



# Master's degree thesis

**LOG950 Logistics**

**Reverse logistics of food waste**

Dina Hansen

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## **Preface**

The world is facing enormous environmental and societal challenges; the future ahead seems trying. Thus, it was important for me to write a thesis about a topic which could potentially provide positive salvation to one of these issues. Where, I believe reverse logistics can offer supply chains economic opportunities, and the social world a more sustainable future.

First of all, I wish to give thanks to my thesis supervisor, who has guided me through the writing and research process. Before starting the process, I was quite frankly scared. However, my supervisor kindly and patiently advised and helped, which made the process by far better than anticipated.

Likewise, I owe thanks to Matsentralen Vestfold og Telemark, BAMA, MatBørsen, TINE, and Nortura for the participation in interviews, as well as their contribution in providing helpful data for the research topic. Without their help and contribution, I would not have been able to study the research problem in such depth.

Lastly, I would like to thank my family and friends for supporting me emotionally through the process; I could have done this without you!

## Summary

Reverse logistics, which is the opposite movement of goods in a supply network, has lately received much attention in academics due to current environmental challenges. Reverse logistics is also a result of business competition due to globalization where companies are forced to make “more out of less.” Equally valid is general societal awareness in terms of food waste problematics, where 1/3 of all food produced is never consumed. Multiple authors and researchers have written about the topic of reverse logistics. However, research regarding reverse logistics in terms of food waste has not been properly conducted yet. Therefore, the purpose of the empirical study is to investigate reverse logistics of food waste using a real-life application. Whereby, a case study a food bank along with its supply chain, is implemented. In short, a food bank is a non-profit redistribution center for donated foods that in turn are redistributed to charities. Researchers especially claim supply availability as an impending factor for successful food bank- and reverse logistics- operations. As a result, the empirical study examines how supply risk might be resolved as well, where four food bank suppliers were interviewed.

The study implements qualitative research methods, where semi-structured interviews, observations, and literature are used as main data sources. Results point to the food bank network resembling a traditional forward network; where, the suppliers function as producers, the food bank operates as a distributor, and the charities behave as retailers. On the other hand, the network corresponds to typical reverse networks, where the network uses centralized network approaches and function as an open loop supply chain. The network members are also highly motivated by ethical reasons, but where supply ambiguity unfortunately is prominent. Findings through interviewing and observation also confirm that supply uncertainty is a risk-factor in food bank operations. Conversely with reverse logistics, the food bank network use supplier/distributor contracts which ensure better planning.

The study confirms that effective communication between suppliers and the food bank, fixed delivery schedules, and a centralized network approach may alleviate supply risk. Additionally, when suppliers use proper supply identification tools and strategies, as well preferring donation over discount selling, supply risk may also reduce. However, a combination of the various methods is presumably most effective for supply risk minimization.

# Contents

1.0 Introduction	1
1.1 Background	1
1.2 Motivations	2
1.2.1 Reverse logistics	2
1.2.2 Food waste reduction	3
1.3 Research questions	4
1.3.1 How is a food bank network structured and how does it operate?	4
1.3.2 How might a food bank, along with its suppliers operating in a reverse logistics network, improve supply security?	5
1.4 Thesis structure	5
2.0 Literature review	6
2.1 Reverse logistics	6
2.1.1 Forward logistics	7
2.1.2 Reverse logistics definitions	7
2.1.3 Reverse logistics network design	9
2.1.4 How is reverse logistics different from forward logistics?	11
2.1.5 Final reverse logistics formulation	14
2.2 Food Waste	14
2.2.1 Food waste definitions	14
2.2.2 Food waste rationale	15
2.2.3 The food waste hierarchy	17
2.3 Food bank	20
3.0 Case description	21
4.0 Methodology	23
4.1 Qualitative methodology	23
4.2 Research design	24
4.2.1 General research question	25
4.2.2 Collection of literature	25
4.2.3 Pilot interviews	26
4.2.4 Selection of relevant site(s) and subject(s)	26
4.2.5 Main interviews and observations	26
4.2.6 Interpretation of data	27
4.2.7 Conceptual and theoretical work	28
4.2.8 Writing up findings and conclusions	28
4.3 Semi-structured interviews	29
4.3.1 Interview guide	30
4.4 Methodological limitations	31
5.0 Findings	32
5.1 How is a food bank network structured and how does it operate?	32
5.1.1 Supply chain structure	33
5.1.2 Supply	36
5.1.3 Suppliers	38
5.1.4 Warehousing	39
5.1.5 Demand	40
5.1.6 Distribution	41
5.2 How might a food bank along with its suppliers, operating in a reverse logistics network, improve supply security?	42
5.2.1 BAMA	42
5.2.2 MatBørsen	44

5.2.3	TINE Meieriet Sem	45
5.2.4	Nortura	47
5.2.5	Supply uncertainty and risk	49
5.2.6	Delivery types (fixed or random)	50
5.2.7	Supply type	51
5.2.8	Donation vs. discount price preference	51
5.2.9	Communication	52
5.2.10	Supply identification tools and strategies	54
5.2.11	Production and manufacturing in primary markets	56
6.0	Discussion	57
6.1	How is a food bank network structured and how does it operate?	58
6.2	How might a food bank along with its suppliers, operating in a reverse logistics network, improve supply security?	60
6.2.1	Communication	62
6.2.2	Contracting with a fixed delivery schedule	64
6.2.3	Centralized network approach	65
6.2.4	Supply identification tools and strategies	66
6.2.5	Donation vs. discount selling	66
7.0	Conclusions	67
7.1	Real implications	69
7.2	Limitations of the study	70
7.3	Suggestions for further research references	71
8.0	References	72
9.0	Appendices	76
9.1	Appendix A	76
9.2	Appendix B	77



# 1.0 Introduction

## 1.1 Background

Current trends suggest progressive resource depletion and increasing urbanizations. As a result, economies are forced to engage in more sustainable production and consumption behaviors (FAO 2019). Consequently, reverse logistics has entered the academic scene in more recent years. Reverse logistics is, however, not a straight-forward concept.

Traditionally reverse logistics, or what some called *return logistics*, was mostly concerned with the return and repair of goods (Fleischmann et al. 1997). Examples of such dealings were consumer products, such as cars and technology, that needed repair and fixing and were sent back to the customer.

Today, reverse logistics is discussed as a concept for better resource utilization. Through which, highly competitive markets and environmental concerns force supply chains to continuously adapt and improve (Pacheco et al. 2018). Thus, reverse logistics is today more concerned with alternative supply chains and general cross-affairs among supply chains. An example is materials distribution from one supply chain to another network that specifically deals with remanufacturing- and redistribution- of materials, where such is sold to a new user. All in all, whether materials enter new supply chains or remain within the original, reverse logistics is concerned with physical flows but in the opposite direction, conversely with forward logistics.

In reference to an increasing world population and global warming, food production and distribution are especially facing immense challenges. Approximately 820 million people go hungry every day. Yet, one third of all food produced is never consumed (FAO 2019). Even more troubling, twenty five percent of the wasted food can help solve the hunger problem, which implies that the world produces more than enough food (FAO 2018). Furthermore, food waste is worrisome in terms of ecological perspectives due to the immense resources required for production. In addition, food waste is harmful due to methane gas elapses from such decomposable wastes. As a result, the notion of more sustainable food -production, -distribution, and -utilization is dire. Hence, reverse logistics may be implemented as a tool for more sustainable production, distribution, and utilization.

In response to reducing overall greenhouse gases from food waste, the Norwegian landfill legislation of 2009 states that decomposable wastes of any kind are not to be discarded utilizing landfills (SFT 2009). By such, firms and organizations are forced to deal with waste in whole other ways. Concepts such as *Too Good To Go* and *HOLDBART.no* are some of the responses to alternative food waste reduction strategies, where consumers can purchase discounted food items which are about to- or have expired.

