veg	387,616	202,272	414,024	153,024	203,664	479,64	632,128	397,864	293,424	365,152	297,064	171,456	**3997,328**	**1,05**
Roots, onions, cabbage						14,5			10,1				**24,6**	**0,01**
Salad vegetables					1,47	21		10,85	16,24		9,73	17,85	**77,14**	**0,02**
Scand. Sauces and spices		19,4											**19,4**	**0,01**
Soda							105,9						**105,9**	**0,03**
Total	**29407**	**21816**	**24595**	**44111**	**4689**	**38149**	**34723**	**31739**	**35995**	**33759**	**37996**	**43580**	**380559**	**100,00**

Table C. Total mass (kg) per category.

Category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total mass per category	Annual % per category
Beef	451,45	379,61	336,43	797,59	50,54	582,72	376,98	450,26	607,39	560,52	776,45	895,78	**6265,72**	**5,43**
Butter				33,9	6,5					60			**100,4**	**0,09**
Candy						60	231,064	186,683	50,04	44,5	70	14,14	**656,427**	**0,57**
Charcuterie	209	264,71	265,895	137,275	9,6	215,54	469,66	168,9	839,92	603	401,09	551,185	**4135,865**	**3,58**
Cheese	200	272,4	101,95	44,45	47,86	155	45,625	192,85	43,125	125,875	54,15	145,85	**1428,835**	**1,24**
Chicken	204	187,1	351,59	308,18	40,83	324,5	223,3	205,83	263,9	498,91	415,03	93,59	**3116,46**	**2,70**
Cream	627	213,7	724,3	1124,105	147,725	1062,85	465,4	619,55	377,35	382,75	486	684,55	**6915,33**	**5,99**
Egg	331	110,376	48,762	329,283	53,298	166,32	321,3	218,778	112,266	182,196	68,04	351,162	**2292,732**	**1,99**
Fish/Seafood				29,16	2,3					17			**48,46**	**0,04**
Juice and Jam	409		77,35	12,25	53,7	540		233,71	392,05	204	232	120	**2274,06**	**1,97**
Margarine		65				48,3	72						**185,3**	**0,16**
Milk, yoghurt	6670,12	3859,59	5620,15	9595,15	1187,72	8160,6	6942,85	8610,99	5637,95	6174,6	5386,67	6521,08	**74367,47**	**64,45**
Minced meat				44		44,8			92	46,4	72		**299,2**	**0,26**
Other dairy	373,3	143,75	257,625	489,05		625	673,5	512,4	280,775	244,475	234,5	216,675	**4051,05**	**3,51**
Other pantry										1,62			**1,62**	**0,00**
Yeast	6,6	5,1			2	51,05	7,8	19,2	20,4	21,4	6,75	26,55	**166,85**	**0,14**
Pasta			117,4										**117,4**	**0,10**
Pork	286	290,08	374,33	654,095	81,77	327,33	1170,145	439,35	361,68	203,92	514,51	665,38	**5369,045**	**4,65**

Potato						50,8	48,4					**99,2**	**0,09**
Ready Meal fish	24	22,05										**46,05**	**0,04**
Ready Meal meat				37,95		39,27	243,37			53,79		**374,38**	**0,32**
Ready Meal veg	242,26	126,42	258,765	95,64	127,29	299,775	395,08	248,665	183,39	228,22	185,665	107,16	**2498,33**	**2,17**
Roots, onions, cabbage						72,5			50,5				**123**	**0,11**
Salad vegetables					1,47	21		10,85			9,73	17,85	**60,9**	**0,05**
Scand. Sauces and spices		19,4							16,24				**35,64**	**0,03**
Soda							353						**353**	**0,31**
Total	**10034**	**5959**	**8535**	**13732**	**1813**	**12797**	**12042**	**12166**	**9329**	**9653**	**8913**	**10411**	**115383**	**100**

Appendix D. Popular science summary

Food waste is a global and complex problem that occurs at all stages from farm to fork. All actors handling food have the responsibility to handle it efficiently to minimize the risk of food going to waste. A third of the food produced globally is wasted every year. When food intended for human consumption does not reach the plate, not only the food itself is wasted, but also the resources and energy that went into the production, processing, transport and cooking of the food.

The retail sector creates a substantial amount of food waste. One common reason is that food items are thrown away when they approach their best before or use by dates. A Swedish start-up company, Deligate, recognized this issue and created a program for retailers to track the expiration dates of their inventory and take action before food expires, primarily by price reducing expiring food items.

In this thesis, Deligate's role in the food system was analyzed and their environmental impact was measured in terms of carbon footprint. The calculations were based on a list of the top price reduced items in 2020 from 82 Swedish retailers that use Deligate's program. The list did not hold information on the number of price reduced items sold, so sales scenarios were created. The scenarios showed that an average retailer can reduce the carbon footprint on food that otherwise would have gone to waste by 4 641 $kgCO_2$ equivalents each year, if they sell 100% of price reduced items. As a more relatable point of reference to be communicated to consumers, this can be translated into saving nearly 2 000 liters of gasoline from being burned. The scenarios serve as an estimation shortcut for retailers to facilitate alignment with their food waste reduction goals.

In addition to in-store price reduction using Deligate's program, Deligate is taking a unique approach by seeking to engage consumers in the reduction of retail food waste. The company launched a self-service price reduction station in April 2021, to let consumers be a part of the price reduction process. In an effort to investigate consumer motivation to try the station, called Datum-Rabatten, an online survey was created to uncover consumer awareness, attitudes and shopping habits in regards to retail food waste. Results revealed that the main driver for trying Datum-Rabatten was economic incentive, followed by desire to prevent food waste. The results also indicated that consumers view retail food waste as the retailers' responsibility to handle, but overall, respondents were receptive to the concept, indicating that they were willing to accept a role in reducing retail food waste.

The results of this study are intended to be used in the further development of Datum-Rabatten and other future initiatives to reduce retail food waste. We hope it can serve as an example of how external actors can join the food system, create new bridges between stakeholders to reduce food waste and contribute to a sustainable food system.