Exploring Coordination Mechanisms and Product Characteristics for Food Waste Reduction Principles:

A Case Study in Physical Distribution

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Zacharias Samuelsson

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Abstract

Title: Exploring Coordination Mechanisms and Product Characteristics for Food Waste Reduction Principles: A Case Study in Physical Distribution

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Thesis Purpose: Identify food waste causes in a global distribution network and develop an improvement proposal for minimizing food waste.

Method: This study develops a food waste mitigation framework based on a literature review and assess it through a case at a company. The framework combines and explores relationships in coordination mechanisms, product characteristics and food waste reduction strategies. Focus of the study is the wholesale part of a food supply chain and it aims to provide direction for food waste mitigation initiatives in the in the distribution interface between supplier and retailer.

Conclusion: The findings categorize two main types of product loss occurring in the distribution stage, these are losses from overstock stemming from produce running old and losses from compliance stemming from goods being unsellable due to policy, damages or regulatory reasons. These types are correlated to a number of both organizational and interorganizational causes. By mapping of the study companies logistics activities and placement in the developed framework the study indicate that product loss mitigation require multiple initiatives at a time, but may be dealt with by picking appropriate focus areas. Four focus areas for reducing food waste at the study company could be identified, these are transparency and traceability, improved quality of deliveries, adapting to disruptions and increased alignment. These four areas differ in the food waste causes they aim to deal with, what coordination mechanisms they utilise and what type of products that are occurring within them. With the taxonomy of food waste causes presented in this study value can be derived by highlighting the challenges of food waste reduction and prioritizing solutions based on weighted importance and applicability.

Keywords: *Food Waste, Food Waste Mitigation, Food Supply Chain, Food Retailing, Food Waste Mitigation in Distribution*

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1. Introduction

This master thesis aims to describe food waste causes and find potential approaches to mitigate food waste occurring in food distribution networks. The study is conducted based on research of a study company utilising cold chain logistics as well as literature focusing on food supply chains. The introducing chapter will begin by providing a background of the topic, followed by a problem description and end with an outline of the report structure.

1.1 Background

Food is a vital resource required by the whole world's growing population. The preciousness of food is being recognized by enterprises, governments and consumers creating a demand for efficient and non-wasting food supply chains in the 21st century (Atkins et al 2018) (Galanakis 2019). Food waste is directly connected to global sustainability, approximately one-third of the food produced aimed for human consumption gets lost every year (Galanakis 2019). The eradication of hunger is prioritised by the United Nations and part of the sustainable development goals in agenda 2030 (UN, 2015). It has been calculated that if half of the world's wasted food were recovered it would be enough to feed all the people in the world suffering from hunger (Atkins et al 2018). There is a trend to acknowledge long term sustainability among today's consumers and governments, this is putting pressure on companies to combat food waste (Neslen 2016). The way consumers look at products is changing, reportedly some consumers have begun to shift their buying habits towards near expiration food or aesthetically imperfect food to help reducing food waste (Godoy 2015). A growing and a more aware consumer base in the future is predicted. This increase in demand will lead to even more energy usage consumed for food production and transportation which in turn increase the importance of reducing food waste (Galanakis 2019).

To stay competitive, companies active in food distribution networks need to constantly strengthen their assortment with new products as well as constantly develop how they operates their distribution network. Improving the quality of the deliveries at reduced cost is key to tackle the retail trends and uncertainties through 2025 (McKinsey 2021). One way towards more efficient flows is to focus on reduction of the amount of obsolete product generated in the supply chain. This waste minimization can generate benefits such as reduced costs, improved company image and reduced climate footprint. Recent studies conducted have reported various benefits of focusing on waste reduction practices (Table 1: Reported benefits of waste minimization).

Table 1: Reported benefits of food waste minimization.

Benefit of waste minimaztion	**Source**
Reducing production costs	(Atkins et al 2018) (Galanakis 2019) (Småros 2018)
Reducing work associated with handling waste.	(Atkins et al 2018) (Galanakis 2019) (Småros 2018)
Reducing the environmental impact.	(Atkins et al 2018) (Galanakis 2019) (Småros 2018)
Improving social sustainability.	(Atkins et al 2018) (Galanakis 2019) (Småros 2018)
Increasing availability and making it timelier.	(Atkins et al 2018) (Galanakis 2019) (Småros 2018)
Improving company image.	(Atkins et al 2018) (Galanakis 2019) (Småros 2018)
Freeing up storing and transportation capacities.	(Atkins et al 2018) (Galanakis 2019) (Småros 2018)

1.2 Problem description

This Master Thesis report aims to propose principles for reduction of food waste occurring in food distribution processes. The study focus has been on food articles operated in cold chain transportation and warehousing services through a company study. The boundaries of the system studied is waste generated in the distribution from supplier dispatch to delivery at retail store. Whitin this system, food waste can occur in different forms at various places in the chain. A common reason for food waste is a mismatch in supply and demand leading to overstock and eventually destruction as the products shelf life runs out (Atkins et al 2018) (Galanakis 2019) (Småros 2018) (Moraes et al 2020). Regulation and quality issues such as product damages can also lead to food waste (Atkins et al 2018) (Galanakis 2019) (Småros 2018) (Moraes et al 2020).

Food products is characterised by high in value and relatively short best before dates which results in high number of turnovers and a lot of daily operational work (Småros 2018) (Moraes 2020). This work involves interactions, processes and routines affecting the movement, prioritisation and visibility of the goods which in turn is associated with the amount of food wasted (Småros 2018) (Moraes 2020). The thesis has aimed to form an understanding of how these distribution processes affect food waste. Then based on that understanding enable precautions that can be used as input for product and process development teams to reduce waste.

1.3 Purpose of the Master Thesis

Identify food waste causes in a global distribution network and develop an improvement proposal for minimizing food waste.

1.4 Research questions

To meet the purpose of the thesis the following research questions has been constructed:

RQ1: What is food waste and why is it occurring in the distribution flow?

Research question one's aim is to understand product loss causes and map different food waste types. It builds the foundation of what the improvement proposal should mitigate.

RQ2: How can business processes and actors in distribution affect food waste?

The second research question wants to form connections and relationships between food waste and logistics activities in the supply chain. It highlights the mechanisms controlling the system, where the improvement proposal is to be set.

> RQ3: How can product and market characteristics affect food waste in the supply chain?

The final research question explores product and market characteristics connection to food waste. The goal of this research question is to showcase areas of importance for the improvement proposal.

1.5 Focus and delimitations

The boundaries of the system studied is food waste occurring in the distribution from supplier dispatch to delivery at retail store of the study company (Figure 1: Study system boundaries).

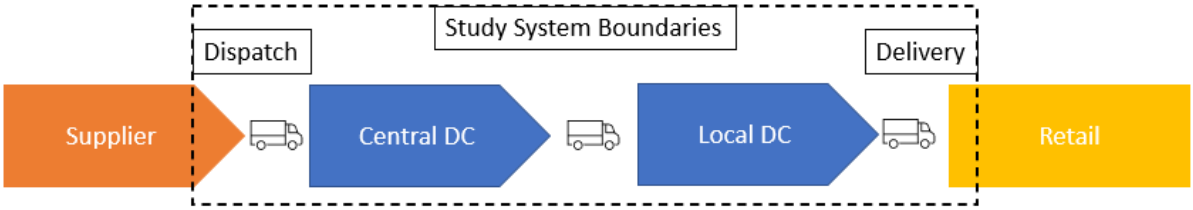

Figure 1: Study system boundaries (Illustration by author).

1.6 The study company intro

The study company is part of a global franchise and works as a wholesaler owning the goods and contracts services through the studied distribution processes. Utilising cold chain transportation and warehousing services, the company reach a wide range of markets offering food through its retail stores. While some local product alternatives are available, the company main offer consist of a standardised global food range. Differences in market requirements and the reach of the company make the distributed assortment very large. Innovation, changes in markets regulations, new variates, upgrades, and product introductions are common occurrences throughout the whole year. There are also activities with time restricted offers such as for easter or christmas. This forms a large global food supply chain at the study company, handling assortment of dry, chilled and frozen articles through sea and land transportation.

1.7 Report structure

Below (Table 2: Report structure) states and describes the report structure.

Table 2: Report structure.

Chapter	Description
1. Introduction	The first chapter introduces the thesis with a background of the topic and a problem description. Then purpose of the thesis, its research questions as well as focus and delimitations are presented in this chapter. Also, a short introduction to the study company is given. Last in the introducing chapter the report structure is provided.
2. Literature Review	For the second chapter, the literature review conducted is presented. The review begins with food supply chains in the broader perspective and is followed by distribution processes and food waste mitigation strategies. The chapter ends with a framework for food waste mitigation.
3. Methodology	The third chapter describes the methodology utilized during the study. The research approach, literature review strategy, data collection strategy is stated. Further on reliability, validation, objectivity, and analysis is discussed in this chapter.
4. The Case Company	Chapter four presents the empirical data of the thesis. Archival, product loss data is described as well as learnings from interviews.
5. Results	Chapter five summarizes the data collected. It starts by providing some main takeaways from the study company. This is followed by a summary of the historical data. Finally, the interview result is presented in this chapter.
6. Discussion	Chapter six discuss the findings from the literature review as well as the collected data.
7. Conclusion	Chapter seven begins with concluding remarks by answering RQ1, RQ2 and RQ3. After that the improvement proposal is presented. The chapter ends by discussing managerial implications of study and a note on future research.

2. Literature Review

This chapter presents the literature review conducted. The review begins with food waste and food supply chains in the broader perspective, followed by the thesis scope of distribution processes and product characteristics. The chapter ends by presenting a framework for food waste mitigation.

2.1 Defining Food Waste

Food waste refers to food produce aimed for human consumption that is discarded before reaching its end consumer (Food and Agriculture Organization of the United Nations 2013). It is considered food waste whichever the reason is for the food not being consumed. Defining food waste and its severity can be done by using the five dimensions FSC stage, human edibility, quality, nature of food use and destination of food (Figure 2: Dimensions used for defining food waste) (Chauhan et al 2021). First, FSC stage concerns the actor in the food supply chain where the waste occurs (Chauhan et al 2021). The second dimension, human edibility, describes the level of avoidability of the waste in terms of possibility for human consumption (Chauhan et al 2021). Thirdly, the quality dimension is connected to product characteristics such as aesthetics, nutritional value and expiry date (Chauhan et al 2021). Furthermore, the nature of the food use dimensions handles whether the usage of the food is what it was originally intended for. This could for example be if overstocked food is used for unplanned activities such as donations (Chauhan et al 2021). Lastly the end destination of the food plays a vital role when defining severity of food waste and loss. End uses can be valued differently in terms of how of a productive use they are, such as return flows in the form of animal feed versus discounting the product in the shop (Chauhan et al 2021). Combining these five dimensions can help describe the character of the food waste and quantify its importance.

Figure 2: Dimensions used for defining food waste (Illustration by author based on (Chauhan et al 2021)).

2.2 Food Waste Mitigation

The first step to mitigate food waste is to recognise how much food get wasted across the FSC (food supply chain) (Chauhan et al 2021). Food waste mitigation is a multifaceted issue involving a varied number of actors, policymakers, and consumers (Chauhan et al 2021), no solution involves only one stage in the chain (Liljestrand 2017). A typical food supply chain involves agricultural production and postharvest handling, manufacturing, distribution, retailing and end consumer (Figure 3: Typical food Supply Chain stages and food waste root causes) (Galanakis 2019) (Liljestrand 2017). While some types of waste are more frequent in some parts of the supply chain, food waste occurs in large volumes at all actors. In Sweden producers, wholesalers and retailers create approximately as much food waste as the households (Liljestrand 2017). It has been reported that waste is dependent on development

level of a country. When comparing the development level with at what stage of the FSC the waste occurs, it shows that a country with high level of development tends to waste less in the early stages of the FSC, but more in the later stages (Atkins et al 2018). The opposite is true for a country with a low level of development. This could be acquainted to that modern production technology is wasting less and that the consumption behaviours in the later stages of the FSC heavily affect the amount of waste (Atkins et al 2018). For the distribution stage better information and communication flows, faster deliveries, lean practices, performance measurements and clear waste management responsibilities has been shown to reduce food waste (De Moares et al 2020). Ideally, modern production and transportation technology, workways accounting for and recognizing waste combined with efficient consumption behaviours could form non-wasting food supply chains.

Three root causes can be linked to food waste, namely megatrends, natural constraints, and management root causes (Liljestrand 2017). Megatrends concern industry and consumer trends, such as a move away from products with preservatives (Liljestrand 2017). Natural constraints are factors that are associated with product and processes. These are issues like short shelf life of products, seasonalities in demand and longer lead times for imported products (Liljestrand 2017). Lastly management root causes are factors where management practices have a direct impact on the waste (Liljestrand 2017).

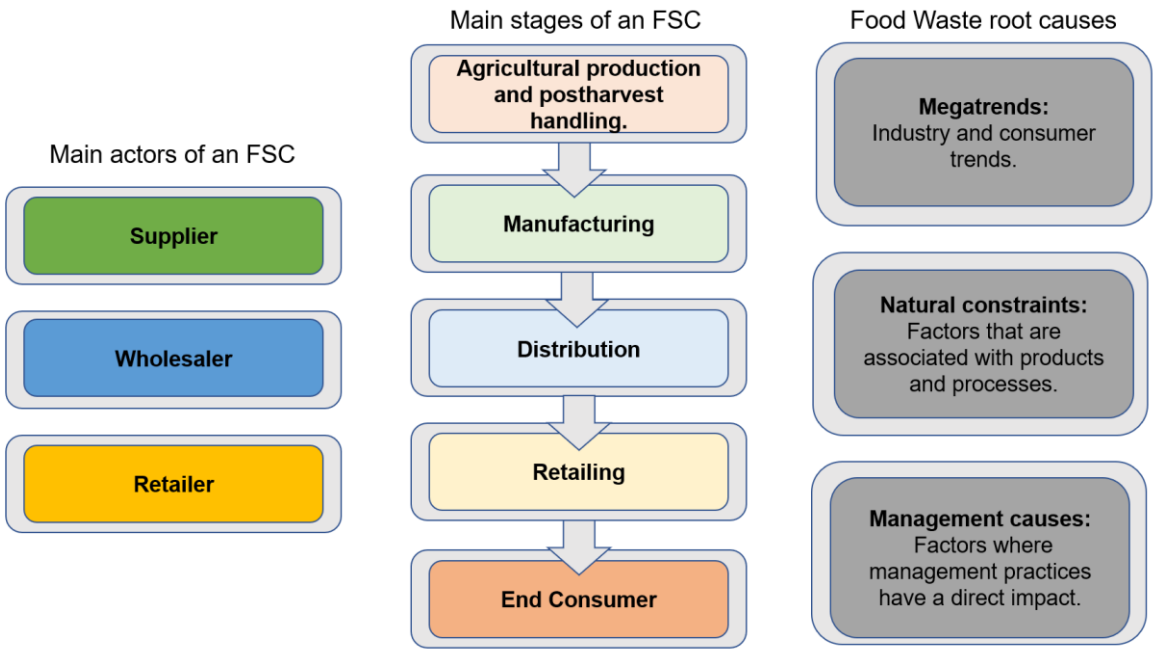

Figure 3: Typical food Supply Chain stages and food waste root causes (Illustration by author based on (Galanakis 2019) and (Liljestrand 2017).