Another solution in reducing food waste and relieving hunger, is the notion of food banks (Schanes and Stalg 2019). According to Nair, Rashidi, and Dixit (2017), food banks are non-profit organizations operating as pantries to charities working to alleviate hunger (Nair, Rashidi, and Dixit 2017). As food banks rely on donations, they generally have to deal with acutely short shelf lives, making redistribution exceptionally challenging to (Persson 2016). Thus, proper reverse logistics management is important in order to manage such challenges. Yet, *food waste reduction* and *reverse logistics* are seldomly discussed as a collective approach. Still, reverse logistics and food waste reduction engage in similar manners, where both find environmental, financial, and societal motivations as basis for implementation.

## **1.2 Motivations**

We acknowledge several points of views in the *reverse logistics of food waste* discussion. As mentioned, both *reverse logistics* and *food waste reduction* hold environmental, societal, and financial as main motivations for application. The two next sections explain such motivations in further detail.

### **1.2.1 Reverse logistics**

In terms of *environmental motivations*, governments are mandating more environmental benevolence. Businesses and organizations also understand the need for greater environmental consciousness due to ever-increasing global warming. Fleischmann et al. (1997), for example, explore the negative environmental impact of single-use products, suggesting increased resource management as a response to global warming. Where,

Brioto and Dekker (2003) believe reverse logistics to specifically be part of a sustainable development, as it is important to exploit the full value of produced products, where both efficient and effective usage and re-usage are meaningful.

Furthermore, Fleischmann et al. (1997) find that financial and environmental motivations are generally intertwined. At least on an idealistic level, the two make for sustainable or ecological economies. In terms of *financial implications* specifically, Fleischmann et al. (1997) also point out that re-manufacturing of parts is especially economically sound as the additional costs to refurbish the products, which are essentially just as well-working as when new, are rather marginal. And more broadly speaking, Pacheco et al. (2018) assert that firms are forced implement better resource utilization due to emergence of highly price competitive markets.

*Social motivations*, such as legislative requirements, are forcing organizations and firms to implement more sustainable practices. Research states that firms and organizations often choose to abide the environmental legislations more or less to avoid legal complications, as opposed to acting on pure environmental consciousness. Yet, reverse logistics is also result of cultural and social awareness representing a change in preferences and demand (Vijayan et al. 2014).

### **1.2.2 Food waste reduction**

Food waste is highly problematic, *environmentally speaking*. Food waste can lead to pollution from Methane and Carbon Dioxide, or GHG gasses, as a result of landfill activities. In a European context, food waste makes up 3% of greenhouse gas emissions (Stenmarck et al. 2011). In addition, we must consider to the resources that were used in order to produce, transport, and handle the food. Resources used in production such as land, water, energy and inputs, augments greenhouse gas emissions are therefore in vain when food is not consumed. Thus, the carbon footprints related to the activity before food becomes waste and after are both factors. Lastly, natural resource depletion and the disruption of biogenic cycles of nitrogen and phosphorus are direct results of overproduction of food. For instance, the extensive use of fertilizers disrupts these biogenic cycles (Papargyropoulou et al. 2014).

There are also *financial motivations* in reducing food waste. Food waste makes little sense as food waste represents a decline in profit, utility, and loss of financial profit due to opportunity costs (Papargyropoulou et al. 2014). Moreover, food waste attribute to an overall efficiency reduction (Papargyropoulou et al. 2014). First of all, the disposal process is rarely a free expense, where firms usually allocate some resources to the proceedings. Secondly, efficiency also declines as the loss of profits reduces the overall efficiency or productivity ratio when studying output over input.

*Social motivations* are strong in terms of reducing food waste. The United Nations wrote “hunger is still one of the most urgent development challenges, yet the world is producing more than enough food” (FAO 2018). Meaning, the hunger problem does not necessarily relate to resource scarcity but rather due to poor resource utilization. In turn, frugality can lead to more equal distribution of food among the world populations, especially as climate changes may slow down future food production (Papargyropoulou et al. 2014).

Food surplus also provide charitable- and food sharing- opportunities. Recent trends and technological advances show a societal shift, whereas there are multiple initiatives in connecting individuals and businesses in the fight against food waste. The general concept is the idea of food sharing through web platforms and applications, dumpster diving, in addition to the traditional food banks and charitable organizations (Schanes and Stalg 2019).

## **1.3 Research questions**

This study evolves around two research questions, where the next two sections 1.3.1 and 1.3.2 explains the motivations- and details regarding the research questions.

### **1.3.1 How is a food bank network structured and how does it operate?**

*Research question one* aims to describe a food bank’s network structures and its operations. In theoretical terms, Papargyropoulou et al. (2014) point out that reuse of foods was more beneficial than recycling-, recovery, and disposal of foods. In the food waste scheme, food banks alleviate food that would’ve else been discarded for other purposes.

As a food bank operates with direct reuse of food waste and surplus, understanding food bank networks is an important consideration when looking to reduce food waste.

Another consideration in understanding how a reverse logistics network is structured and how it operates, is looking to typical reverse logistics characteristics. Tibben-Lembke, Ronald, and Rogers (2002) underline multiple reverse logistics characteristics through comparing reverse- with forward- logistics. For the purpose of further discussion, using such comparing material is helpful whilst studying the specific food bank case because it helps us understand further how this specific food bank is structured and how it may defer from reverse logistics and/or food bank literature.

### **1.3.2 How might a food bank, along with its suppliers operating in a reverse logistics network, improve supply security?**

*Research question two* relates to a more specific problem within a food bank network. Literature often points out that supply uncertainty is one of the main challenges in reverse logistics operations (Tibben-Lembke, Ronald, and Rogers 2002; Fleischmann et al. 1997; Gou et al. 2008). Where, most food banks also operate with high supply uncertainties (Persson 2016; Davis et al. 2014). Davis et al. (2014) specifically point out that a food bank's success is heavily reliant on supply donations. Persson (2016) confirms that food banks are especially tested as supplies arrive intermittently.

Supply security is often low reverse logistics networks because supply is generally *free of charge* donations, excess supplies from primary markets, or used items that are no longer wanted by consumers. Such pose a huge problem; supplies in reverse logistics networks are therefore contingent on production behaviors in primary market. I.e., reverse logistics operators are reliant on the matter of excess supplies from primary markets. In the food bank context, the concerns are specifically in reference to when donations arrive, what is donated, and in what quantity is supply donated?

## **1.4 Thesis Structure**

The disposition of this thesis follows as; chapter two "literature review" covers reverse logistics, food waste, and food bank theory. Chapter three covers a short case description,

denoted “case description.” Chapter four “methodology” will cover research method, the research process, and interview process, as well as the methodological limitations of the study. Chapter five “findings” presents results of the study, where the chapter is divided into two sections; first section pertaining to research question one and the second section relating to research question two. Chapter six “discussion” examines and deliberate findings. Chapter six is also divided into two sections where the first section relates to research question one and the second section pertains to research question two. Chapter seven “conclusion” include overall conclusions of the study, real implications, suggestions for future research, and limitations of the study. Chapter eight “references” lists sources and citations used in the thesis. Lastly, chapter 9 “appendices” provides an appendix.

## **2.0 Literature review**

### **2.1 Reverse logistics**

Originally, reverse logistics was initiated by firms as a way to handle the opposite flow of goods within the same logistical chain. Where, such goods needed maintenance, adjustments, or repairs. This meant the goods had to be sent back to the original manufacturer. In turn, such products were sent back to the designated consumer. Naturally some firms in earlier years also understood the value of economic and environmental gains from material-frugality (Brioto and Dekker 2003). Regardless of motivations, Brioto and Dekker (2003) explain that the idea of such a reversal process received enough traction to be named “reverse logistics.” In later years, reverse logistics has received attention especially due to critical environmental concerns. Through which, the massive overproduction of consumer goods has led governments, companies, and even private persons to take action in order to reverse the climatic and environmental burden. Consequently, the strengthened preaction for end-of-life products make researchers study environmental- and economic opportunities from such products (Ene, Seval, and Öztürk 2014).

However, since reverse logistics originates from forward logistics, studying forward logistics is helpful in understanding reverse logistics. Whereby, the next section encompasses forward logistics.