To reduce food waste it is required to have a thorough understanding of how the different logistics activities are linked (Liljestrand 2017). Logistics activities are work tasks, equipment and facilities occurring in and between all the actors in the chain. In food supply chains, the wholesaler work as a coordinator and intermediate of the logistics activities from producer and towards the retailer. Therefore, as a large central coordinator the wholesaler plays a vital role in reducing food waste even though the majority of the waste may not occur at their stage (Liljestrand 2017). For the producer, decisions on pricing, packaging and joint

development affect the amount of food waste (Liljestrand 2017). As last in the chain the retailer can work with limiting ordering variations, share and update the sales planning continuously, as well as focus on activities for stock with short best before dates. When doing reduction initiatives for food waste it is important to acknowledge that the problem is dynamic, the resources (e.g amount of available food) as well as the destinations (e.g demand location) keep changing (Chauhan et al 2021). Food Waste is thereby in essence an efficiency problem and the overall focus for reduction practices is understanding the needed shelf life for a specific flow, limiting variations in the chain and always reducing both operational and administrative lead times. The objective is to balance the trade-offs of minimizing food waste while also taking into account other operational performance indicators such as service levels or fillrates (Chauhan et al 2021).

2.3 Food Waste Mitigation Model

Chauhan et al presents an overview for food waste mitigation in their FLW (Food Loss and Waste) mitigation model (Figure 4: FLW Mitigation Model) (Chauhan et al 2021). The core of their model stems from the questions of who, how, where/when and why/what. Who refers to actors that can influence food waste throughout the FSCs, it involves the farmers, manufactures, retailers, government and society. How refers to different actions that can be taken for food waste mitigation such as operational strategies, behavioural strategies, policy-related strategies, charity and waste quantification. Where refers to the stage of the FSC consisting of farm, processing, wholesale, retail and consumer (the consumer stage is outside the scope of their review). The what/why handles the indicators and drivers of food waste mitigation. Indicators are described as factors responsible for food waste, quantified waste and sustainability. The drivers are stated as social, moral, political, macroeconomic, microeconomic and environmental. The indicators and drivers are feedback and input for what action the actor should take for food waste mitigation. The thesis analysis is based on Chauhnas framework for generating mitigation action, but with a focus on the perspective for the wholesaler of the FSC. However, as the model suggests, it should be kept in mind how other actors also influence FLW. Such as how policymakers can influence importation and market regulation, or the costs associated with surplus food management (Chauhan et al 2021).

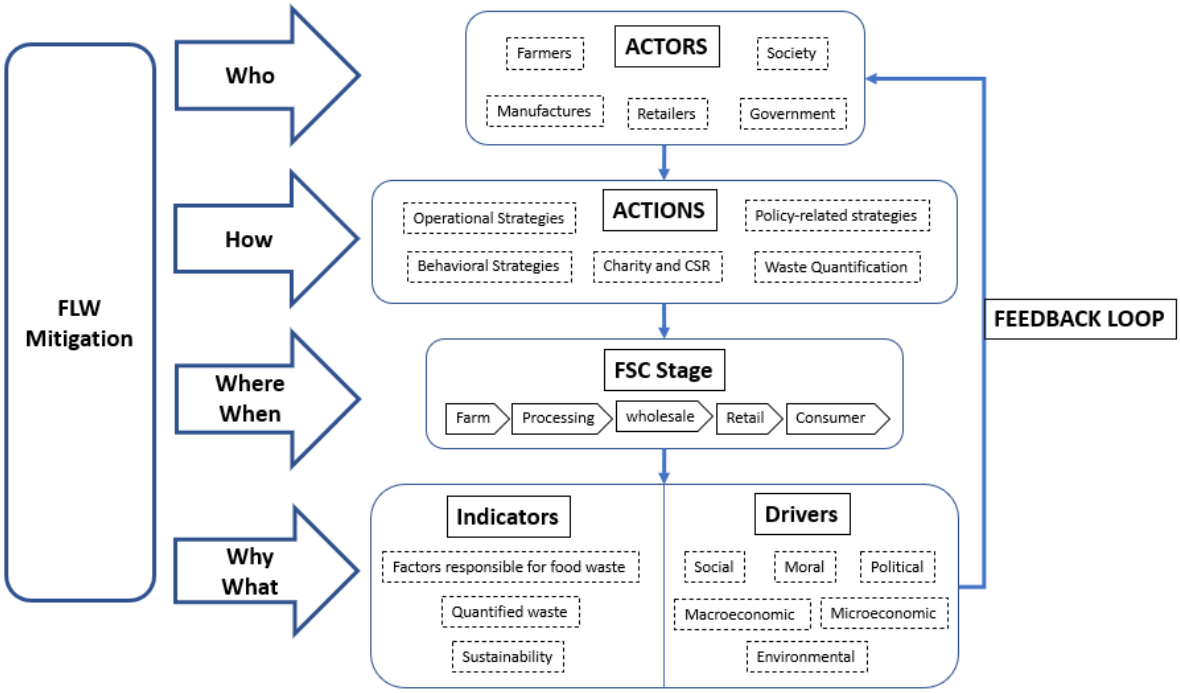

Figure 4: FLW Mitigation Model (Illustration by author based on food waste mitigation model in (Chauhan et al 2021)).

2.4 Distribution Coordination

For the distribution process of the FSC the amount of food waste is the result of the efficiency of a chosen logistics solution used for the product delivery. Food waste depend on context and stems from the combination of both coordination mechanisms throughout the flow and the product and market characteristics. Coordination mechanisms can be defined as “tools to address particular coordination problems” (Liljestrand. 2017). The need for coordination arises from the division of labour and the various specialisations working within the flows (Liljestrand. 2017). Coordination is required at and in between all the stages of the chain from producer, wholesaler to retailer (Simatupang and Sridharan 2005). In supply chains coordination can be analysed in terms of interfaces and responsibilities between roles and their logistics activities (Liljestrand. 2017). These coordination mechanisms fall into four main categories contracts, information technology, information sharing, and joint decision making (Liljestrand 2017). Contracts coordinate the work through dictating responsibilities for the roles and thereby affect their decisions. The second coordination mechanism, information technology concerns the technology used in the execution of the operational flow. It is about how certain work tasks are performed in the planning and management systems, for example how measurements such as KPIs are aligned throughout the flow (Simatupang and Sridharan 2005). Thirdly information sharing concern visibility, transparency, and communication between the functions (Simatupang and Sridharan 2005). The last coordination mechanism joint decisions making concerns cross-functionality, dialogues, and the level of involvement of other functions in the decision processes (Simatupang and Sridharan 2005). This coordination mechanism handles the base of input and information that is used when the role is making its decision. The mechanisms are present both in their own and together in the logistics activities throughout the product flow for processes such as customer service, demand forecasting, distribution planning, inventory

control, materials handling, order processing, parts and service support, plant and warehouse selection, procurement, and packaging and transportation decisions (Liljestrand 2017) (Simatupang and Sridharan 2005). The responsibility for the logistics activities is divided among the roles in the supply chain, the routines of these activities and how they make us of the coordination mechanisms affect the amount food waste. Below (Figure 5: Coordination Mechanisms for distribution processes) illustrates planning roles, their responsibilities within the logistics activities and coordination mechanisms of a typical food distribution chain.

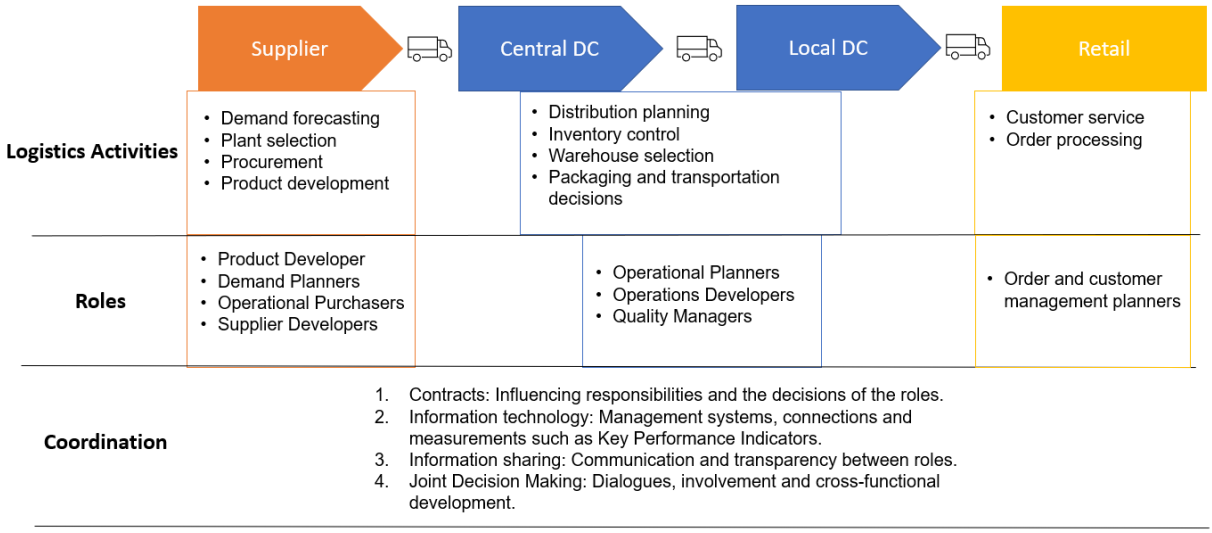

Figure 5: Coordination Mechanisms for distribution processes (Illustration by author based on (Liljestrand 2017) and (Simatupang and Sridharan 2005)).

2.5 Product and Market Characteristics

Product and market characteristics affect the complexity of the flow and by that the amount of food waste. Depending on the products characteristics it can reach through several regions, processes, and distribution stages before being sold (Atkins et al 2018). Literature attributes a large amount of waste in food supply chains to erratic demand and improper replenishment policies (Chauhan et al 2021) (Atkins et al 2018) (Småros 2018) (Moraes et al 2020). Food products that are assigned for destruction due to passed expiration dates have three underlying causes (Liljestrand 2017). First it is the misalignment of demand, which often is due to variation at both the supply and the receiver (Galanakis 2019). For example, if its starts raining, less customers will buy watermelons and if there is cloudy weather it can reduce crop yields (Liljestrand 2017). The variates in seasonalities are complex to account for and the reaction them is often not quick enough (Atkins et al 2018) (Småros 2018) (Moraes et al 2020). Secondly a mismatch in shelf life and lead times is a driving factor (Liljestrand 2017). Products shelf life, minimum order quantities and market characteristics is hard to align, but heavily affect the losses for aging commodities (Moraes et al 2020) (Atkins et al 2018) (Småros 2018). Third the megatrend of increasing store assortments can cause cannibalization effects and product combinations that mismatch and work against each other throughout food supply chains (Småros 2018). Compliance issues stemming from unmet or sudden changes in market regulations preventing or delaying importation of already produced food has shown to be another major cause of food waste (Galanakis 2019).

Improper design for food packing is also considered as a driver of food waste (Chauhan et al 2021). Food produce that is destroyed due to damages stems from transport, warehousing and retailing activities (Liljestrand 2017). Damages can for example come from vibrations during long route shipping, misaligned load factors in the packaging system, overhang and undersized pallets, moisture or temperature issues during transportation (Liljestrand 2017). Inappropriate work procedures during the distribution activities have also shown to cause damages for food produce (Moraes et al 2020). In food supply chains labelling activities of the consumption packages are common and can break the packaging system and cause faulty constructions when repackaging into secondary packages at the warehouse occurs (Liljestrand 2017). Product and market characteristics that can be connected to food waste in the parts of the chain is summarized below (Figure 6: Product and Market Characteristics).

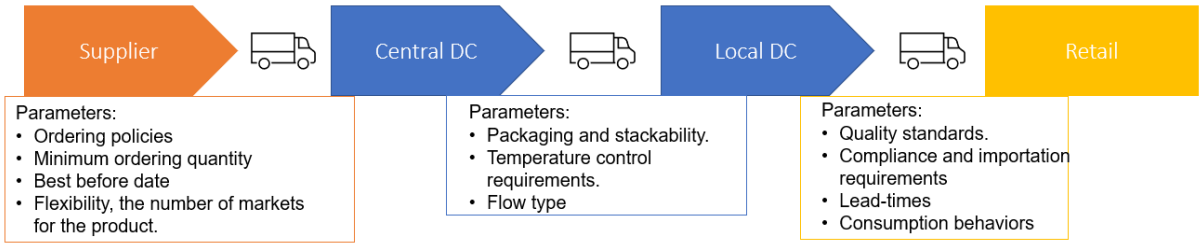

Figure 6: Product and Market Characteristics (Illustration by author based on (Chauhan et al 2021) (Atkins et al 2018) (Småros 2018) (Moraes et al 2020) (Liljestrand 2017) and (Galanakis 2019).

2.6 Food Waste Mitigation Strategies

Literature presents solutions for reducing food waste through efficient information sharing and adaptions in the material flows. The reduction initiatives focus on practices triggering food waste such as supply and demand management, availability and inventory management, quality and process control, shelf-life management, and packaging and labelling activities (Liljestrand 2017). The solutions from literature have been divided into *Packaging, Operations* and *Supply chain Setup solutions* based upon what mechanism the solution utilise for the mitigation. The solutions are presented in below chapter and summarized in (Figure 7: Framework for food waste mitigation) (Liljestrand 2017) (Aramyan et al 2020) (Moraes et al 2020) (Chauhan et al 2021) (Atkins et al 2018) (Wang et al 2019) (Batista et al 2021) (Simatupang and Sridharan 2005) and (Galanakis 2019).

2.6.1 Food Waste Mitigation Through Packaging

In reviewed literature three main solutions for reducing food waste through packaging can be found. First is packaging development (1) which highlights the importance of adopting an holistic approach during improvements in the packaging system (Liljestrand 2017) (Aramyan et al 2020). Higher procurement prices due to increased packaging could be paid off by lowering logistics handling costs and generating higher sales (Liljestrand 2017). External covers, changes in size and portion as well as loading sequence on pallets could reduce food waste (Liljestrand 2017). Secondly visualising damaged packaging (2) is provided as a potential mitigator of food waste. This is done through sharing information about damages in terms of magnitude and causes through pictures or video. The information can be collected

from logistics activities at transportation, warehouse and retail to draw learnings for procurement choices, packaging development and packing improvements (Liljestrand 2017). Last mitigator concerning packages is making use of digitalization for better monitoring (3) of the products throughout their journey to the customer (Chauhan et al 2021) (Aramyan et al 2020) (Moraes et al 2020). Different types of sensors to monitor food quality, administering the right physical environment especially concerning temperature and humidity could prevent losses (Chauhan et al 2021) (Aramyan et al 2020) (Moraes et al 2020).