### **2.1.1 Forward logistics**

It is important to understand forward logistics before learning the complexities of reverse logistics. In general, *logistics* is correlated with logic; where, logistics follow similar patterns. Such patterns are ballistics, linguistics, statistics, and physics. From Greek etymology, logistics is explained as the “capability of computation” (Briffaut 2015). From a historical point of view, logistics was first noted in terms of military operations dealing with procurement, maintenance, and transportation of military resources (Merriam-Webster 2019). Whereas, Antoine-Henri Jomini in his *Summary of the Art of War* (1838) made the first noted attempt in history to define logistics. Inspired by Napoleon, Jomini focused on the physical processes of relocating, moving, and bolster armies. Such processes also involved massive coordination of military support functions (Briffaut 2015).

Today, logistics is associated with business and finance. For example, Lenahan (2005) characterizes logistics as activities that ensure “*the right item is in the right place at the right time and in a fit condition to perform its function*” (Lenahan 2005). Christopher (2011) defines logistics as the strategical management of procurement, movement and storage of materials, parts, and finished inventories. Where, such processes are structured through organizational- and marketing channels. In turn, profitability is maximized through efficient order fulfillments (Christopher 2011). Lastly, Briffaut (2015) finds that logistics is the intervolving and coordination among supply, transportation, facilities, and services such that they properly fulfill supply and demand.

Thus, based on above definitions, logistics are the processes and activities moving from the uttermost upstream supply chain partners to the most downstream supply chain partners, which ensure that appropriate materials, information, and people are connected at appropriate times, in appropriate quantities and qualities to fulfill the demand and supply requirements, with the ultimate goal of making profit.

### **2.1.2 Reverse logistics definitions**

Fleischmann et al. (1997) understand reverse logistics as a result of the reuse phenomenon; where, the opposite material flow is initiated. Furthermore, reverse logistics is the set of activities dealing with used products in either remaining usable in its market or of finished

capacities. The main steps in the reverse logistics process is the physical movement of used goods from consumer to the producer, as well as the conversion or refurbishing of goods by the producer in order to create adaptable products (Fleischmann et al. 1997).

According Fleischmann et al. (1997), these reverse logistics activities most prominent:

1. Remanufacturing conserves product identities such that the products are *as good as new* by providing appropriate repairs.
2. Direct reuse, such as bottles, pallets, containers, which can be used without any structural or functional changes.
3. Repairing products such as industrial machines, domestic appliances, and electronics, where normally the product loose certain amount of quality.
4. Recycling, where materials such as scraps from glass, paper, metal, and plastics are recovered from products. The recycling aspect implies that products might lose their structural integrity.
5. Scrap is the elimination of materials and goods.

Tibben-Lembke, Ronald, and Rogers (2002) define reverse logistics as the reverse flow of goods or materials sent in the opposite direction with the aspiration to create or restore value. The authors also state that reverse logistics can involve the process of total destruction of goods (Tibben-Lembke, Ronald, and Rogers 2002).

Brioto and Dekker (2003) suggest reverse logistics to be the “*process of planning, implementing and controlling flows of raw materials, in process inventory, and finished goods, from a manufacturing, distribution or use point, to a point of recovery or point of proper disposal*” (Brioto and Dekker 2003). In their definition, we see that Brioto and Dekker (2003) merely understand reverse logistics as a process of recovery and/or disposal, eliminating many of the later beliefs regarding opportunities within reverse logistics.

Vijayan et al. (2014) interpret reverse logistics to be waste management along the reverse supply chain. Where similarly to forward logistics, reverse logistics must also allocate and manage costs carefully. Because the quality of the returned goods usually varies, the cost also differs on a frequent basis. Further comparable to forward logistics is the importance of effective inventory management, as well as remaining effective partnerships among the various players in the supply chain. Preferably, firms and organizations should implement



functional information systems in order to manage reverse logistics -inventories and -partnerships better (Vijayan et al. 2014).

Prajapati, Kant, and Shankar (2019) perceive reverse logistics as the reversal of used products and their components in such ways that they may be used again. Although the authors suggest taking old material to generate new products remind us of forward logistics, the sourcing of materials and production process differ from forward logistics (Prajapati, Kant, and Shankar 2019).

### **2.1.3 Reverse logistics network design**

Determining the design of the reverse supply chain network also become crucial. Where, understanding the choice of location-, nodes-, and the product flows- within the network become just as important as in forward logistics networks. A reverse logistics network may either adopt a *closed-loop* or *open-loop* system (Ene, Seval, and Öztürk 2014). The first known examples of reverse logistics talked about *closing the loop* in a supply chain. Meaning, a product's lifecycle was carefully considered and followed in order to maximize the overall use of that single product. Traditionally, closed loop supply chains were practiced in order to limit the product's overall environmental impact but also in order to maximize that product's overall output in terms of input. However, in more recent years, open loop supply chains have gained attention.

Within *closed-loop networks*, products are merely returned to the initial producer or manufacturer (figure 2.1), but usually sold to new customers in other markets (Cannella, Bruccoleri, and Framinan 2016). Similarly, Kalverkamp and Young (2019) explained that closed loop networks ensure that the value of a product is maximized throughout its lifecycle, and where generally such products returned to the same firm or company (figure 2.1). Kalverkamp and Young (2019) further argued closed loop networks are not necessarily supporting a more environmentally friendly cycle, as such business decision is merely in regard to financial considerations and not sustainable motivations. For example, some firms initiate closed loop strategies in order to gain market share through creating market entrance barriers for other firms that recover resources. Hence, closed loop networks do not always reduce overall wasteful activity (Kalverkamp and Young 2019).

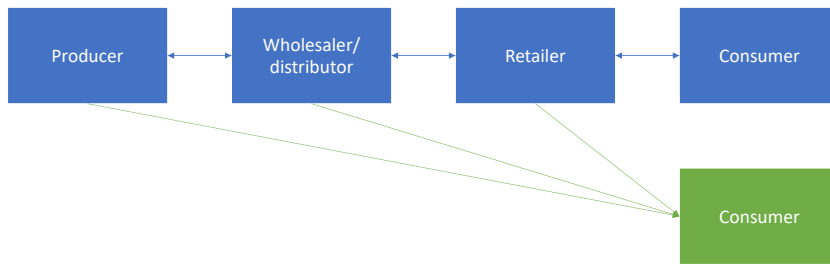


Figure 2.1: closed loop network

Reference: My interpretation of a closed loop network

Kalverkamp and Young (2019) explain that *open loop networks* allow for a more diversified supply chain network. Open loop supply chains present sustainable solutions, in addition to certain market leverages (Kalverkamp and Young 2019). To specify, open-loop networks leave end-of-life products with outside firms rather, finding these end-of-life products new purposes and customers (figure 2.2). The normal process in open-loop reverse networks is to collect end-of-life-products from customers, retailers, or distributors, etc., and transporting said products to a reprocessing facility, where in turn decisions are made in regard to the products' afterlives (Ene, Seval, and Ôztürk 2014) (figure 2.2).

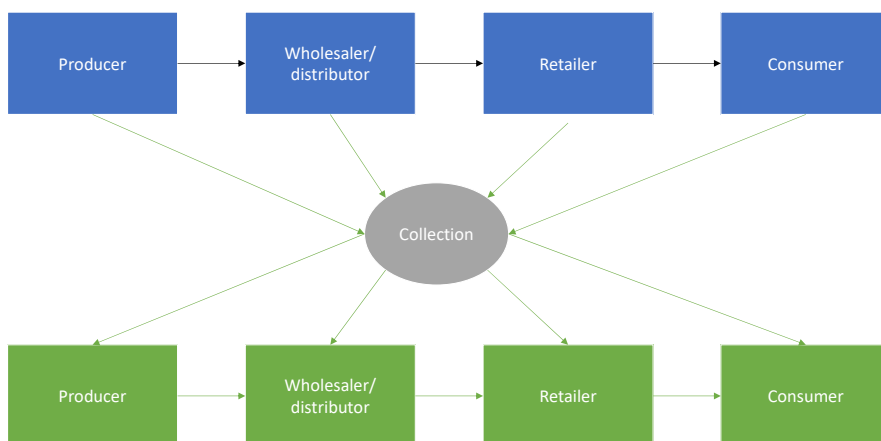


Figure 2.2: open loop network

Reference: my interpretation of an open loop network

#### **2.1.4 How is reverse logistics different from forward logistics?**

As the concept of reverse logistics emerges from forward logistics it is useful to compare the two in order to understand reverse logistics terminology further. Additionally, such comparisons can help us understand potential as reverse logistics challenges. Moreover, comparing forward logistics and reverse logistics clearly defines typical reverse logistics characteristics.

Tibben-Lembke, Ronald, and Rogers (2002) identify that *decision-making* in reverse logistics differs from forward logistics. The authors explain that the typical forward logistics flow differ from reverse logistics in that forward logistics focuses on activities based on forecast or predictions. Such planning determines much of the materials requirements at each stage in the logistics process. When the product is needed, it must first be sent to a distribution center and then to a retail facility. However, the nature of reverse logistics implies more uncertainty in regard to the logistics flow, as reverse logistics happens as a result of downstream member activities. For example, if a customer returns a product to a retail store, the retailer has the option to send the product to a centralized sorting facility, where the product is further sent to a returns center where additional decisions are made. However, the process would not have been possible without the customer returning the product (Tibben-Lembke, Ronald, and Rogers 2002).

Furthermore, it is important to acknowledge the difference between *centralized-* and *decentralized- networks* in terms of decision-making (Duan and Warren Liao 2013). *Decentralized decision-making* suggests that each partner in the network have the individual capacity to make decisions. In such networks, the buyer and supplier make autonomous inventory decisions (Giannoccaro 2018) without regard to the other supply chain partners. Quite oppositely applies to *centralized decision-making*, where these networks rely on communication within the network, as decisions are made collectively rather. Furthermore, adhering to a centralized supply chain strategy ensure that each network member's opinion is considered before any accord. Though decisions are made

with the collective network in mind, it is generally a centralized authority that make the ultimate decision (Duan and Warren Liao 2013).

Generally, reverse logistics processes undergo *less visibility* than traditional logistics processes, especially in terms of supply. Oppositely with traditional logistics, it is the downstream partners in reverse networks that experience the most logistical- challenges and complications. Such is related to the fact that the most downstream partners usually deal with end-customers directly, where much of the returned products never reach far upstream (Tibben-Lembke, Ronald, and Rogers 2002). Also, reverse networks tend to be highly vulnerable due to the uncertainty concerning supply (Fleischmann et al. 1997). According to Gou et al. (2008), the two main concerns in reverse networks are “how to obtain used products” and “where to process to process collected products.” Therefore Gou et al. (2008) point to the importance of collection and recovery.

As previously mentioned, decision making in supply chains are generally determined by demand estimates. Some of the problems within reverse logistics is the inability to carefully estimate future demand, as demand, in this case, is the influxes returned goods. The same problem applies to *inventory management* in reverse logistics planning, as inventory cannot easily be determined by specific inventory ordering methodologies such as the EOQ model. Not only is the inventory level rather difficult to administer, the inventory arrival rates and times are as well (Tibben-Lembke, Ronald, and Rogers 2002).

Furthermore, items going through the reverse logistics cycle are more difficult to market to customers because of their continuously *changing lifecycles*. The main challenge is to determine whether a product’s lifecycle is changing due to whether the product has reached extinction or if a new product is replacing the product in question (Tibben-Lembke, Ronald, and Rogers 2002).

Reverse logistics also differ from forward logistics in terms of *how materials are sourced*. Rather than origination from one vendor, goods are generally collected from multiple places. In turn, collection from multiple places of origin implies a financial and efficiency problem as no route appears to be standard (Tibben-Lembke, Ronald, and Rogers 2002).

On the other hand, Bonev (2012) establishes that reverse logistics indeed offered higher *cost-efficient solutions* compared to traditional logistics and supply chain management. And even though Bonev (2012) regards reverse logistics in the closed-loop context, Bonev (2012) further states that utilizing resources further and gaining larger usage of each item produced naturally provide better materials productivity. Bonev (2012) describes the economic advantages of implementing reverse logistics systems. For example, some suppliers or distributors would rather implement reverse logistics than dealing with the costs of discarding of items; where, such could also improve the firm's efficiency (Bonev 2012).

Tibben-Lembke, Ronald, and Dale S. Rogers (2002) propose that the *negotiation* of reversed products is also less straight forward than of forward logistical products. The assumption is that reversed products are instantly received. Whereby, negotiations regarding such products are also made instantaneously, rather than ahead of a sale. The other implication is that certain goods are also seasonal, making them less or more depending on the season. Furthermore, product quality also varies with products undergoing reverse logistics. The variety implies complication regarding buyer-seller trust; i.e., can the buyer trust that the seller is honest regarding the state of the product (Tibben-Lembke, Ronald, and Rogers 2002)?

### **2.1.5 Final reverse logistics formulation**

This study acknowledges the various definitions of reverse logistics. Especially as reverse logistics is not a straightforward concept, it is important to define the parameters used in this study specifically.

For the purpose of this particular discussion, reverse logistics is defined as the opposite movement of end-of-life materials and products in a supply chain (figure 2.3). Such products and materials are either unwanted, simply dated, or broken. This implies that end of life products and materials rather move upstream as opposed to the normal downstream movement of inventories. In turn, the materials and products are either scrapped, recycled, repaired, remanufactured, or for direct reuse in the reversal process (figure 2.3). Most of all, reverse logistics implies that new network structures and strategies emerge, where such new structures may either relate to the creation of an entirely new network (open loop

network) or redefinition of the current network (closed loop network). Throughout this particular discussion, reverse logistics pertains to open-loop networks, where end of life products generally enters new supply chains with new end-users (figure 2.3).

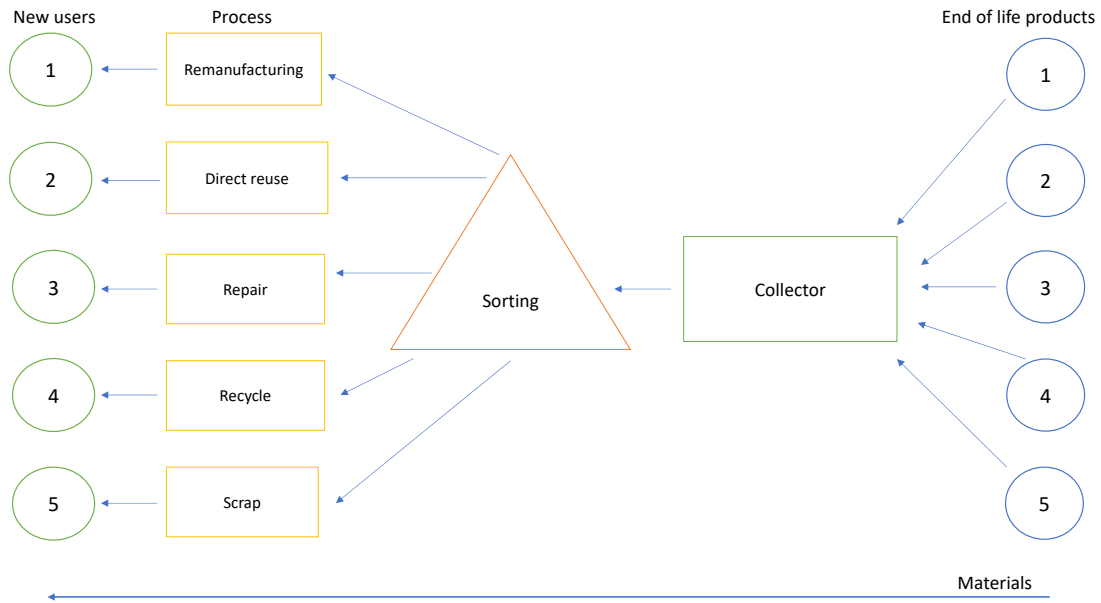


Figure 2.3: Reverse logistics

Reference: My interpretation of reverse logistics

## 2.2 Food waste

### 2.2.1 Food waste definitions

Nahman and de Lange (2013) suggest food waste to be consumable or inconsumable food losses throughout the supply chain due to production, storage, transportation, processing, and during intended consumption. Specifically, Nahman and de Lange (2013) consider food waste to be any food losses before the food reach the consumer in addition to food losses discarded by the consumer.