2.6.2 Food Waste Mitigation Through Operations

Literature contributes with various solutions for how the supply chain operations can mitigate food waste though their planning activities. To reduce misalignment in supply and demand collaborative forecasting (4) is provided as a mitigator of food waste. This is based on joint decision making and can be executed between producer, wholesaler, and retailer to reduce the forecasting error (Atkins et al 2018) (Moraes et al 2020) (Liljestrand 2017). It can be done in various ways, such as sharing stock information and making common targets for handling deviations, in essence it is about deciding together (Liljestrand 2017). Next solution provided is to determine level of safety stock as a daily process (5) to better react to fluctuations and thereby reduce waste from overstock (Liljestrand 2017). Price reductions (6) has also shown to reduce waste (Liljestrand 2017). For very short shelf-life items (like fresh meat), price reduction is the trade of with service level. For other short shelf life items the trade-off is service level and tied up capital (Liljestrand 2017). Improvement initiatives focusing on efficiency (7) such as lean practices, quality management, faster delivers and KPIs is a popular way to reduce food waste (Chauhan et al 2021) (Atkins et al 2018) (Moraes et al 2020). Another way the operations can help reduce food waste is through new ordering policies and improved shelf-life strategies (8) (Chauhan et al 2021) (Wang et al 2019) (Aramyan et al 2020). In the ordering policies strategies that account for current best before dates of products could help reduce food waste occurring due to produce getting old. Making use of digitization for better coordination between stakeholders (9) is a solution for better alignment of the enterprise planning systems with service providers, suppliers and customers (Chauhan et al 2021) (Aramyan et al 2020). Better tracking through RFID (10) can help reduce food waste through improved inventory and transportation management (Chauhan et al 2021). Reducing food waste can be done through behavioural strategies (11) (Chauhan et al 2021) (Aramyan et al 2020). Forming operational focus through food waste reduction initiatives, projects and management ambition can make employees acknowledge it in their everyday work (Chauhan et al 2021) (Aramyan et al 2020). Implementation of a proper system for waste quantification (12) with standards and formal guidelines for accurate data logging of food waste could enable the company to compare and benchmark their data overtime (Chauhan et al 2021) (Moraes et al 2020). Clear waste management responsibilities (13) through mapping of processes that involve food waste or short shelf-life items can priorities reduction in the daily work of the organisation (Atkins et al 2018).

2.6.3 Food Waste Mitigation Through Supply Chain Setup

The last category of solutions presented for food waste mitigation in reviewed literature concerns the supply chain setup. To better align the flows division of lead time (14) is provided as a solution to address mismatch between lead time and a products shelf life. This is done through identifying products which a longer shelf life could help reduce the waste, example ketchup is stored longer, while potato chips are not (Liljestrand 2017). Introduction

of make to order flows (15) has shown to reduce waste due to using the most accurate demand data (Liljestrand 2017). However, MTO flows could be impractical if products are characterised by long production or transportation times (Liljestrand 2017). Another solution is to reform measures of service levels (16) to address mismatch between assortment and shelf life (Liljestrand 2017). Combine service level for same/similar products or limit service during market campaigns such as Christmas (Liljestrand 2017). Through joint product group revisions (17) wholesalers, suppliers and retailers can review and update the assortment (Liljestrand 2017). These revisions can identify what products to include and exclude, as many perspectives are present these meetings can highlight issues in short-shelf life, bad deliveries, seasonal effects and issues due to the breadth of assortment (Liljestrand 2017). Reform contracts or change contract type (18) is also provided as a food waste mitigator (Chauhan et al 2021). Subscription-based orders and take-back contracts have shown to have a significant influence on food waste, especially on where in the chain the waste occurs (Chauhan et al 2021). Adapting new quality and cosmetic standards that are less stringent (19) can reduce food waste (Chauhan et al 2021) (Aramyan et al 2020) (Moraes et al 2020). Demanding high standards can incentives suppliers to provide good quality, however to high standards can also lead to unnecessary disposals at different stages of the chain. Therefore proper assessment and monitoring of required quality levels is needed (Chauhan et al 2021) (Aramyan et al 2020) (Moraes et al 2020). Working with the returns flows through recycling, reuse, circular economy and donation channels (20) can make the waste less significant (Chauhan et al 2021) (Batista et al 2021).

2.7 Framework for food waste mitigation

Stemming from the presented food waste mitigation model from Chauhan et al in chapter 3.3 this chapter present a framework for utilizing the model in the study system of the thesis, the food distribution processes (Figure 7: framework for food waste mitigation). The framework combines the various parts of the literature review and utilise Chauhan model to zoom in on food waste mitigation at distribution stage of the food supply chain. It is directly connected to the study research questions*: What is food waste and why is it occurring in the distribution flow? How can business processes and actors in distribution affect food waste? How can product and market characteristics affect food waste in the supply chain?*

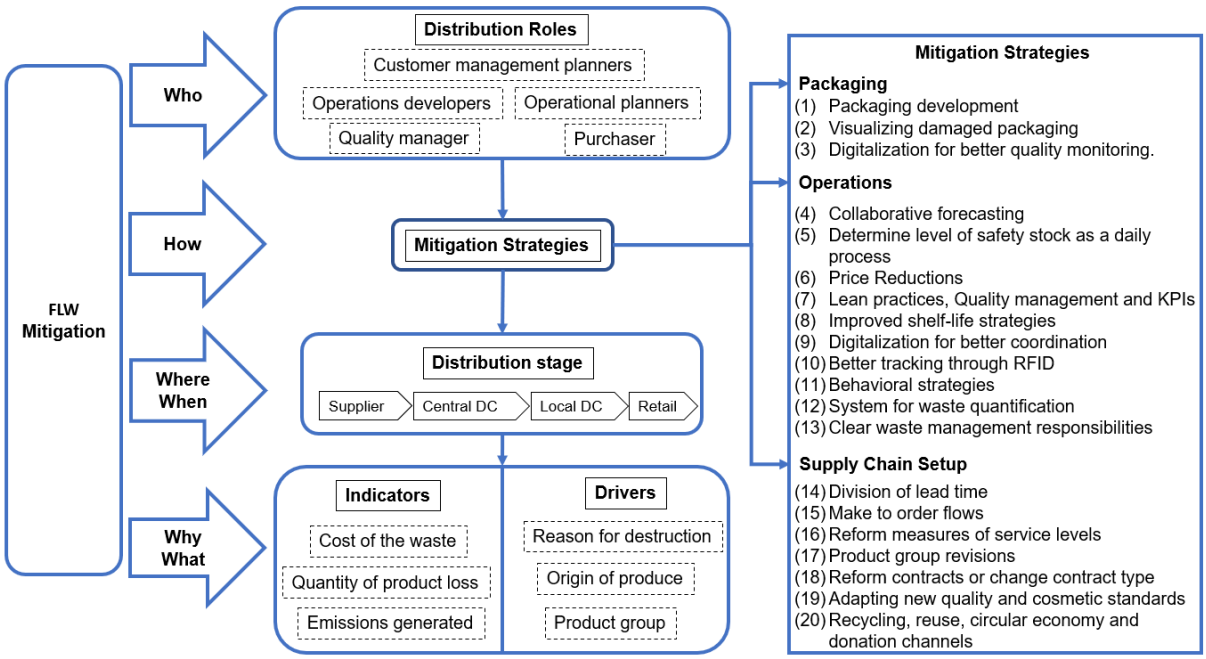

Figure 7: Framework for food waste mitigation (Illustration by author based on (Liljestrand 2017) (Aramyan et al 2020) (Moraes et al 2020) (Chauhan et al 2021) (Atkins et al 2018) (Småros 2018) (Wang et al 2019) (Batista et al 2021) (Simatupang and Sridharan 2005) and (Galanakis 2019).

3. Methodology

The thesis attempts to describe how case research can be conducted at a company to develop a proposal for food waste mitigation. When developing the proposal inspiration has drawn from data collected, processes, and interviews at a studied company. This chapter describes the methodology utilized during the study. The research approach, literature review strategy, data collection strategy are stated. Further on reliability, validation, objectivity and analysis is discussed in this chapter. A summary of the methodologies steps is presented in below figure (Figure 8: The steps of the methodology utilised).

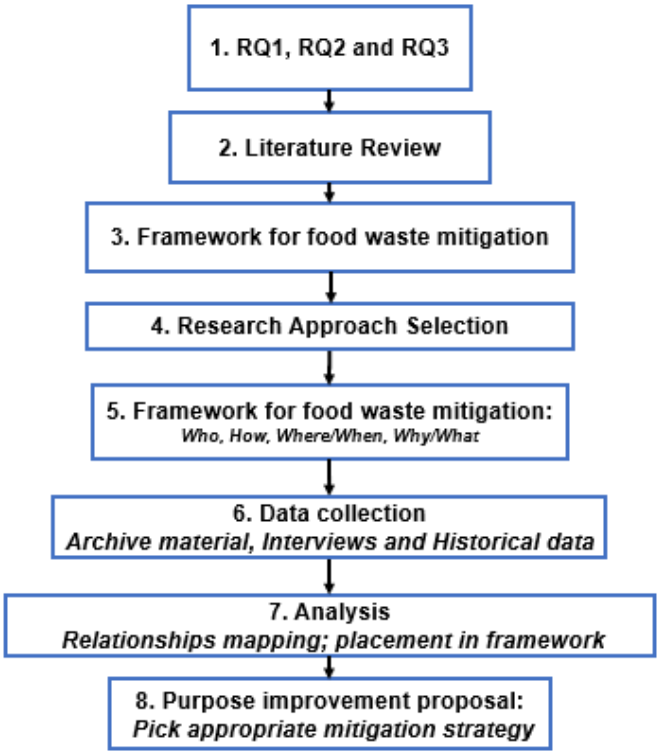

Figure 8: The steps of the methodology utilised (Illustration by author).

The methodology starts from the research questions RQ1, RQ2 and RQ3 that initiated the literature review. From that review a framework on the thesis scope for food waste mitigation at distribution stage of the food supply chain was constructed which was used for the company study. The fourth step of the methodology defines the parts building up the research approach, followed by the fifth and sixth step that utilize the formed framework for direction and guidance in the data collection. Next the analysis consists of discussing the collected data and placing the study company in the mitigation framework. Finally appropriate mitigation strategies are to be picked to meet the purpose of the thesis.

3.1 Research approach

The selected research approach for the study follows a case research approach. A case research approach is characterised by contributing to theory by building on observations of the phenomena as it occurs in practice (Stuart et al 2002). These direct observations are

valuable for adding richness to existing concepts. Therefore, case research is particularly good for forming an understanding of links and relationships in an operations environment (Stuart et al 2002) (Eisenhardt and Graebner 2007). Due to that the cases that build the theory is gained from real experiences, case research is often considered interesting and highly cited (Eisenhardt and Graebner 2007). With the approach there is a possibility to bring new findings enriching both the academics, companies, and the researcher themselves (Voss et al 2002). These characteristics, connecting reality with theory, of case research make it very useful for use in the Master Thesis. In their publication Voss et al (2002) lists three strength of case reasearch. These can be connected to the thesis (Table 3: Case Research Strengths).

Table 3: Case Research Strengths

Strength	**Master Thesis connection**
1. The phenomenon can be studied in its natural setting and generate relevant theory from the understanding gained through observing actual practice.	The thesis is about reoccurring a phenomenon in active distribution flows.
2. The case method allows the questions of why and how, to be answered with a relatively full understanding of the nature and complexity of the complete phenomenon.	The research questions are of why and how nature connecting to the phenomenon.
3. The case method lends itself to early, exploratory investigations where the variables are still unknown and the phenomenon not at all understood.	While phenomenon has been studied and highlighted in various ways before, the particular scope could be said to be exploratory.

3.1.1 Case study design

Yin (2009) describe case study designs in four types through a 2x2 matrix (Figure 9: Basic types of designs for case studies) (Yin 2009). The matrix reflect the different types in two dimensions, the case can be either of single-case or multiple-case design as well as of either holistic or embedded nature. Single-case studies are when a single case is used to study the phenomenon and can be appropriate if the case represents a critical case, unique case, representative case, revelatory case or a longitudinal case (Yin 2009). In general single-case studies are well suited for cases that test significant theory in a well-defined but unexplored setting or system. Multiple-case designs utilise multiple cases to study the phenomenon. A multiple-case design can be advantageous in that its evidence is often seen as more compelling due to drawing from more sources of data (Yin 2009). A disadvantage of a multi-case design is that it complicates the research and is often more time consuming than a single-case study (Yin 2009). Both the single and multiple-case study can then be either holistic or embedded in nature. Depending on if the case is holistic or embedded in nature it involves one or more than one unit of analysis (Yin 2009). A embedded case study involves multiple unit of analysis that builds the case (Yin 2009). The embedded design takes thereby a wider approach than the holistic, but it is also a more complex design (Yin 2009). The advantageous of the embedded design could be that it deals in more detail and clarity of subunits building up the context in comparison with the holistic approach (Yin 2009). A major

pitfall however is that the complexity of the embedded design may make it fail to connect its parts not being able to return the larger formed unit of analysis (Yin 2009).

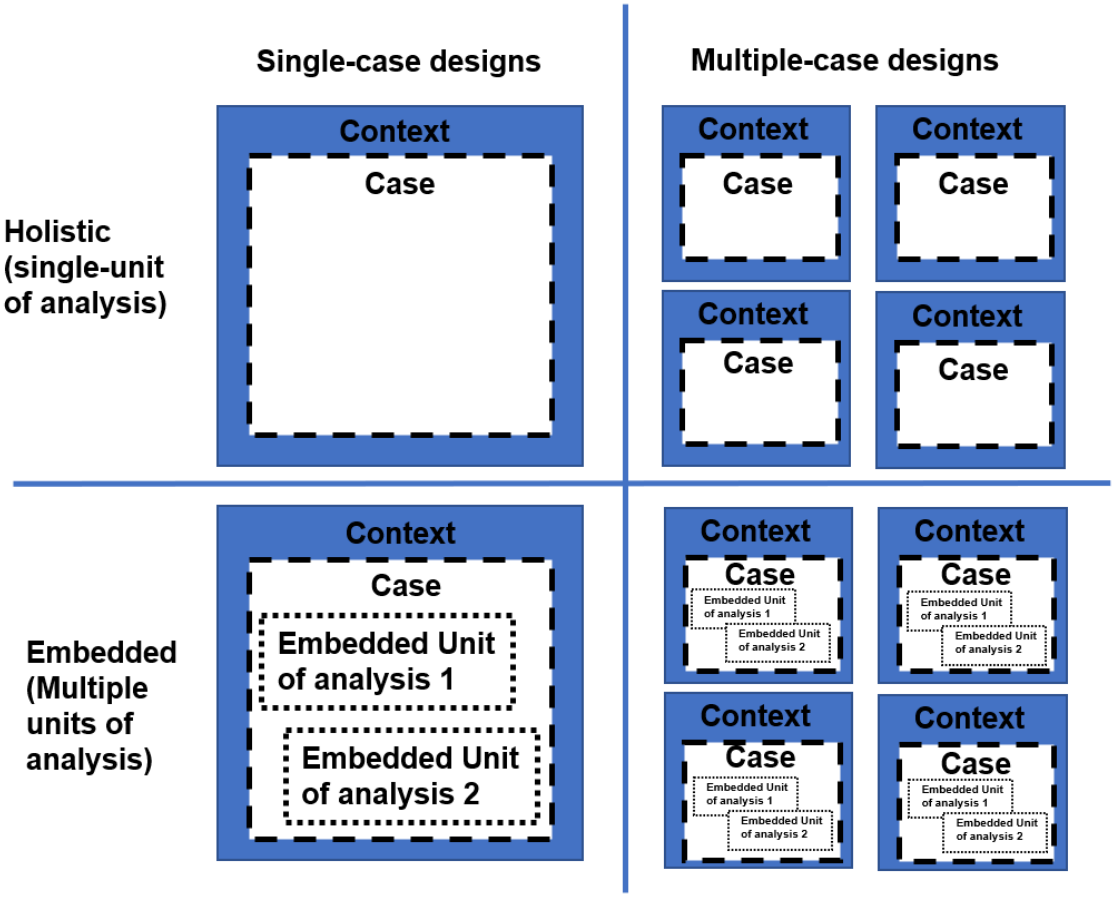

Figure 9: Basic types of designs for case studies (Illustration by author based on (Yin 2009)).