The Food and Agriculture Organization of the United Nations defines food waste as “*the decrease of food in subsequent stages of the food supply chain intended for human consumption*” (FAO 2018). Meaning, food waste is food that is equipped for consumption, but is tossed by consumers or retailers, or simply left to spoil (FAO 2018).

Hanson et al. (2016) refer to the *Food Loss and Waste Accounting and Report Standard* (FLWS), which is a developed set of rules and guidelines in order to understand the food waste classifications of the United Nations. Food that is intended for human consumption are raw-, partly processed-, or completely processed- foods. Furthermore, food intended for human consumption is considered as food loss once deteriorated, which means food waste is also healthy food but that has turned ingestible. Thus, the only foods that are not considered as food waste are foods that were never intended for humans and have always been inedible (Hanson et al. 2016). On the other hand, food loss is food which is decayed or accidentally lost before reaching the retailers. Simply put, food loss is accidental or unintended as a result of supply chain operations, whereas food waste implies that better supply chain management could be enforced in order to reduce intentional food wastes (Teller et al. 2017).

### 2.2.2 Food waste rationale

*Supply chain activities* is the main reason why food is wasted. Papargyropoulou et al. (2014) mapped the most common activities in the food supply chain leading to food waste (figure 2.4). Food wastes take place at all stages in the food supply chain; from preliminary stages to consumption stage (FAO 2018). The food supply chain generally finds the farmer as the most upstream partner and the consumer at the most downstream level. Usually, there is at least a retailer functioning as intermediary the agent supplying end-customers, even in transitional economies (figure 2.4).

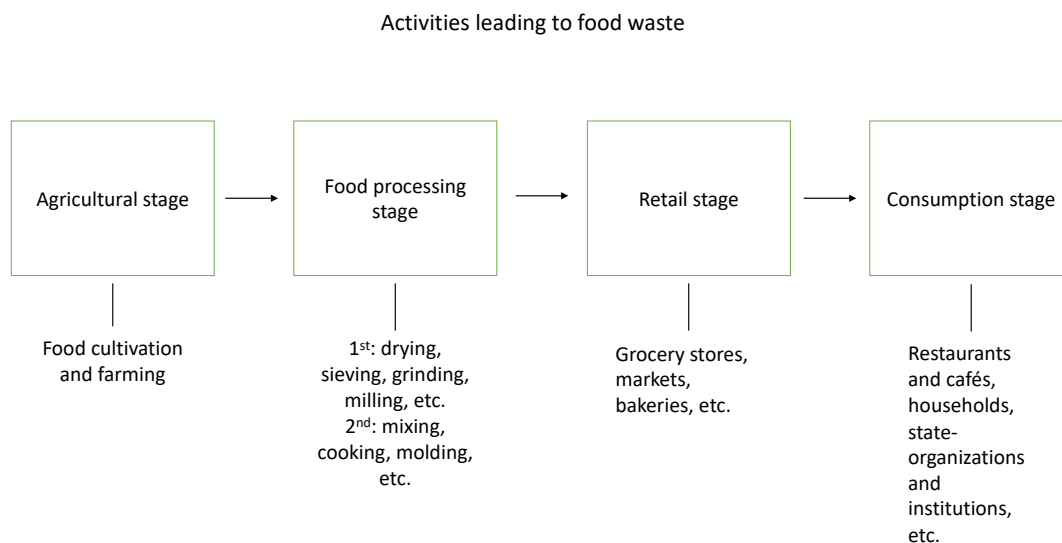


Figure 2.4: Activities leading to food waste  
(Papargyropoulou et al. 2014) pp. 107

Yet, there are regional differences when it comes to where in the supply chain food is wasted. In less developed economies, small farming makes up much of the supply chain (Papargyropoulou et al. 2014). Thus, food waste in developed economies is more prominent upstream, such as the agricultural and processing stage, accounting about fifty percent of food waste (Stenmarck et al. 2016). Such is often due to ineffective logistics and climatic challenges (Papargyropoulou et al. 2014). Conversely, in developed and industrialized economies in urban settings there are usually several intermediaries, each representing opportunities for wasteful behavior (Parfitt, Barthel, and Macnaughton 2010). Therefore, developed economies experience higher food wastes downstream, accounting approximately forty percent of food waste (Papargyropoulou et al. 2014).

Stenmarck et al. (2011) claim that food waste is a problem rooted in *societal behavioral problems*, most likely to arise from date markings of products. The United Nations also claim food waste to be a result of *best by*- and *best before*- dates (FAO 2018). In clarifying the difference between *best before* and *use by*, foods in which are safe to eat still past their expiration dates are labeled with *best before* dates. The *best before* labeling is meant to underline that foods' qualities in terms of texture and flavor might experience slight transformation, though safe to eat (Valant 2015). On the other hand, *use by* dates refer to foods in which should be consumed within suggested dates. Whereby, the safety of *use by* products normally diminishes after the suggested dates (Valant 2015).

*Best before* markings generate certain misinterpretations in households regarding food safety (FAO 2018). According to Valant (2015), a 2012 European Union study confirmed that approximately thirty percent of consumers understand the best before labeling. Where, the European Commission notes that *best by* date markings are responsible for ten percent of all food wasted in the European Union (EuropeanCommission 2019). There is also confusion among consumers in regard to the difference between *use by* and *best before* labeling. Where, a 2013 European Study estimated that another thirty percent of consumers found date labeling in general to be confusing (Valant 2015). The European Commission states that how food producers decide to employ, *best by* dates vs. *best before* dates can also impact food waste greatly. In addition, how long retailers keep food on the



shelves, in terms of expiry dates, also affect food waste levels. Lastly, national rules or laws impact food waste in terms of whether goods may be further distributed past their dates (EuropeanCommission 2019).

According to Stenmarck et al. (2011) vegetables, fruits, and bakery items, at the retail level, are the most wasted food products due to their short shelf lives. Meats and dairy are also among those products more frequently discarded. On the other hand, canned, dried, and frozen foods are less wasted. Customers generally choose products with the longest lifespan over short-lived products, which nudges the products with shorter lifespan even further back in line (Stenmarck et al. 2011).

Furthermore, because retailers are in the grocery business to make revenue, they do not necessarily have carry a *waste focus*. Rather, retailers focus on making profits. Certain food producers even take back unsold food items at no expense for the retailer. Naturally, such do not increase incentives to lessen wasteful activities. In generating higher sales, retail stores jampack the shelves in order to appear more attractive and bountiful to customers. The problem is, however, that fruits and vegetables collected in large piles tend to decay and squish more easily. Rotten fruits and vegetables tend to deteriorate surrounding fruits and vegetables, in turn making them unsellable or indigestible.

Further upstream in the food supply chain food waste is a result of wrongly forecasting customer demand. Demand is difficult to estimate as customers generally purchase food based on mood and/or personal preferences. Additionally, food waste at upstream levels happen due to mishandling and mistreatment in form of temperatures, lightning, and elapsed food gasses of food items which makes the unsellable (Stenmarck et al. 2011).

### **2.2.3 The food waste hierarchy**

The food waste hierarchy (figure 2.5) explains the prioritization regarding the ways to reduce food waste. We find *prevention* at the top, *re-use* second, *recycling* third, *recovery* fourth, and *disposal*. Prevention- and re-using of food implies that the food is categorized as healthy and still consumable. The other half of the hierarchy involves recycling, recovery, and disposal. Food quality at these stages are defined as wastes and are no longer fit for human intake (Papargyropoulou et al. 2014).