Given the above mentioned points an embedded and multiple-case design would give more detail and better generalizability in this research. However due to time and resource limitation a holistic single-case study has ben chosen for the study. Further on the thesis purpose of developing an improvement proposal at a specific study company motivates that picking this case study design is sufficient.

3.1.2 Unit of analysis

Defining the unit of analysis is part of the fundamental components when conducting a case study (Yin 2009). Obtaining a correct unit of analysis can be a complex task. When forming the study one can be tempted to form a wide unit of analysis to cover as much as possible about the topic (Yin 2009). However, this would lead to a never-ending investigation, therefore for manageability the unit of analysis should be closely connected to the research questions and clearly indicate the study focus area (Yin 2009). With this in mind the thesis unit of analysis has been chosen as: food waste occurring in the interface between supplier dispatch until delivery at retail store in the study companies supply chain. This is food waste in the distribution stage of a food supply chain.

3.1.3 Research objective

Voss et al (2002) provide four different types of research purposes, exploration, theory building, theory testing and theory extension/refinement (Table 4: Research objective). The purpose of exploration lends itself in new unresearched areas to find potential for development of theory (Voss et al 2002). Theory building research purposes aims to build theory through identification of key variables and relationships (Voss et al 2002). Theory testing is about testing the developed theories and use them to predict future outcomes (Voss et al 2002). Lastly theory extension/refinement is a follow up on case studies and previous studies to gain a deeper understanding or validate empirical results (Voss et al 2002).

Table 4: Research objective (Obtained from (Voss et al 2002))

Purpose	**Research question**	**Research structure**
Exploration	Is there something interesting enough to justify research?	In-depth case studies Unfocused, longitudinal field study
Theory building	What are the key variables? What are the patterns or linkages between variables? Why should these relationships exist?	Few focused case studies In-depth field studies. Multi-site case studies Best-in-class case studies
Theory testing	Are the theories we have generated able to survive the test of empirical data? Did we get the behaviour that was predicted by the theory or did we observe another unanticipated behaviour?	Experiment Quasi-experiment Multiple case studies Large-scale sample of population
Theory extension/refinement	How generalisable is the theory? Where does the theory apply?	Experiment Quasi-experiment Case studies Large-scale sample of population

Following this table from Voss et al (2002), case studies of explorative nature with the aim of finding potential relationships lends themselves with a research structure consisting of in-depth case studies and unfocused, longitudinal field studies. The master thesis is about utilising theory in the search for relationships with focus on one case at a company and therefore the research purpose is placed at exploration.

3.1.4 Research process approach

The research process approach chosen can be explained as utilising case research in a combination of both the inductive(Qauntitative) and deductive(Qaulitative) path. This is described as the abductive path or the balanced approach (Golicic et al 2005). The aim of the abductive path is to balance both the inductive and deductive path to utilise their

respective strengths (Golicic et al 2005). The thesis has attempted this by following the below listed and illustrated steps (Figure 10: Research process approach).

1. **Deductive(Qualitative) Path**:
    - Data collection: Interviews, archive material and historical product loss data.
    - Description: Categorization of product loss data, themes for processes from interviews.
    - Substantive Theory: Relationships mapping
    - Phenomenon: Food wasted in distribution processes
2. **Inductive(Quantitative) Path**:
    - Literature review: Food Supply Chains, Food Waste Mitigation Strategies, Supply Chain Management.
    - Formal Theory: Framework for distribution planning processes, Coordination Mechanisms, Food Product Characteristics.
    - Field Verification: Not utilised

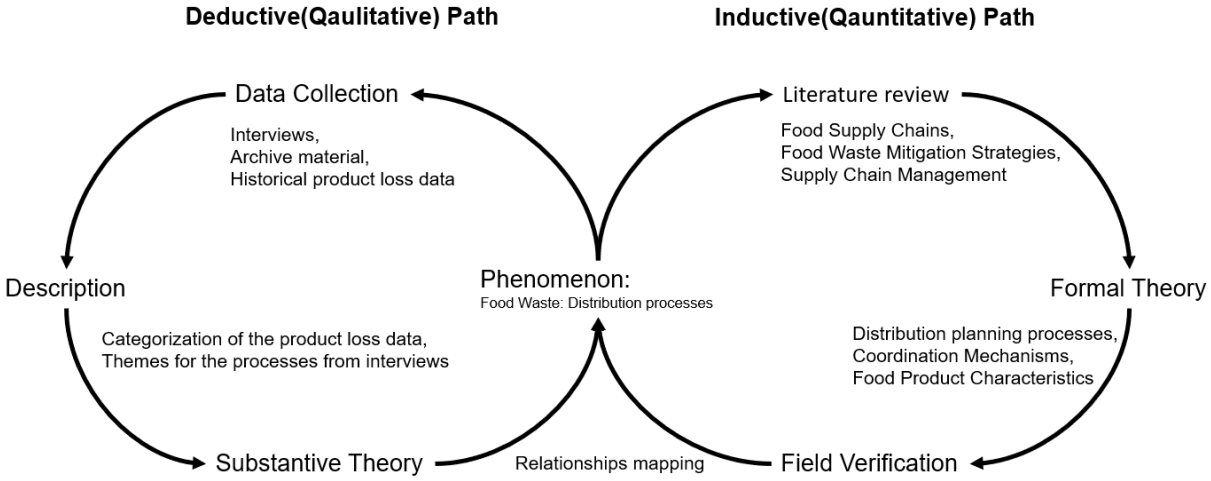

Figure 10: Research process approach (Illustration by author based on (Golicic et al 2005)).

3.2 Data collection

This section explains the strategy used for data collection. Following the abductive research process approach, the data collection consisted of both a literature review, Interviews, archive material and historical data. The starting point for the data collection was the literature review forming the framework of *who, how, where/when* and *why/what*, during the formation of this framework initial meetings at the company about the topic of food waste was also utilized. Based on this framework the different parts of the data collection aimed to fill the frameworks foundation. The data for *who* and *how* was retrieved from the conducted interviews. Further on the data for *where/when* and *why/what* was obtained through archive materials as well as historical data. This data collection is discussed next.

3.2.1 Literature Review Strategy

While case research is about bringing something new to the stakeholders there still needs to be prior knowledge (Voss et al 2002). To ensure this a literature review process has been

carried out. The researcher should enter the study with theory in mind (Stuart et al 2002). Sound empirical research begins with a strong grounding in present academic literature (Eisenhardt and Graebner 2007). The literature review is required for getting the academic depth, however it should be kept in mind that it could also cause biases hindering nuances (Stuart et al 2002). Literature should be utilized to strengthen the research strategy and preventing re-inventing of the wheel. It should clarify known concepts, but at the same time make room for formation of new findings.

The literature review was conducted in two main steps. First phenomenon and its context were studied in a general literature review. After that a more specific literature review for the topic was carried out. The reviews main focus was academic journals retrieved through the search engine LUBSearch, but it also incorporated some newspaper reports and academic journals retrieved through google when forming the study narrative. For the general review the aim was to build the context for the phenomenon, and it was looked upon in the broad supply chain context. Here the literature consisted of trends and facts for the topic and was retrieved with search words of “food waste”, “supply chain management” and “case research in operations management” (Table 5: General literature review).

Table 5: General literature review.

Search word	**Material Type**	**Search Engine**	**Results**
Food Waste	Academic Journals	LUBsearch	164 860
Supply Chain Management	Academic Journals	LUBsearch	254 405
Business Process Management	Academic Journals	LUBsearch	476 051
Case Research in Operations Management	Academic Journals	LUBsearch	89 913

For the specific literature review, the main focus of the literature review, the empathize was on characteristics of food supply chains and food waste mitigation strategies. The specific literature review consisted of studies in “food supply chains”, “food retailing” and “food waste mitigation” (Table 6: Specific literature review).

Table 6: Specific literature review.

Search word	**Material Type**	**Search Engine**	**Results**
Food Supply Chain	Academic Journals	LUBsearch	52 013
Food Retailing	Academic Journals	LUBsearch	12 337
Food Waste in Food Supply Chains	Academic Journals	LUBsearch	4 715
Food Waste Mitigation	Academic Journals	LUBsearch	2 425
Food waste Mitigation Strategies	Academic Journals	LUBsearch	637
Food Waste Mitigation in Food Supply Chains	Academic Journals	LUBsearch	232
Food Waste Mitigation in Distribution	Academic Journals	LUBsearch	122

While the obtained search result in the above two tables narrows down when closing in on the study phenomenon, both the general and specific review showed a large number of publications. The literature review was thereby used as a base for building the methodology of the study, refining the research questions and as preparation for interviews and data collection by forming the presented framework. Literature was also used for trends and facts

of food waste. Finally, literature was utilised as inspiration for the improvement proposal with its provided solutions for strategies connected to food waste mitigation.

3.2.2 Data Collection at the study company

Different methods for the data collection were used. Interviews, direct observations, archived information, and product loss data were collected. The data collection strategy was thereby based on the method of triangulation to construct validity (Voss et al 2002). Noting, sorting and categorization of the data was done continuously to form a narrative and base for deeper research and further collection. In the Initial phase of the data collection weekly meetings with stakeholders at the study company regarding the topic of food waste and supervisors was utilised. Notes and minutes from these meetings were then used to find potential interviewees at the company and what to look for in the product loss data. The goal was to connect the study company with the formed food waste mitigation framework.

3.2.3 Interviews: *Who* and *how*

To get an understanding of how the various roles and actors in the supply chain work with food waste and how it is prioritized within their routines, interviews were conducted. The challenge with interview conversations is to mitigate biases (Voss et al 2002) and ensure that it eventually uncovers all the pertinent data (Stuart et al 2002). There should be a clear direction from the interviewer, such as a prepared interview guide. However, the interviewer should also make room for reflection and deterrence from the guide with new questions based how the interview goes on. The most interesting findings usually comes when the interviewee uncover what he/she really thinks (Stuart et al 2002). It is not uncommon to find incomplete views between the interviewees, finding gaps and investigate them can uncover very valuable relationships (Voss et al 2002). Interviews often give highly efficient and rich variety of the data, but one need to be wary of retrospective sensemaking when conducting them (Eisenhardt and Graebner 2007). Therefore, a prepared interview guide based on previous research with room for discussion and reflection was used for conducting the interviews.

For the thesis, interviewees were chosen in two main categories. The first category regards employees working in the operational execution for the planning of the distribution processes. The roles in this category followed the set of management processes for the various part of the deliveries execution from purchasers, planners, and main customer contacts (Figure 11: Overview of roles responsibility areas in supply chain management) (Mentzer et al 2001) (*Archival data at the study company*). For this interview category the questions aimed to generate data for how supply chain activities such as integration, mutually sharing of information, cooperation and goals (Mentzer et al 2001) could be connected to the phenomenon food waste. The interviews wanted to form an understanding of the *who* can take action and *how* that action affect food waste by answering: *How do the roles work together, interact and balance the plans? Are the responsibilities regarding food waste in the flow clear? Is there possibilities to incorporate food waste mitigation?* To catch this, the interview guide focused on how three main areas within supply chain planning affect food waste, namely communication, goals, and routines. Interview question examples are summarized in (Table 7: Focus areas and questions used during interview for operational roles).

Figure 11: Overview of roles responsibility areas in distribution planning ((Illustration by author based on (Mentzer et al 2001) and archival data at the study company).

Table 7: Focus areas and questions used during interview for operational roles.

Area	**Question examples**	**Practical example**
Operational Routines	Does the management of food waste occur in the routines of your role?	Stock management, prioritization of goods movements, procurement
Goals	How is the performance of your role monitored?	Service levels, Measuring deviations, Fillrates
Communication	Do you have channels for handling issues related to overstock and quality issues?	E-mail check-ups, meetings, or inputs to management systems.

The second category of interviewees was chosen based on their connection to quality management, data analyses and development work. The roles of consisted of developers, quality managers and analysts within food distribution. For this interview category the questions were aimed to gain an understanding of current initiatives regarding mitigation of food waste. These interviews were also used for leads for further investigations (Table 8**:** Focus areas and questions used during interview for development roles).

Table 8: Focus areas and questions used during interview for development roles.

Area	**Question examples**	**Practical example**
Quality	How does the handling and investigations in relations to quality issues work? Is there any follow up done after investigation, information used for further developments?	The measures taken to prevent product loss of an that article that is under quality investigation or have compliance issues.
Products and Markets	Are you familiar with cases regarding preventing or mitigating food waste? Would you say one can see any trend in terms of products and markets connected to destruction of goods?	Examples of food waste cases.
Data and reporting	How is the reporting done regarding when a product is assigned for destruction? How is the historical data used?	Categorization of data in information systems.

At the studied company the below semi-structured interviews were conducted (Table 9: Interviewees at the study company). The interview guide followed the above mentioned focus areas, but incorporated input from the interviewee forming a discussion of food waste with the different roles.

Table 9: Interviewees at the study company.

Role	**Date**	**Interview Type**
Customer Order Planner	24/02 – 22	Semi-structured, part of data collection
Operational Planner	08/04 – 22	Semi-structured, part of data collection
Operations Developer	07/04 – 22	Semi-structured, part of data collection
Quality Engineer	24/03 – 22	Semi-structured, part of data collection
Purchaser	12/04 – 22	Semi-structured, part of data collection
Distribution Manager	28/02 – 22	Unstructured, for direction in data collection
Business analyst	23/03 – 22	Unstructured, for direction in data analysis

3.2.4 Archival and Historical data: *Where, why* and *what*

Following the outlines of the formed FLW mitigation framework for distribution processes, after *who* and *how,* the *where, why* and *what* need to be understood when picking a mitigation strategy. *Where* is at what point in the distribution process the data point concerns.

This could be the geographical placement of the distribution centre in the chain and the markets it serves. The *why* is the driver of the data point and *why* it should be looked upon, such as its associated costs, emissions generated or the quantity of the product loss. Lastly, the *what* describe the character of the waste and its associations such as product group, origin of the produce or reason for its destruction.

To build the foundation of *where*, *why* and *what* both archival and historical data was retrieved at the study company. The archival data consisted of information of the distribution processes and actors to map the *where* part of the framework. For the historical data information on product loss was retrieved with the aim to answer *why* and *what*.

3.3 Analysis connecting RQ1, RQ2 and RQ3

Data analysis can provide great insights for making valuable business decisions. However, the value is not the data itself, it is the strategic use case of it that makes it valuable, the transition between business and technology (Mckinsey 2021). The data collection is a crucial step, as well as the way it is translated into visualizations and results for making decisions (Mckinsey 2021). One can draw learnings from historical data trough trying to find patterns or extreme cases such as polar types (Eisenhardt and Graebner 2007), however there is a threat of post rationalisation or justification of it by knowledge that was not available at the time of occurrence (Voss et al 2002). There is also a risk of misinterpretation or hindsight bias when looking at historical data which compromises the objectivity. Therefore, the thesis focus for the analysis is on main takeaways of the collected data.

The analysis follows the abductive path by attempting to form both formal theory and description. For formal theory, with the use of literature the presented framework connecting distribution planning processes, coordination mechanisms with product and market characteristics were constructed. This framework formed the methodology for obtaining the information required for RQ1, RQ2 and RQ3 and was the base for the data collection. Description was then created through categorization of the data collected by consolidating themes from archival data, historical data and the interviewees. The analysis then attempts to connect formal theory with the description into substantive theory through relationship mapping by placement of that data into the FLW mitigation framework answering RQ1, RQ2 and RQ3 (*Figure 12: Analysis overview approach)*. Finally, the purpose of thesis is to be fulfilled by picking appropriate mitigation strategy.

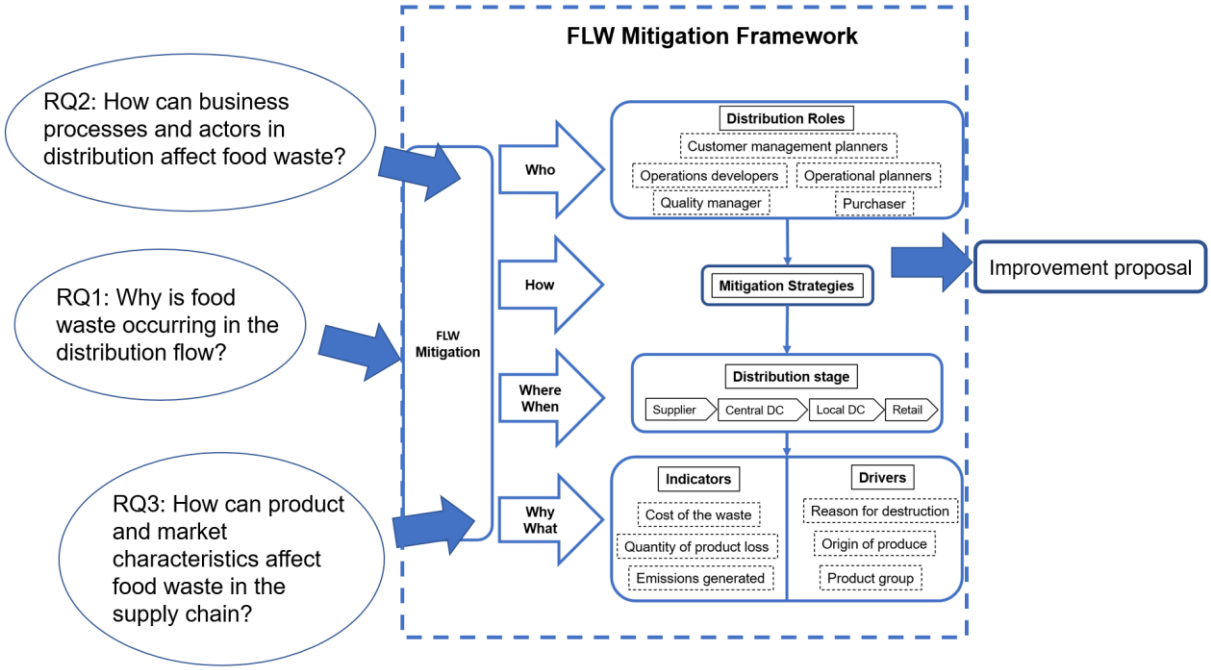

Figure 12: Analysis overview approach (Illustration by author).

3.4 Reliability, Validation and Objectivity

Reliability is to what extent the study operations can be repeated generating the same results (Stuart et al 2002). The thesis as aimed to construct reliability by exposing all the steps of the research methodology with examples, description of them as well as state limitations in the data collected.

Yin (1994) describe three types of validity, construct validity, internal validity and external validity. Construct validity concern the data collection and its composition. This has been attempted in the thesis by the use of multiple sources for data from areas based upon the research questions. Internal validity concerns the validity of data analysis. For the thesis, the analysis follows an exploration approach with the aim to explore relationships between the observed causes. Lastly external validity concerns the research design, while the thesis only uses one case study the findings are discussed and connected to theory from literature.

For objectivity the thesis as aimed to be open to new viewpoints during the data collection as well discuss and account for different perspectives during the analysis.

4. The Case Company

In chapter 4 the thesis presents the data collected for the case. It begins by presenting the distribution processes, the *where* in the mitigation model. This is followed by, the *why* and *what* through historical data on produce loss. Finally, *interview data,* the *who* and *how* is depicted.

4.1 The distribution processes of the study company: *Where*

This section aims to describe the distribution process of the study company. The distribution process was retrieved from archival data as well as meeting notes obtained during the course of study at the company.

The study company is part of a global franchise and works as a wholesaler owning the goods and contracts services through the studied distribution processes. The flow of articles consists of food produce from a standardized assortment of the company. There are articles such as coffee, jams, frozen meat and vegetables as well as fresh produces such as lettuce, eggs and milk. The products have best before date making the time they have in the chain limited. The company reach a wide range of markets causing complexity in the assortment due to many language requirements and different laws and regulation on importation. This complexity makes a high number of the company products to come in different clusters, such as different information on the consumer unit, even though it is one type of product. The products can be divided into two main business areas, one for serving customers through restaurant and one for packaged goods for the consumer to bring home. By the company different service requirements are put on the products affecting their stock levels, as well as range classification affecting their prioritisation.

The supply chain of the company follows the product requirements and is temperature controlled through ambient, dry, chilled and frozen temperature zones during storing and transportation. The distribution utilises sea and land transportation and consists of four main types of setups, supplier to central-DC to local-DC to retail store, Supplier to central-DC to retail store, supplier to local-DC to retail store and supplier directly to retail store (Figure 13: The Study Companies Supply Chain). Throughout the supply chain the goods are owned by the company while transportation and warehousing services are contracted through logistics service providers.

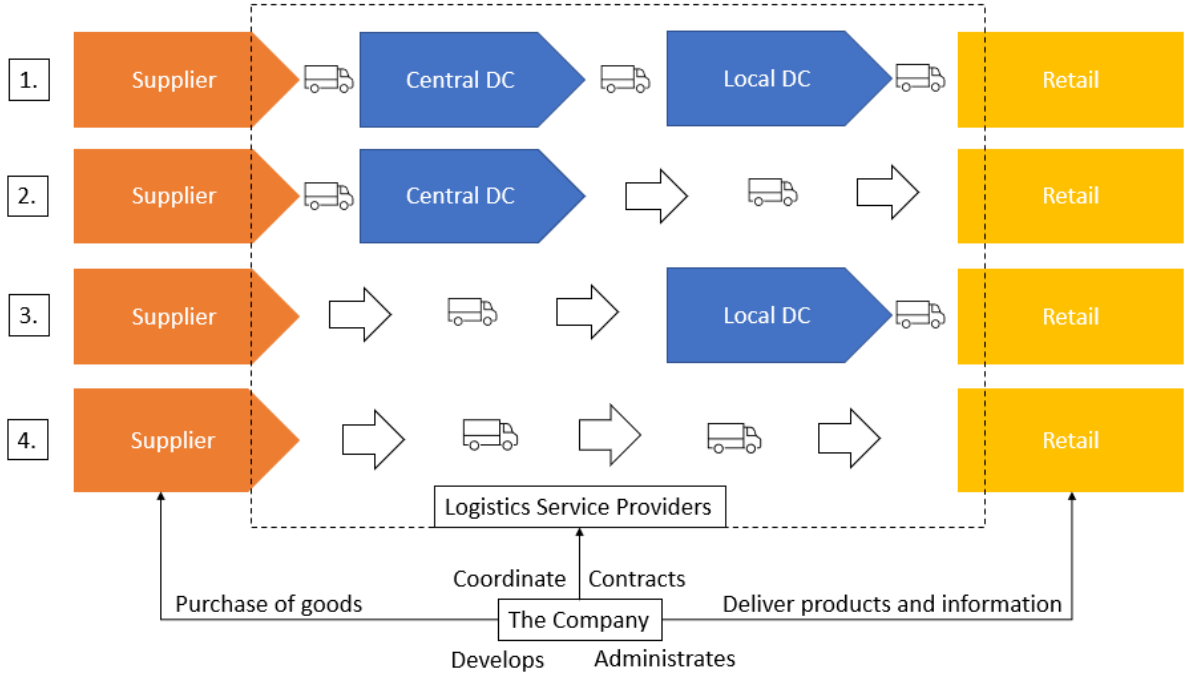

Figure 13: Study Companies Supply Chain (Illustration by author based on archival data from the study company).

In the thesis scope, supply chain execution, the functions that affect the coordination of the stock movement can be categorized into four main parts, supply planning, operational planning and customer order planning. Supply planning handles the interface between supplier and the company and introduces the goods by purchasing it into the supply chain. The operational planning handles the planning for transportation and inventory management. Customer order planning handles the interface between the company and the retailer. In the topic of food waste, the supporting function for assuring quality also plays a vital role. The functions presented in figure (Figure 14: Four function parts of the studied company).

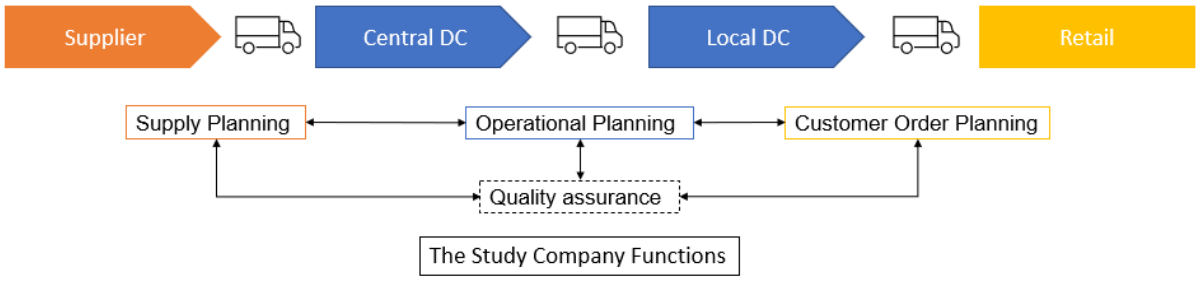

Figure 14: Four function parts of the studied company (Illustration by author based on archival data from the study company).

Two main operational planning models for the distribution processes are used by the study company. One operational forecast driven model and one order-initiated model. For the operational forecast driven model replenishment is initiated based on expected customer demand. The operational forecast is updated on short term basis and aims to as accurately

as possible predict the current customer demand. Thereby for products driven by the operational forecast model stock is purchased and managed through the warehouses and sent when an order is placed by the customer. For the order-initiated model replenishment from supplier is only initiated once a customer order is placed. The order-initiated model therefore does not require storing at the warehouse and lends itself to cross-docking and supplier directly to retail setup. Both of the models require long term strategic forecasting for capacity planning in the supply chain as a whole.

4.2 Historical data: *Why* and *What*

This section aims to describe the data on product loss retrieved at the study company. The data set consisted of produce loss reported in the studied systems distribution centres over a couple of months. The weighting and division of the data set has been done by the author based on the authors interpretation of the data.

The historical data consists of various reasons for the product loss. These have been divided by the author into two main types, overstock and quality/compliance issues (Table 10: Overall table of the historical data). The overstock product loss type aims to highlight reasons causing a mismatch in supply compared to the demand, thus reasons making the best before date of the product run out. The quality product loss type aims to highlight reasons making the product unsellable due to damages, quality or compliance issue.

Table 10: Overall table of the historical data.

Product loss Type	**Reasons**
Overstock: The Best Before Date of product runs out before being sold.	• Supply Chain Disruptions such as Covid-19 pandemic. • Purchasing errors. • Too high forecasts. • Too high MOQs. • Coordination issue between operational roles. • Stock management errors. • Prioritisation issue during stock management. • Suppliers send insufficient Best Before Dates.
Compliance issue: The product is unsellable due to damaged or quality issue.	• Distribution damages from packing and loading procedure at warehouse. • Distribution damages from unloading at warehouse. • Damages occurred during transportation. • Transportation temperature deviation affecting the quality of the product. • Supplier send damaged goods. • Supplier send goods not compliant to current regulation. • Quality deviation causing food safety or compliance issues.

Next the product loss data was weighted based on two factors, *indicator value* and *occurrence*. The *indicator value* is related to *why* is this significant and follow the framework indicators from *Figure 7*, it could for example thereby be an indication of associated value, emissions generated or quantity of the loss. The *occurrence* is related to the number of times the type occurred in the studied data set. The aim of these two factors was to weight the data in an attempt to understand the *why* and *what* at the study company. In presented table in the next section a pattern coding is used to showcase this weight, it consists of three patterns in the range of 1-20%, 20- 60 % and 60-100 % (Table 11: Pattern coding historical data).

Table 11: Pattern coding historical data.

Weight	**Pattern**	**Rules**
Low		1-20 %
Mid		20-60 %
High		60-100%

First a table with overall result is presented between the two divided types of product loss (Table 12: Overall Overstock and Compliance). In the studied data overstock got a high to high weight and compliance got mid to mid weight.

Table 12: Result overall Overstock and Compliance.

Type	**Indicator**	**Occurrence**	**Weight**
Overstock			High-High
Compliance			Mid-Mid

Next the product loss types were divided and weighted into five subcategories by the author based on the mechanism they concern. The overstock product loss type was divided into two categories, planning and coordination and supply chain disruptions (Table 13: Result overall overstock with subcategories). The planning and coordination consisted of reasons such as purchasing errors, coordination issues and prioritisation issues, it showed a low to mid weight. Next category was supply chain disruptions which consists of major supply chain issues with global impact, such as the covid-19 pandemic showing a high to high weight.

Table 13: Result overall overstock with subcategories.

Type	Category	Indicator	Occurrence	Weight
Overstock	Planning and Coordination			Low-Mid
	Supply Chain Disruptions			High-High

The compliance product loss type was divided into three main categories, physical distribution, quality investigation and supplier (Table 14: Compliance overall with subcategories). Physical distribution concerned reasons stemming from distribution and transportation damages, such as damages during packing, loading or temperature deviations. This category showed a low to mid weight. The quality investigation category consisted of reasons stemming from when a quality investigation has been conducted and ordered the destruction. For this the weight was high to mid. Lastly the supplier category consisted of reasons from the supplier, such as if the supplier sent damaged or not compliant items showing a mid to low weight.