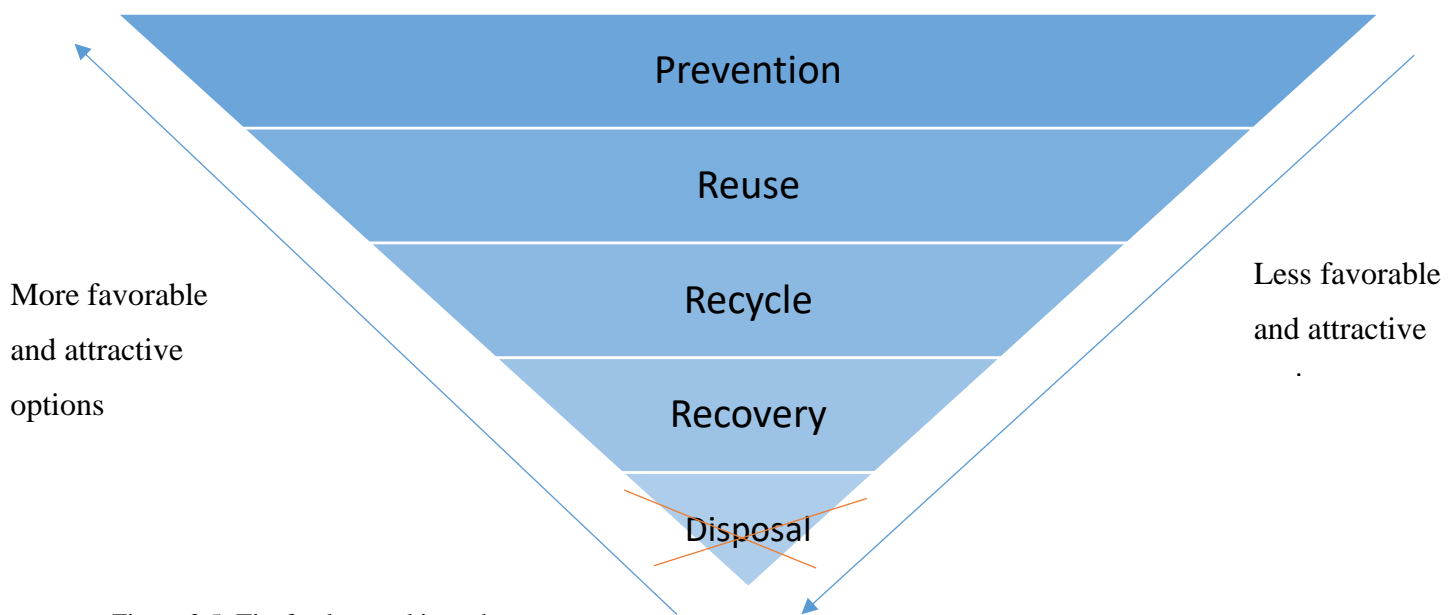


Figure 2.5: The food waste hierarchy  
(Papargyropoulou et al. 2014) pp. 108

The food waste hierarchy was first introduced by the European Commission in 1975 (Eriksson, Strid, and Hansson 2015). However, the hierarchy did not receive much attention until 2008, as part of the “Directive 2008/98/EC.” The “Directive 2008/98/EC” was set in place in order to provide a standard structure for how member states should manage waste (EC 2008). Furthermore, the “Directive 2008/98/EC” has also provided inspiration to the EU member states. The member states, in turn, created personal food waste systems where luckily the distinctive systems all deemed prevention at the top and disposal at the bottom (Eriksson, Strid, and Hansson 2015).

Most of all, the *prevention* measure is the most attractive level as the planet struggles to sustain our current production level. What was supposed to be a thirty percent buffer has now resulted in a food surplus of more than fifty percent. Diminishing the current food production could ensure more viable soils and in turn ensure larger buffers if needed in the future. In addition, reducing current food production may reduce overall carbon footprint due to a reduction in overall resource- and energy utilization (Papargyropoulou et al. 2014). As a response to the avid overproduction of food, (Stenmarck et al. 2011) suggest four prevention strategies:

1. Market products with short life cycles in a way that make them more attractive: put them on display and/or reduce their price. Donations of such products is also a viable option.
2. Bettering education of staff in terms of ordering-, handling-, storing of food.
3. Improving forecasting and/or sales estimations, as well as the understanding of customers.
4. Generally improved knowledge in terms om handling- and storing food.

However, (Stenmarck et al. 2011) found waste regulations at authority level to be rather inefficient. The most effective regulation found was changing the “best-before” dates, in addition to packaging regulations such as incentives to use optimal packaging.

The notion of donating rather than disposing of food is highly preferred, putting *reuse* as the second most favorable option (Stenmarck et al. 2011). This may involve players, such as restaurants, grocers, producers, and distributors donating food items to charities which no longer fit for sale, or by simply reducing the price of the sellable items (Papargyropoulou et al. 2014). A big part of the reuse aspect is the *direct use aspect*, which means the food is usually not further processed or disassembled and may be consumed as is. The reuse aspect is beneficial because eating food as opposed to using it for other purposes are always preferable, especially ethically speaking.

*Recycling* means re-purposing the food waste. Some examples are transforming the waste into compost and fertilizers, or using it as feed for livestock (Papargyropoulou et al. 2014). Even though more preferable than recovery or disposal, recycling is less preferable than reuse because it is always more favorable if foods are consumed by humans. And if food waste needs processing, it perhaps needs additional resources and treatments which could imply additional waste.

*Recovery* of food items means to harness the last bit of potential of the waste. At this point, the food waste has become so indigestible that it needs an anaerobic waste treatment; i.e., burning the waste to retrieve energy to use for power and heated water. However, anaerobic treatment does not necessarily mean the waste emits a zero-carbon footprint (Papargyropoulou et al. 2014).

At least at the *disposal* level, landfills are no longer to be utilized for discarding biodegradable wastes as due to the landfill regulation of 2009 (SFT 2009), which in turn eliminates the least attractive option.

### **2.3 Food bank**

According to Nair, Rashidi, and Dixit (2017), food banks do not operate with profit as the ultimate goal. Rather, food banks protect social interests and are generally motivated by fairness and equity. Food banks reclaim food items from farmers, manufactures, and retailers. Such donations generally include food items with long shelf lives but that are incorrectly labeled, including highly perishable items. Food banks store and redistribute these items, where upon arrival at the food bank's warehouse the items are sorted, sometimes packed and further processed before redistributed. Altogether, food banks' main operations are the collecting of- and redistributing of food surplus (Nair, Rashidi, and Dixit 2017).

According to Persson (2016), food redistribution propose certain challenges. First of all, organization and efficiency of the redistribution process could be impacted. Second challenge relates to the health and safety of the food items, where appropriate storage and transporting of such items become crucial. Food health and safety precautions is important especially on the donor or supplier side as the donor is just as responsible as the food bank if unsafe foods were to be redistributed. Thirdly, Persson (2016) points out challenges in terms of supply characteristics, whereas supplies are received rather intermittently.

Davis et al. (2014) examine the successes of food supply security in U.S. households, in reference to food pantries and soup kitchens. Not surprisingly, the authors claim that the success of these food banks relies on the upstream food supply generated from food banks. According to Davis et al. (2014), food banks function as aggregators and distributors to especially private charities. Additionally, food banks collect and manage the storage and distribution of this collected food. Rather challenging is the balancing of delivery and collection, especially as food banks generally have limited transportation funds and operate in networks that act diverse and dynamic (Davis et al. 2014).

According to Davis et al. (2014), configuring an efficient transportation schedule is influenced by the distribution strategy, network topology, and supplier specifications. Most of all, delivery and collection strategies depend on the characteristics of the donated food items. Collection and further distribution strategies become especially challenging when foods are more perishable or need cooling or freezing. Therefore, a food bank's location in terms of distance from suppliers also matter in terms of collection-, delivery-, and redistribution efficiency. The location of a food bank also matters in terms of distance to the collecting charities, because limited transportation funds are normally an obstacle food banks deal with (Davis et al. 2014).