Table 14: Compliance overall with subcategories.

Type	Category	Indicator	Occurrence	Weight
Compliance	Physical distribution			Low-Mid
	Quality Investigation			High-Mid
	Supplier			Mid-Low

With the aim to find relationships between product specifications and the divided subcategories the data was sorted into four different specifications, product temperature requirement, inbound type, business area and service. Product temperature requirement consisted of the products associated required temperature zone of ambient, dry, chilled and frozen. The table for product temperature requirement overstock saw mid to high weight of ambient and mid to mid of frozen temperature requirement for category planning and coordination (Table 15: Result Overstock Overall with subcategories and temperature

requirement). Here supply chain disruptions show mid to mid weight on ambient and high to mid weight for frozen product requirement.

Table 15: Result Overstock Overall with subcategories and temp specification.

Type	Category	Temp Requirement	Indicator	Occurrence	Weight
Overstock	Planning and Coordination	Ambient			Mid-High
		Dry			Low-Low
		Chilled			Low-Low
		Frozen			Mid-Mid
	Supply Chain Disruptions	Ambient			Mid-Mid
		Dry			Low-Low
		Chilled			Low-Low
		Frozen			High-Mid

The table for product temperature requirement compliance show mid to high weight on ambient temperature requirement for quality investigation. Supplier category show mid to mid on ambient, mid to mid on frozen and mid to low weight on chilled product requirement. For physical distribution frozen show high to mid weight, while ambient show low to mid weight (Table 16: Result compliance overall with subcategories and temperature requirement).

Table 16: Result compliance overall with subcategories and temperature requirement.

Type	Category	Temp Requirement	Indicator	Occurrence	Weight
Compliance	Physical distribution	Ambient			Low-Mid
		Dry			Low-Low
		Chilled			Low-Low
		Frozen			High-Mid
	Quality Investigation	Ambient			Mid-High
		Dry			Low-Low
		Chilled			Low-Low
		Frozen			Low-Low
	Supplier	Ambient			Mid-Mid
		Dry			Low-Low
		Chilled			Mid-Low
		Frozen			Mid-Mid

Inbound type consisted of the inbound delivery type for the distribution centre. These were sorted into either container or truck as well as one for reports at the centrally located distribution centre. The table for inbound type for overstock for category planning and coordination saw high to mid weight on container and mid to mid on CDC, while truck show low to mid (Table 17: Result overstock overall with subcategories and inbound type). For supply chain disruptions container and truck saw high to mid weight, while CDC show low to low.

Table 17: Result overstock overall with subcategories and inbound type.

Type	Category	Inbound type	Indicator	Occurrence	Weight
Overstock	Planning and Coordination	Container			High-Mid
		Truck			Low-Mid
		CDC			Mid-Mid
	Supply Chain Disruptions	Container			High-Mid
		Truck			Mid-High
		CDC			Low-Low

The table for inbound type for compliance in category physical distribution saw high to mid weight truck, while container show low to mid and CDC show low to low weight (Table 18: Result compliance overall with subcategory and inbound type). For quality investigation container show mid to mid weight, while truck and CDC show low to mid weight. Supplier saw high to high weight on container and low to mid weight CDC, while truck show low to low for this category.

Table 18: Result compliance overall with subcategory and inbound type.

Type	Category	Inbound type	Indicator	Occurrence	Weight
Compliance	Physical distribution	Container			Low-Mid
		Truck			High-Mid
		CDC			Low-Low
	Quality Investigation	Container			Mid-Mid
		Truck			Low-Mid
		CDC			Mid-Low
	Supplier	Container			High-High
		Truck			Low-Low
		CDC			Low-Mid

Business area consisted of two main product groups of the study company, restaurant products (area1) and consumer packaged goods (area2). The table for business area for overstock show the same weight for both categories, high to mid weight for area1 and mid to mid weight for area2 (Table 19: Result overstock overall with subcategories and business area).

Table 19: Result overstock overall with subcategories and business area.

Type	Category	Business Area	Indicator	Occurrence	Weight
Overstock	Planning and Coordination	Area1			High-Mid
		Area2			Mid-Mid
	Supply Chain Disruptions	Area1			High-Mid
		Area2			Mid-Mid

The table for business area for compliance show mid to mid weight for both areas for physical distribution (Table 20: Result compliance overall with subcategories and business area). Quality investigation show low to low for area1 and high to high on area2. Supplier category show high to mid for area1 and mid to high for area2.

Table 20: Result compliance overall with subcategories and business area.

Type	Category	Business Area	Indicator	Occurrence	Weight
Compliance	Physical distribution	Area1			Mid-Mid
		Area2			Mid-Mid
	Quality Investigation	Area1			Low-Low
		Area2			High-High
	Supplier	Area1			High-Mid
		Area2			Mid-High

Finally, the specification of service consisted of three different service level requirements for customers put on the products ranging from highest service on serv1 to lower service on serv2 and serv3. The table for overstock for category planning and coordination based on service specification show mid to mid for serv2 and serv3 (Table 21: Result overstock overall with subcategories and service). For supply chain disruptions it showed high to mid on serv2 and mid to mid on serv3.

Table 21: Result overstock overall with subcategories and service.

Type	Category	Service	Indicator	Occurrence	Weight
Overstock	Planning and Coordination	Serv1			Low-Low
		Serv2			Mid-Mid
		Serv3			Mid-Mid
	Supply Chain Disruptions	Serv1			Low-Low
		Serv2			High-Mid
		Serv3			Mid-Mid

The table for compliance for category physical distribution based on service show mid to mid weight on all service parameters (Table 22: Result overstock overall with subcategories and service). For quality investigation it show mid to mid weight on serv2 and high to high weight on serv3. For supplier it show mid to mid on serv2 and low to mid on serv3.

Table 22: Result overstock overall with subcategories and service.

Type	Category	Service	Indicator	Occurrence	Weight
Compliance	Physical distribution	Serv1			Mid-Mid
		Serv2			Mid-Mid
		Serv3			Mid-Mid
	Quality Investigation	Serv1			Low-Low
		Serv2			Mid-Mid
		Serv3			High-High
	Supplier	Serv1			Low-Low
		Serv2			Mid-Mid
		Serv3			Low-Mid

4.3 Interviews: *Who* and *how*

As described in the literature review the actors of the chain can affect food waste through their different means of coordination. This section describes learnings from interviewed roles in the distribution process. The interviewed roles responsibility areas follow the division presented in the data collection (*Figure 11)*.

Interview 1 Customer Order Planner

The customer order planner works in the distribution centre - retail interface as a main point of contact for deliveries to the retail store. The role is both contact for information sharing regarding availability as well as operational routines for the last mile delivery.

The customer order planner express how all actors in the chain affect each other. One point denoted when it comes to food waste by the planner is how the later in the distribution chain the role is the more reactive their work becomes in terms of reducing food waste. The more distribution points the stock have moved through the less flexibility for its next move there is. This limits the decisions power for overstock depending on where stock is located. Therefore, when working at the end of the distribution channel in the DC and retail interface, information sharing of what best before dates are available and joint decision making on what to make of them is argued to be key for reducing food waste by the planner. For information sharing different tools are used for transparency of the stock levels and best before dates towards the retailer. Sales steering, splitting short shelf-life articles, redirecting stock, relabelling, and donating overstock are explained as potential ways to reduce food waste by the planner. In this stage handling overstock is described to be complicated by that when highlighted the best before date sometimes already is short as well as the decision of what to make of it requires confirmation from other stakeholders, such as the buyer or other functions in the supply chain.

Further on the customer order planner exemplifies that there is also complexity due to market variations and different types of setups causing varying requirements such as lead times depending on region. KPIs for fillrate is explained to may have connection to food waste due some time incentivising adding of articles not being able to be rotated in time before running old or being damaged from forced stacking. Lastly assortment is provided as a complicator

through multiple sourcing, updates launched before importation requirement finished and recipe like article combinations causing a mismatch in supply and demand.

Interview 2 Operational planner

The operational planner works in the distribution centre – transportation interface as responsible for the planning of deliveries inbound and between distribution centres. The role is both a point of contact regarding incoming deliveries as well as operational routines for stock management.

Moving further back in the chain to a role working with the transportation and distribution planning the prioritisation of stock movements in terms of what best before dates is shipped to what region is of concern. The further away the produce is to be shipped the importance of its best before date increases for its sellability. For the prioritisation the interviewed planner indicate that they aim to prioritise the stock movements giving regions with longer lead times better best before dates, but that there are limitations in the available tools used and workways connected to it. The process of stock prioritisation is complicated by that the normal procedure for most volumes from the distribution centres is to follow the first expired first out (FEFO) picking principle, making prioritisation based on best before dates somewhat of an exception when planning at the study company.

The interviewed planner discuss the effects of how the different product types and assortments affect their work. A small number of markets for a product simplify the planning when the product is active in the distribution stage due to being less to account for, but it also limits the flexibility. The argument to what's good in terms of minimizing food waste depends. When there is a small number of potential customers for a product the prioritisation between them becomes simpler and thus easier to get right, however if there is overstock a larger number of potential customers is to prefer.

Interview 3 Purchaser

The purchaser works in the Supplier – Distribution interface as responsible for replenishment of stock and inventory management. The purchaser introduces the products into the studied distribution stage by placing purchase orders based on forecasts, current stock information and outflow.

For roles in the initial phase of the supply chain execution the purchasers, the setup of the minimum order quantity and the forecast accuracy is described as vital for reducing waste occurring from overstock. The interviewee highlight that these two parameters are complicated by new product introductions and seasonality in the chain, making it a requirement to adjust and collaboratively update them on a regular basis.

The purchaser describe different tools and analysis of the stock levels are utilised at the distribution stage by the company both on weekly and monthly basis. For these tools three parameters are described to be important in association to food waste by the interviewed purchaser, the best before date of the product indicating urgency, the number of weeks in stock indicating if a product is slow moving, the actual outflow of the product versus the forecasted outflow of the product indicating where the issue may stem from. Further on the purchaser empathize the importance of the parameter of weeks in stock by describing how they used to look at the value in cost of the stock levels to dictate their decision. While this put focus on the stock with the highest value, the procedure of looking at value of the stock

could miss overstock quantities of low value goods causing increased waste handling in terms of volume. The purchaser address that the tools for analysing stock levels are used for operational decisions, as well as to raise awareness to other stakeholders in different meeting forms or dialogues throughout the flow.

Interview 4 Product Quality Engineer

The product quality engineer handles any escalated quality issues and ensures that active articles are compliant to market regulations. The responsibilities include investigation of quality concerns, finding the causing point and follow up actions by coordinating the associated stakeholders to prevent issues from reoccurring.

The quality engineer explains that in the scope of the supply chain, one area where quality issues occur is when breaking the temperature zones. One example given is when the articles get relabelled into market specific labels at a distribution centre. To be able to relabel, the warehouse personnel is required to break down the tertiary package all the way down to the consumer package. The quality engineer explains that the time for this process is limited due to the requirement of keeping the temperature zone. Further on, once the goods is labelled and repacked into the tertiary package the sturdiness it is not certain to have been maintained. The quality engineer also describe that the supply chain handles products with both ambient, dry, chilled and frozen articles, but in most just chilled and frozen transportation services are utilised. Meaning that quality issues sometime arise from that ambient and dry products are transported in chilled temperature zones.

During issues where products are safe for consumption and legally accepted, but may be unsellable in the retail store such as a misprint on the labels, the quality engineer indicate that they investigate alternative flows for the produce either internally or through donation channels.

Interview 5 Operations Developer

The operations developer works with developing the distribution stage of the studied supply chain. The responsibilities include development projects, follow up on KPIs and ensuring efficiency through working closely with the logistics service providers and the roles part of executing the deliveries.

Quality issues also occur in distribution from damages and temperature deviations. The interviewed operations developer describe that one area that could be improved on is the principle used when palletizing articles. The way warehouse currently palletize is by placing heaviest articles in the bottom layer. While this often works fine, it’s not always it is the heaviest articles that can withstand the most weight which sometime cause damaged products upon arrival. Instead picking according to what each article could withstand could reduce waste occurring from damages. The developer further explains that a new picking strategy is possible, however it is complicated by the large assortment and that it would require implementation of new processes both at the wholesaler and the logistics providers.

Lastly the developer exemplifies that different key performance indicators are utilised by the study company to measure the quality development. Some have direct connection to food waste such as the measurement of product damages that directly concerns loss of goods. There are also indirect connections such as picking accuracy. Worsen picking accuracy could mean food waste if articles unable to sell have been sent.

5. Results

Chapter five summarizes the data collected. It starts by providing some main takeaways from the study company. This is followed by a summary of the historical data. Finally, the interview result is presented in this chapter.

5.1 Result Overview

The results from the case indicate that the study company handles a varied number of actors, flows and products. Integration, information sharing, and accuracy plays a vital role for the quality of the study company's deliveries. The company also clearly have reduction of product loss on the agenda, the topic is natural to the interviewed roles, reported and stored through the historical data and incorporated into the processes and functions of the everyday execution.

5.2 Historical data Summary

A summary of the historical data for the overstock product loss type is presented below (Figure 15: Historical data summary overstock categories). The figure illustrates the subcategories of overstock and the parameters that show over a high to mid weight for the articles occurring in the studied data set. The article parameters are independently weighted with in the subcategory, meaning that the summarized data of the product loss could consist of any number of products. The aim of the summary is to showcase what article parameters are of importance and occur frequently with in the associated food waste category.

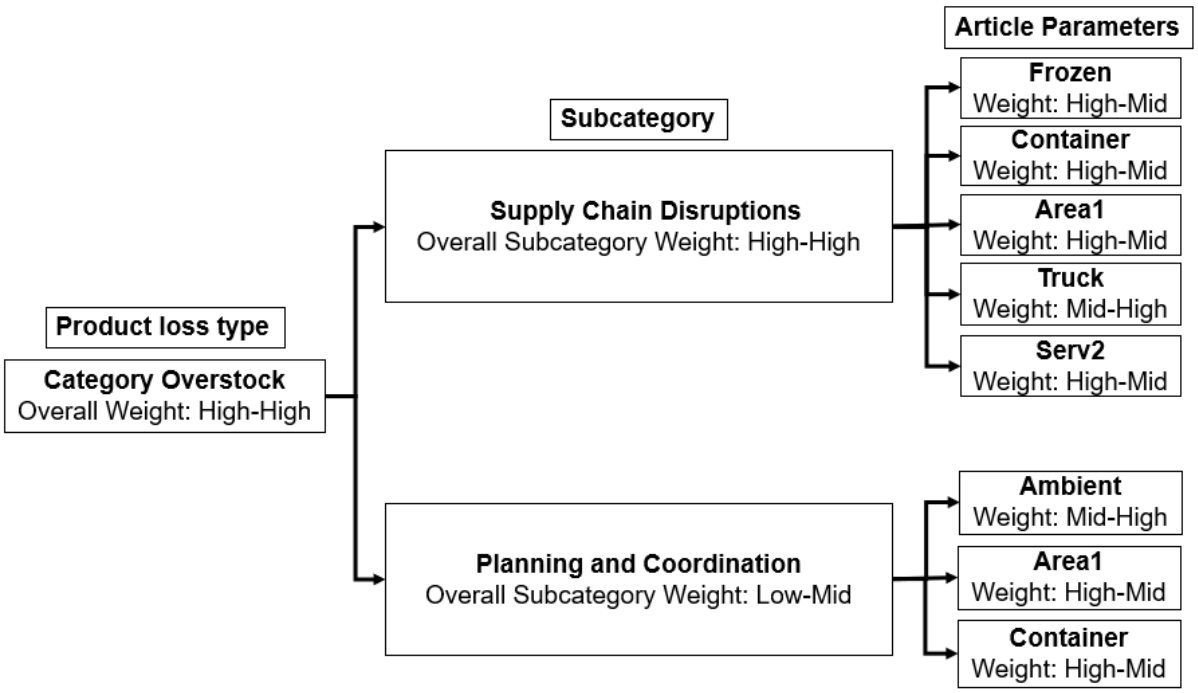

Figure 15: Historical data summary overstock categories (Illustration by author).