### **3.0 Case description**

The concept of food banks is not new. In the U.K., food banks were originally established to provide short time solutions for individuals waiting for the government to provide further welfare assistance. Yet, the U.K. food banks today are the results of increasing poverty rates over the last decade (Thompson, Smith, and Cummins 2018). In Germany, the food bank initiative “Tafel” entered the food redistribution arena in 1993, as a response to hunger relief among the homeless in Berlin. The food bank initiative has today more than 930 locations across Germany, serving not only the homeless but any person of low- or no- income (Simmet, Peter Tinnemann, and Stroebele-Benschop 2018). However, in a Norwegian context the food bank concept is rather new. In 2013, *Matsentralen Oslo* entered the Norwegian food bank sector, which is the first official food bank part of *Matsentralen*. Today, there are seven food banks part of the network, stretching from Tromsø to Southern Norway. The network cooperates with more than 250 organizations and charities, which in turn redistributes the food to individuals affected by hardship. In addition, *Matsentralen*'s work alleviates general food waste. The network is fortunate in that it also receives financial and business support from other organizations, government functions, and companies (matsentralen.no 2019).

The case study will, in particular, study the network structure and operations of *Matsentralen Vestfold og Telemark*, a food bank located in Larvik (figure 3.1) and a participating sister organization of *Matsentralen*. *Matsentralen Vestfold og Telemark*, herein additionally referred to as “the food bank,” operates as an independent organization.

The food bank does not adhere to Matsentralen Norge’s rules and recommendations, where Matsentralen Vestfold og Telemark is rather encouraged to follow the principles (Matsentralen-Vestfold-og-Telemark 2019). The food bank was only established in January 2019, but has since its founding been a large contributor for food redistribution in South-Eastern Norway. With currently 23 willing-to-donate suppliers and 30 receiving organizations, the food bank operates as a centralized redistribution center for donated foods. Thus far, the food bank has redistributed 125 metric tons since January 2019, and in turn collected 154 metric tons (Matsentralen-Vestfold-og-Telemark 2019).

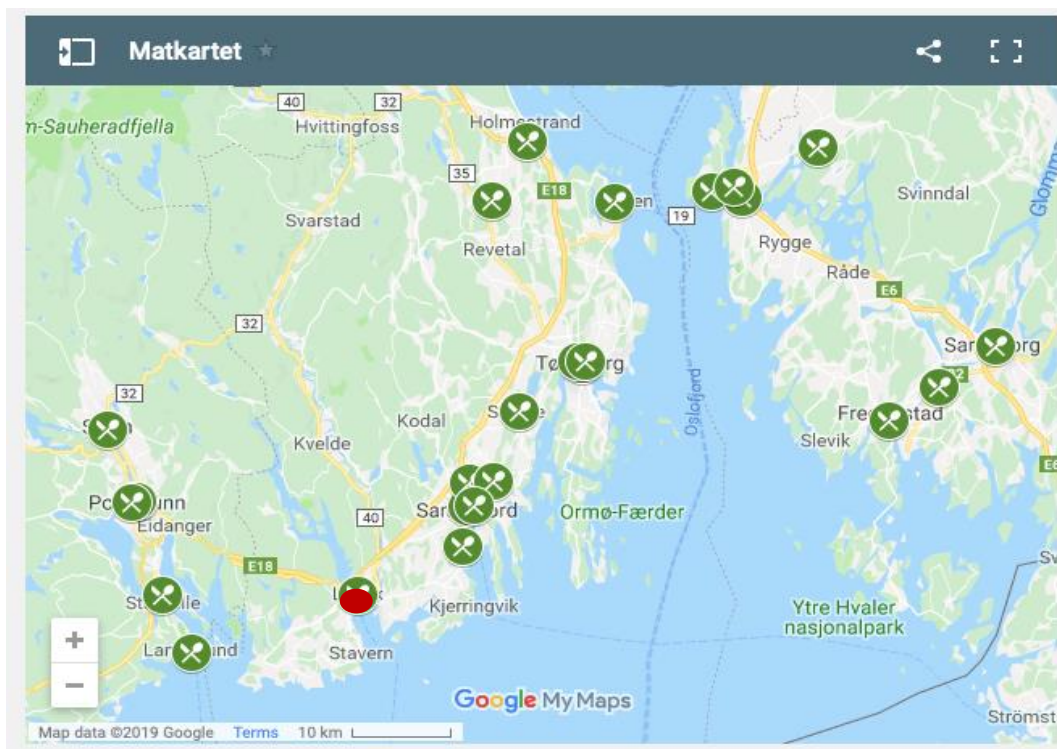


Figure 3.1: Matsentralen Vestfold og Telemark’s position marked in red  
Reference: Matsentralen.no (2019)

Furthermore, the case will also include suppliers of the food bank *BAMA*, *MatBørsen*, *TINE*, and *Nortura*. Where, the case will especially focus on supply uncertainty, a topic in which is particularly mentioned in literature (Tibben-Lembke, Ronald, and Rogers 2002; Fleischmann et al. 1997; Gou et al. 2008; Davis et al. 2014; Persson 2016). Additional information and findings are mentioned in chapter 5 “findings.”

## **4.0 Methodology**

The purpose of this section is to provide the readers with an understanding of how research was conducted and analyzed. In addition, the section will cover methodological limitations. According to Bryman (2008), a research method is an approach in terms of how data is collected. Moreover, the empirical study is based on a qualitative research method, where a case study has been implemented. Interviews, observations, as well as literature and theory, are main sources for data collection. Data was further analyzed by means of interpretations and comparisons.

### **4.1 Qualitative methodology**

According to Miles and Huberman (1994) and Bryman (2008), qualitative methodology is grounded in data extraction from words rather than numbers as opposed to quantitative methodology. Where, words are gathered from studying documents, through interviews and observations. Qualitative methodology can help researchers furthering theories and concepts; where, in some cases qualitative methodology guides researchers in altering and improving upon existing theoretical structures (Miles and Huberman 1994). Furthermore, as qualitative data are rich, they are a source to rather exuberant explanations of processes (Tracy 2013).

Bryman (2008) states that qualitative research methods differ from one another. The methods, according to Bryman (2008), includes ethnography/participant observation, qualitative interviewing, focus groups, language-based approaches, and data collection from text analysis. Tracy (2013) understand qualitative methodology to be an umbrella concept for research conducted either from groups or individuals, where such data are interviews, observations, or documents. Opposed to qualitative research, quantitative research use theory to formulate a research question, which in turn formulates a research strategy for data collection. With qualitative research, theory is often the outcome of the research instead of functioning as the guiding factor as in quantitative research (Bryman 2008).

## 4.2 Research design

Research design functions as a framework by which how data is collected and analyzed (Bryman 2008). Thus, this section aims to explain the research process of the study. I followed a research process similar to the one suggested by Bryman (2008) (figure 4.1).