In the same way a summary of the historical data for compliance product loss type is presented below (Figure 16: Historical data summary compliance categories). Also, here the aim of the summary is to showcase what article parameters are of importance and occur frequently with in the associated food waste category.

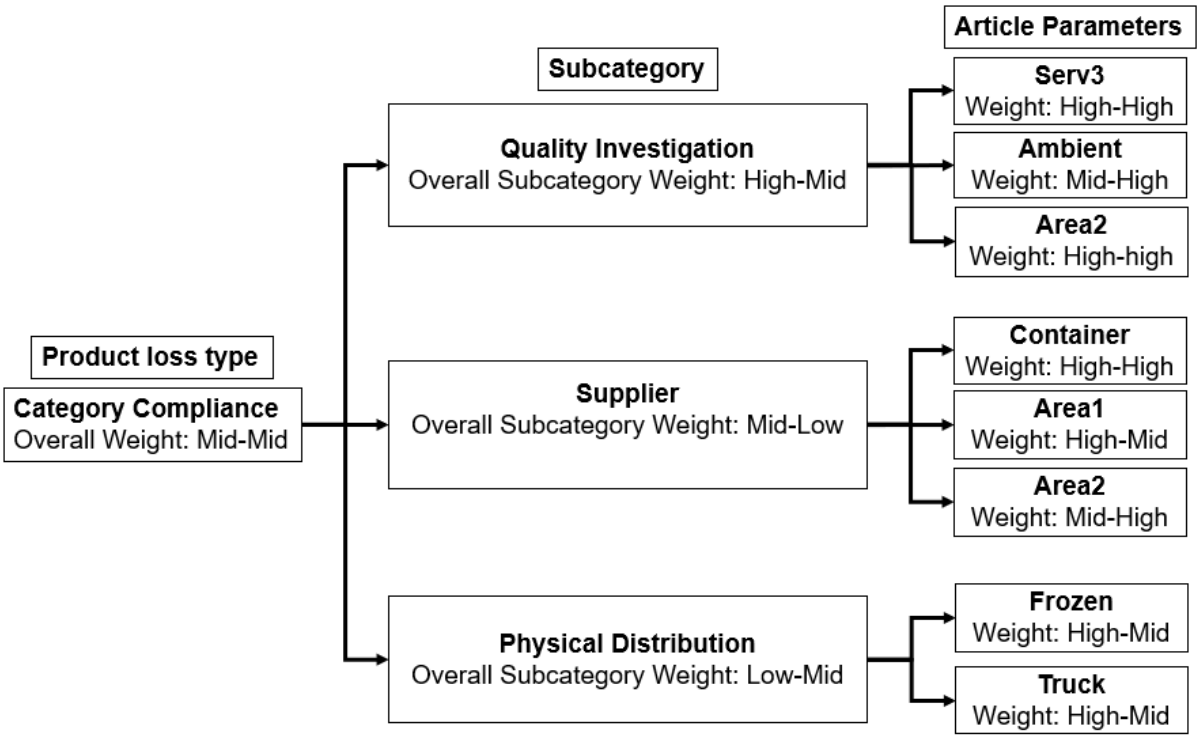

Figure 16: Historical data summary compliance categories (Illustration by author).

5.3 Interview data Summary

Next the Interview results have been sorted into the five areas *coordination, goals, communication, quality* as well as *product and markets* based on the interview questions. *Coordination, goals* and *communication* are illustrated first in below figure (Figure 17: C*oordination, goals* and *communication summary of interviewed roles).*

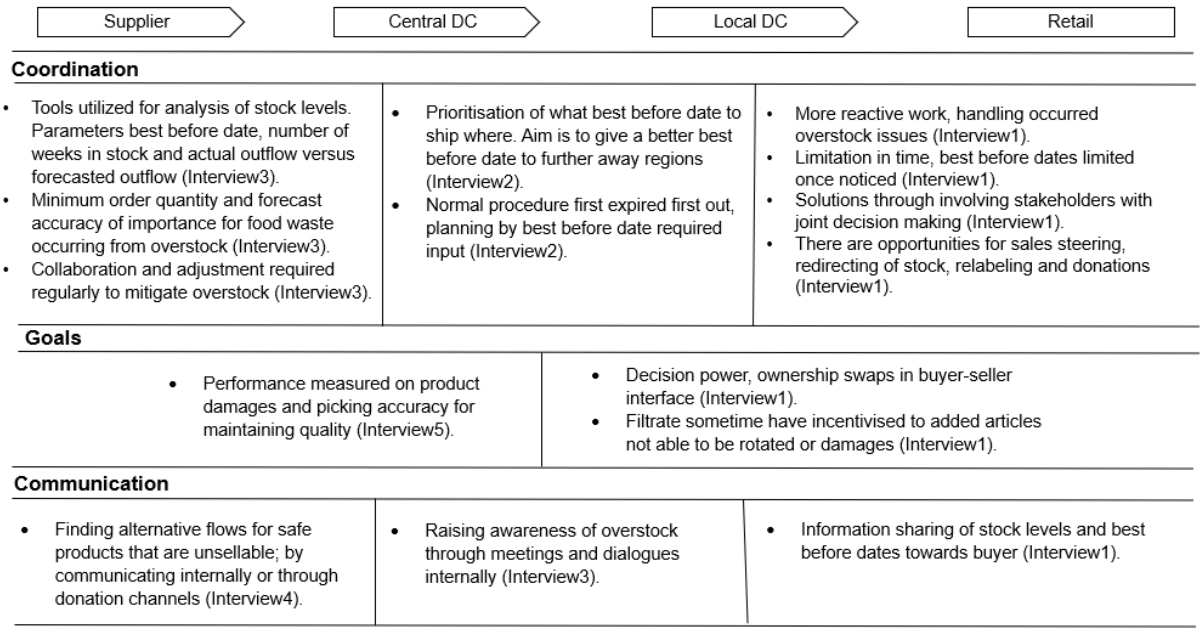

Figure 17: Coordination, goals and communication summary of interviewed roles (Illustration by author).

For *quality, product and markets* the below figure illustrates the interview results (Figure 18: *quality* and *product and markets summary of interviewed roles*).

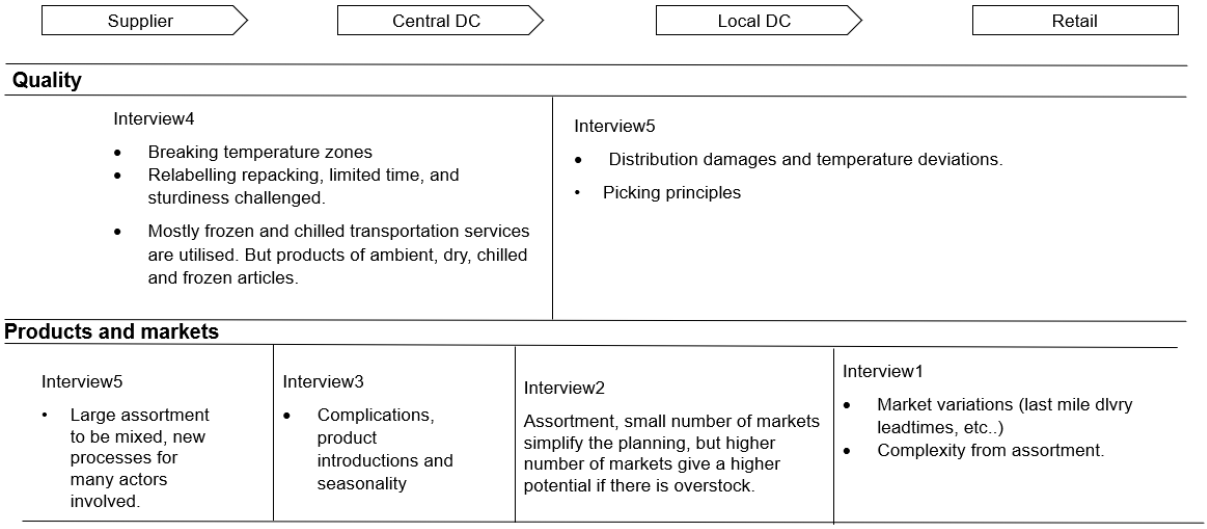

Figure 18: Quality and product and markets summary of interviewed roles (Illustration by author).

6. Discussion

Chapter 6 connects the results from the case at the study company and with the literature review. It starts by denoting delimitations of the collected data, followed by a discussing the case study findings.

6.1 Delimitations

It is important to note that even though collected data covers various parts of the studied system there are limitation in the picture it depicts. For the distribution processes, they are reviewed on a high level and based upon both archival and interview data, but a detail view of specific transactions or information exchanges has not been drawn. Further on the historical data of product loss covers a limited time period and limited part of the studied system, it is also sorted based on the authors interpretation of the data which could question its reliability. The focus of the study has been challenges and causes of food waste and thus trade-offs in terms of high selling volume or other types of performance have not been accounted for.

6.2 Four directions for reducing food waste

By studying the case results and connecting it to the mitigation framework the causes can be divided into four themes and directions for improvement. These are mitigating quality investigation and supplier related causes by increased transparency and traceability in the flow, mitigating distribution causes by improved quality of deliveries, mitigating supply chain disruptions by managing risk and mitigating planning and coordination causes by increased alignment. These are presented in the following paragraphs.

6.2.1 Quality investigation and Supplier related causes: Transparency and traceability

The data regarding product loss from quality investigation and supplier related causes are high to mid and mid to low weight (Table 14), they seem to thereby consist of important and medium frequent cases. Further on market parameter of container seems to be more representative for these types of issues (Table 18). We know from interviews as well as literature that market variations and planning complexity increases with geographical reach (*Figure 18) (Figure 6)*. We also learn that once a quality deviation is noticed the investigation of causing point addressing the correct stakeholders is key (*Figure 17*). To deal with this complexity, one way to reduce issues stemming from quality investigation and supplier is by strategies increasing the transparency and traceability in the flow.

From the FLW framework (*Figure 7*) two strategies are given for this, visualizing damaged products through video and digitalization for better quality monitoring through sensors for humidity and temperature. Collecting more accurate data in and between the flow interfaces of supplier-DC-Retail can empower quality investigations, reduce the time to find causing points and reduce efforts required to settle disagreements.

Another note taken from the data regarding quality investigation, is that it seems to consist mostly of one business area, area2 (Table 20) and the ambient product requirement (Table 16). Using the mitigation strategies from the framework of adopting new quality standards or

product group revisions with a focus on this business area and product requirement may thereby also be applicable to reduce product loss causes of this sort.

6.2.2 Distribution causes: Improved quality of deliveries

The data regarding physical distribution causes are low to mid weight (Table 14), they seem to thereby consist of frequent, but smaller cases. Further on the product parameter of frozen (Table 16) and inbound type of truck (Table 18) seems have highest weight for reasons stemming from physical distribution. From the interviews packing and labelling principles, maintenance of temperature zones and product package variations in the large assortment is deemed to be connected to quality issues caused during distribution (*Figure 18*). Also, from the interviews one way the performance of the quality for the delivery is measured on damages and picking accuracy (*Figure 17*).

To increase this performance, based on the strategies from the mitigation framework, packaging development and behavioural strategies may be utilized (*Figure 7*). For packaging development a focus on frozen articles that incorporates relabelling activities of breaking down to consumer units and that allow for packing principles of mixing articles is sought for. Behavioural strategies through increased corporation with DC personnel can also increase the efficiency. A close cooperation that raises awareness of food losses, with the goal of forming clear learnings at the DC on how to ensure delivery quality.

6.2.3 Supply Chain Disruptions: Adapting to disruptions

The data regarding supply chain disruptions causes have high to high weight (Table 13). These causes consist of major issues affecting the supply chain as a whole such as the covid 19 pandemic or major supply chain disruptions affecting the demand for all volumes. From literature we know the parameter of service is connected to stock levels (Liljestrand 2017), and from the historical data the chosen service level of serv2 gains high to mid weight (Table 21).

From the FLW mitigation framework (*Figure 7*), reforming service level when events that affect the demand is provided as a mitigator for food waste from overstock as well as utilising donation channels. The interviews indicate that raising awareness when overstock occurs is key as well as the aim is to donate when possible (*Figure 17*). The time to adapt the flow to disruptions affect the losses, therefore clear policy that allow for collaboration and exception handling once major disruptions occur could mitigate product loss from disruptions.

6.2.4 Planning and Coordination: Increased alignment

For planning and coordination causes the data show low to mid weight on the overall result (Table 13). The container and CDC inbound delivery type seem to be in higher representation for the causes in this category (Table 17). As well as mid to mid weight on serv2 and serv3 (Table 21). From interviews four measurements when analysis stock levels to mitigate overstock is provided, the best before date, number of weeks in stock and actual outflow versus forecasted outflow (*Figure 17*). The minimum order quantity and forecast accuracy is also described to affect overstock (*Figure 17*). Adjustment through collaboration regularly of these is deemed key for reducing overstock (*Figure 17*). These parameters are also connected to the chosen operational planning model for the flow due to that an order-

initiated flow does not require an operational forecast. In interview with the operational planner the prioritisation procedures of what to send where as well as the push for fill rate is connected to the alignment of supply and demand (*Figure 17*). There are also examples of planning complexity from number of product variates, market variations and seasonality (*Figure 18*). The decision power and ownership in buyer- seller interface is also discussed by the interviewees (*Figure 17*). Later in the chain it is noted that the work becomes more reactive, there is a limitation in time for handling overstock and the solutions require involvement of various stakeholders (*Figure 17*). In the terms of reducing overstock from planning and coordination, the interviews exemplify opportunities for sales steering, relabelling, donating and sharing information of stock levels and best before dates (*Figure 17*).

From the literature review and FLW mitigation framework similar causes and solutions is discussed. For operations the mitigation strategies of collaborative forecasting, improved shelf life management, digitalization for better coordination, behavioural strategies, clear waste management responsibilities and updating level of safety stock levels more frequent is provided (*Figure 7*). The setup of the supply chain can also increase the alignment and the framework provides make to order flows, division of lead time, product group revisions, adapting new quality standards and introducing recycling channels to mitigate food waste (*Figure 7*).

The interview and historical data result for the category of planning and coordination sure indicate how multifaceted reduction of food waste can be. A combination of solutions and strategies is required for mitigation a misalignment in supply and demand. Two main themes may be drawn supply chain discontent and SKU proliferation (Figure 19: Coordination complexity). For the supply chain actors supply chain discontent through disintegration, misrepresentation, distortion, misalignment, and fragmentation can cause both operational as well as commercial inefficiencies (Simatupang and Sridharan 2005). Further on from the interviews they indicate many variates in the assortment and thus the phenomena of SKU or market proliferation may be occurring. SKU proliferation is the phenomena of while a larger assortment reaches a wider customer demand, thus may increase sales, it at the same time increase the complexity in the chain and thus the accuracy of the planning (Rogers 2012).

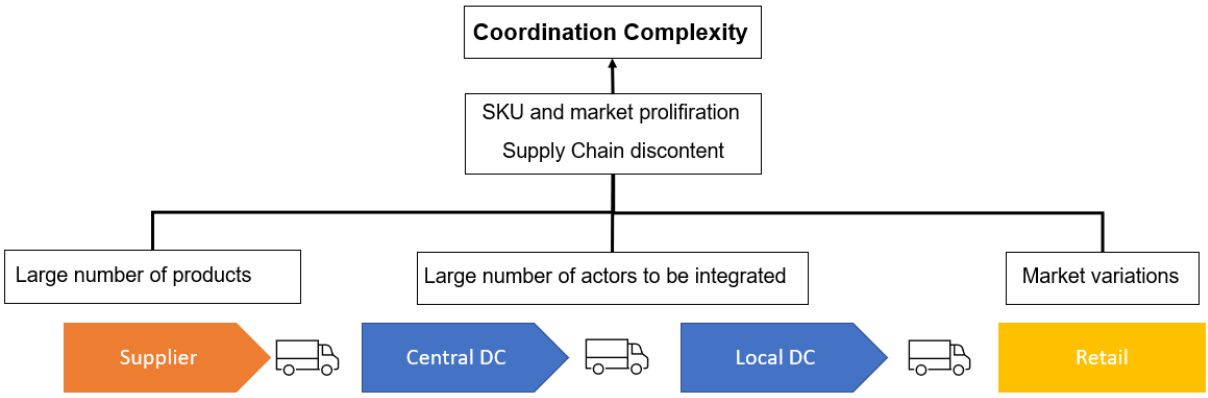

Figure 19: Coordination complexity (Illustration by author).

Supply chain strategies aiming for reducing the number of inputs may reduce this type of waste. Where possible short cutting the supply chain by make to order flows may create a

better balance and less hands in the flow, however the availability and flexibility is of concern due to most probably an increase in lead time. The accuracy of information early in the chain at the purchaser seems vital. It is what introduce the products into the chain and initiate the distribution process. Increased coordination that connects the parties to act on the same information may mitigate waste stemming from misalignment. It could be done through consolidating the information systems. While the company already utilize different tools for shelf-life analysis and information sharing, more frequent and accurate information by combining the actors should be the aim. Improving the continuity in the systems by automated notifying of parties when deviation occur could help, for example notification when there is a discrepancy in the outflow versus forecast. One area that is discussed by the interviews is that the decisions require other stakeholders approval or incorporation, more empowerment through consolidating information may reduce this need and ease the process for handling overstock. For the executionary roles like the operational planner, easing of the prioritisation process could help. Digital tools showcasing accurate market lead time requirements and inventory information and simplified process for allocating best before dates could mitigate overstock issues stemming from planning errors. Last in the chain time is provided to be a limitation, there is has described by the interviewee also opportunities for steering sales, relabelling and donating, thus strengthening the roles in these processes, through clearer responsibilities and more decision power over the solutions could mitigate food waste. Based on the historical data, the highest focus are markets with inbound delivery type container (Table 13), as well as ambient (Table 15), service level 2 and 3 items (Table 21) in business area1 (table 19).

7. Conclusions

This chapter begins with concluding remarks by answering RQ1, RQ2 and RQ3. After that the improvement proposal is presented. The chapter ends by discussing managerial implications of study and a note on future research.

7.1 Relationships RQ1, RQ2 and RQ3

The case study aimed to utilise literature in a combination with a company study to introduce improvement proposal for reducing food waste. The research questions with answers from the study is presented below.

> RQ1: Why is food waste occurring in the distribution flow?

Two main types of food waste could be identified in the distribution flow. These are food waste stemming from overstock and food waste stemming from compliance issues (Table 10). They differ both by their ability to be consumed as well as in their causes. The overstock stems from when products best before date runs out and the compliance stems from quality and regulatory issues. Two main whys in why food waste is occurring is thereby the mismatch in supply and demand and compliance issues due to product safety or regulatory reasons.

> RQ2: How can business processes and actors in distribution affect food waste?

The framework utilises literature and the company study for understanding how actors and processes can affect food waste in the distribution flow. Three main possibilities could be identified for the studied actors, through their different means of coordination, through their goals and incentives and through their ways of communicating (*Figure 17)*. For coordination, the utilization of digital tools for joint decision making between the functions in distribution, prioritisation procedures for stock movements and the number of opportunities for sales steering, relabelling and donating is deemed to affect food waste. Further on the study highlights on how goals, performance and ownership of goods and processes in the distribution stages can affect food waste. Finally, the limitation of time as well as the event like nature of overstock in execution empathises the importance of accurate information sharing, quick raising of awareness and solution orientation for reducing food waste.

> RQ3: How can product and market characteristics affect food waste in the supply chain?

The interviews as well as the historical data of the case study indicate that product and market characteristics affect food waste in the distribution stage. From interviews temperature requirements, market lead times, large number of product clusters, order quantities and forecast accuracy of products is described to affect food waste (*Figure 18*). Further on the historical data on product loss and its reasons seems to differ in weighted importance when altering certain product and market parameters such as temperature requirements, delivery mode, business area and service level requirements (*Figure 15)* (*Figure 16*). This differ indicate that depending on company context product and market characteristics seems to affect food waste.

A summary of RQ1, RQ2 and RQ3 is given in below table (Table 23: Summary of RQ1, RQ2 and RQ3).

Table 23: Summary of RQ1, RQ2 and RQ3

RQ1: **The types of food waste**	**RQ2:** **Processes and actors**	**RQ3:** **Product and market characteristics**
Overstock: The Best Before Date of product runs out before being sold: **Compliance issue:** The product is unsellable due to damaged or quality issue:	• Purchasing errors. • Coordination between operational roles. • Stock management errors. • Prioritisation issue during stock management. • Distribution damages from packing and loading procedure at warehouse. • Distribution damages from unloading at warehouse. • Damages occurred during transportation. • Transportation temperature deviation affecting the quality of the product. • Supplier send damaged goods. • Supplier send goods not compliant to current regulation. • Quality deviation causing food safety or compliance issues.	• Temperature requirements. • Market variations, lead time, delivery types and regulations • Product variations and assortment seize. • Business area • Service level requirements • Minimum Order Quantities • Forecast accuracy • Supply Chain Disruptions • Best Before Dates

7.2 Improvement proposal

Four directions for improvements based on the causes of food waste in the distribution stage may be identified and is presented next. The improvements are divided by reasons for the waste identified in the data collection and tries to mitigate based on strategies from the mitigation framework (*Figure 7)*. A placement of the improvement proposal in the study system is also presented (Figure 20: Improvement proposal in the study system).

1. Quality investigation and Supplier related causes: Transparency and traceability

Reduce administrative lead times for handling quality investigation by working with increased transparency and traceability. Collect more accurate data through visualizing the flow with video and better-quality monitoring with improved sensors. This to empower quality investigators, reduce the time to find causing points and reduce efforts required to settle disagreements. The quality investigation category also seems to in most consist of products in one business area and of ambient product requirement. A focus on these through adopting new quality standards or product group revisions may also be applicable.

2. Distribution causes: Improved quality of deliveries

Improve the performance of delivers, based on the strategies from the mitigation framework, packaging development and behavioural strategies. For packaging development a focus on frozen articles that incorporates relabelling activities of breaking down to consumer units and that allow for packing principles of mixing articles. Behavioural strategies through increased

corporation with DC personnel can also increase the efficiency. A close cooperation that raises awareness of food losses, with the goal of forming clear learnings at the DC on how to ensure delivery quality.

3. Supply Chain Disruptions: Adapting to disruptions

From the FLW mitigation framework, reforming service level when events that affect the demand is provided as a mitigator for food waste from overstock as well as utilising donation channels. The interviews indicate that raising awareness when overstock occurs is key as well as the aim is to donate when possible (*Figure 17*). The time to adapt the flow to disruptions affect the losses, therefore clear policy that allow for collaboration and exception handling once major disruptions occur could mitigate product loss from disruptions. Prepare by investigating opportunities of donation channels for the different markets beforehand.

4. Planning and Coordination: Increased alignment

A combination of solutions and strategies is required for mitigation a misalignment in supply and demand. Supply chain strategies aiming for reducing the number of inputs may reduce this type of waste. If possible short cutting the supply chain by make to order flows, but at the same time insure availability and flexibility. Increased coordination that connects the parties to act on the same information may mitigate overstock waste. Develop the companies different tools for shelf-life analysis and information sharing for more frequent and accurate information by combining the actors. Improving the continuity in the systems by automated notifying of parties when deviation occur could help, for example notification when there is a discrepancy in the outflow and forecast. One area that is discussed by the interviews is that the decisions require other stakeholders approval or incorporation, more empowerment from digitization may reduce this need and ease the process for handling overstock. For the executionary roles like the operational planner, easing of the prioritisation process could help. Digital tools showcasing accurate market lead time requirements and inventory information and simplified process for allocating best before dates could mitigate overstock issues stemming from planning errors. Last in the chain time is provided to be a limitation, there is also described opportunities for steering sales, relabelling and donating, thus strengthening the roles in these processes, through clearer responsibilities and more decision power over the solutions could mitigate food waste. Based on the historical data, the highest focus are markets with inbound delivery type CDC and container (Table 13), as well as service level 2 and 3 items (Table 21) in business area1 (table 19) for overstock waste.

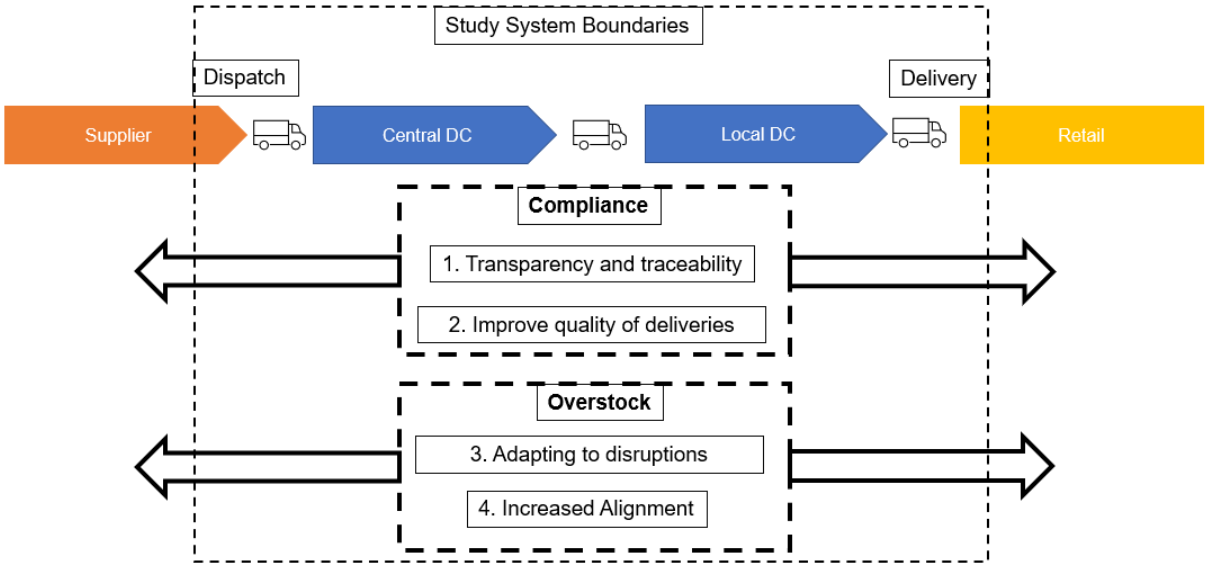

Figure 20: Improvement proposal in the study system (Illustration by author).

7.3 Implications

This study findings have managerial implications. Actors in today's food supply chains is dealing with a lot of complexity to deal with changes in consumer trends, rising regulations as well as new demands on product characteristics. There is a need to combat product losses in the strive to stay competitive and relevant for the future. This study explores how with the help of literature a framework for mitigating food waste can be designed and fitted for a distribution network. The framework breaks down the complexity of the food supply chain into various connected parts and associates both product characteristics and coordination mechanisms with food waste reduction principles. Further on the study exemplifies the practicality of food waste reduction strategies by relating them to a study company's logistic activities in the food supply chain. This enables inspiration and brings clarity for actors wanting direction in their food waste mitigation initiatives. The results of the study provide focus by showcasing how certain causes of food waste may be matched with certain business processes, product specifications and food waste mitigation strategies. While implementation is to be tested, the study forms a base for reflection and discussion on the topic of food waste reduction for experts and practitioners in the field.

7.4 Future Studies

Several further investigations are of interest. First this study does not incorporate how the reasons of product loss is connected to other measurements of performance such as sales volume, availability, delivery accuracy or risk avoidance. For decision making these trade-offs in performance and risk need to be accounted for, otherwise the danger of a suboptimal solution orientation is high. Therefore, studies that map the connection between performance and the characteristics of the different food waste types is sought for. The study highlights the multifaceted issue of food waste, but future investigations in how performance indicators can be designed to integrate the topic food waste is of value. For this, due to that product loss is usually a combination of reasons and causes, more reliable and accurate ways of measuring is needed. Making comparisons by comparable volume for benchmarking

purposes is of interest to draw cross-learnings, but it requires a full understanding of the company context. Companies workways keep changing, therefore clarity and direction in what parameters that is of value to be stored and processed in terms of food waste is needed for future reference.

How product characteristics affect food waste also require further investigation. In the topic of assortment, weighting can be done based on different product areas for the product food groups such as fruits, vegetables, grains, protein foods and dairy. Also, the best before dates is described both in literature and from the study to affect food waste, therefore mapping the requirements on shelf life for products could be an effort to find practices reducing food waste. This could be built on further by looking into sourcing locations and comparing producer regions, not only affecting short shelf life issues, but may also have relations to compliance issues. Finally connecting as studied the distribution system with the full food supply chain for holistic reduction principles could draw valuable learnings and form the needed joint big picture incentives.

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