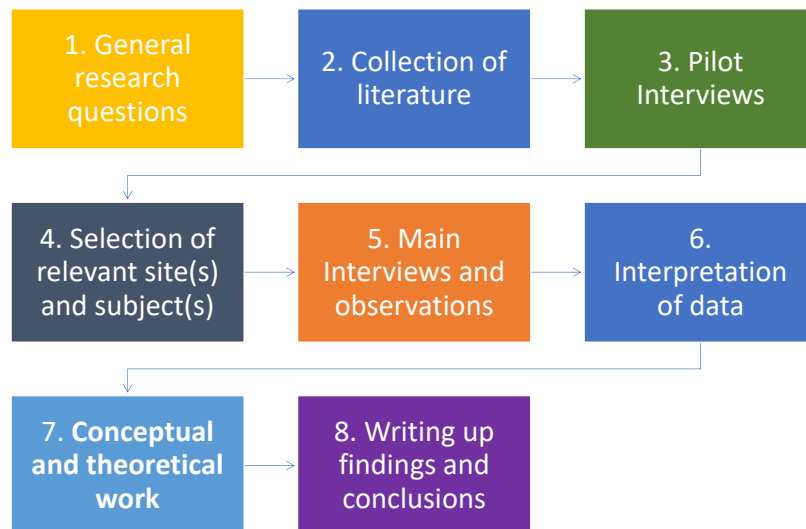


Figure 4.1: My steps in the qualitative research  
Reference: Bryman (2008) pp. 370

Bryman (2008) suggests that a researcher should begin the research process by formulating general research questions (figure 4.1). The second step in the research process is collecting of relevant literature, because it is important to gain a fundamental understanding of the research area (figure 4.1). The third step is carried out by pilot interviews in order to further understand which area of the research topic seemed most interesting (figure 4.1). Step four, engages the researcher to examine and choose the most appropriate subjects and sites (figure 4.1). Once the research area was specified it is time to collect interviews and make observations for further data collection, which is step five in the research process (figure 4.1). Interpretation of the collected data is step six in the research process (figure 4.1). Furthermore, Bryman (2008) also suggests that a researcher might need to tighten the specification of the research question(s) as well as potentially collecting more data, which is step seven in the research process. The last step, as proposed by Bryman (2008), is writing up findings and conclusions based on the collected data (figure 4.1). Especially in reference to qualitative research, findings and conclusions must demonstrate credibility. Because qualitative research relies on words, a researcher



must convince its audience in regards to why the findings matter and are significant (Bryman 2008).

#### **4.2.1 General research questions**

General research questions were formulated by reading literature and research reports. I had been aware of the thematic of reverse logistics previously and I was rather interested in figuring out more regarding the topic. However, studying reverse logistics exclusively was inadequate. Therefore, I began researching food waste problematics, as the topic is trending. As a result, I picked “reverse logistics of food waste” as the main research topic. I also wished to link the research problem to supply chain management specifically. Hence, I chose to study the general research question of “how does a reverse logistics network in regard to food waste look like?” The next step was to collect more data in order to understand the research area fully so that a more specific research question could be formulated.

#### **4.2.2 Collection of literature**

In researching the topics of “food waste” and “reverse logistics,” I needed to gain fundamental understanding of the topics. I gathered a comprehensive literature review regarding reverse logistics where I mainly used scholarly- and peer reviewed- articles in order to do such. However, there was also a point to gather information regarding forward logistics and how reverse logistics differ from it, because it made clearer how exactly reverse logistics is unique. Also, such uncovered potential challenges and opportunities regarding reverse logistics, which in turn helped formulate more specific research questions.

I used reports and statistics for collecting food waste information, in addition to scholarly- and peer reviewed- articles. Especially the food waste pyramid helped shaping my understanding of the research area. Food waste reports contributed in understanding the problematics which gave strength to the motivations part of the research topic.

### **4.2.3 Pilot interviews**

I began the next phase of the research process using exploratory interviews to gain further insight regarding the reverse logistics and food waste topic. With such, I talked to environmental advisors of the Kristiansand municipality whom had expertise regarding food waste problematics. The advisors suggested looking into the field of charities and non-profits. These organizations deal with food redistribution, which sparked my interest as food redistribution implies enforcement of the reuse perspective. I was further suggested to contact participants of a local startup project *Matsentralen Sør*. The interviews were informative and offered potential research problems. However, as the project has not yet been established, I saw it best to explore other options for richer data collection. Fortunately, through conversation with one of the *Matsentralen Sør* participants, I was referred to *Matsentralen Vestfold og Telemark*, which is another non-profit food redistributor.

### **4.2.4 Selection of relevant site(s) and subject(s)**

In selection of relevant sites and subjects, I knew from running pilot interviews that I should look further into the food bank *Matsentralen Vestfold og Telemark*. As the food bank is dealing with redistribution of food waste, the case study would promote the reuse aspect also. Furthermore, I collected additional literature, such as scholarly articles, research reports, and general information regarding the food bank.

### **4.2.5 Main interviews and observations**

For this section of the research process, I implemented semi-structured interviews for further data collection. The main interview pertained first to *Matsentralen Vestfold og Telemark*. All in all, the interview guide is based upon reverse logistics theory. The main goal of the interview guide was asking questions that revealed whether the food bank experienced the same challenges as mentioned in literature, as well as similarities to reverse logistics networks, or not. For example, one thing I wished to discover was how food was donated; i.e. through standard or fixed contracts using scheduled deliveries or if the proceedings were rather random. Another discovery I wished to find was whether the food bank operated as a closed loop or open loop network. I also made observations, such

as taking photographs of the food bank's warehouse, and supplier- and charity- contract templates.

It is noteworthy to mention that the empirical study began with a general research question. Such research question was further developed and specified through collecting additional data, i.e., interviewing Matsentralen Vestfold og Telemark and studying additional articles. In furthering the research question, additional information regarding critical research areas became apparent to me. Thus, an additional research question was formulated. Subsequently, it was necessary to collect more information regarding suppliers of Matsentralen Vestfold og Telemark due to supply problematics observed but also mentioned in literature. The additional research question was formulated as "how might supply risk reduce in a food bank network?" Thus, I proceeded to interview food bank suppliers, asking questions mainly relating to supply challenges. The main goal was to study the suppliers' potential challenges and strategies in terms of food redistribution.

#### **4.2.6 Interpretation of data**

The data collected from interviewing Matsentralen Vestfold og Telemark was first of all translated into English from Norwegian. Second of all, the transcripts were analyzed such that full sentences were formulated, and observations were noted. Then, I proceeded to separate create sections based on the data collected. These sections pertained to topics such as *suppliers, supply, warehouse, customers, demand*, etc. At the same time, I drew a reverse logistics map with network members and important processes in order to visualize the data.

Similarly, the data collected from the supplier interviews were first translated into English from Norwegian, as all the interviews were in Norwegian. Then, I proceeded create comprehensive summaries of the interview data. Each paragraph of the summaries contained a different topic in which was covered. Further, I found parallels and contrasts in the data, where I categorized the data based upon what areas which deemed most relatable to the supply risk discussion, such as *supply type(s), contract, communication*, etc. I proceeded to draw figures based on the collection information to visualize the interpreted information.

#### **4.2.7 Conceptual and theoretical work**

After collecting relevant data, it was easier to revise and fine tune the research questions. First of all, I had collected data pertaining to network structure and operations, thus research question one became “how is a food bank network structured and how does it operate?”. Secondly, I had collected data responding to the supply side of the food bank network, where data confirmed certain supplier preferences which either cultivated or eased supply risk. Therefore, the second research question was constructed as “how might a food bank, along with its suppliers operating in a reverse logistics network, improve supply security?”

Likewise, data collected from the interviews affected what theoretical concepts that became interesting in researching. In understanding which focus areas that deemed more important, collection of additional data was also needed in order to confirm or invalidate certain research questions. Such data collection related to data from literature in addition to other data such as company information and statistics. Gathering of supplementary data was also important in order to avoid researcher bias.

#### **4.2.8 Writing up findings and conclusions**

Findings are based on the collection of data generated from the various interviews, through observations, and literature. Where, findings were analyzed in terms of the category they belong to. The processes in which I used, however, are different for research question one and research question two, as there are some differences in terms of what the research questions require. For example, research question one is merely asking for descriptions, whereas research question two asks for specific suggestions.

Findings and conclusions, related to research question one, are mainly based upon descriptive data. The analytical process mainly pertained to correct categorization of the collected data such that it helped explaining the network structures and reverse logistics operations. The categories found were associated with the supply chain network structure, supply, suppliers, warehousing, demand, and distribution. Data such as pictures were helpful in the descriptive part of writing up findings in order to give visuals. Also important was the designing of different figures such as the supply chain map and network

organization of decision-making. All in all, conclusions of this study are based on how findings deviated or correlated with literature, where comparison of data were carried out.

Findings and conclusions in accordance with research question two are concerned with identifying potential solutions to the supply risk problem. The first step in detecting findings was to collect background information regarding each supplier, such as the supplier's position in the supply chain, the size of company in NOK, and general company values. This step is important to overall findings because it provides the readers with a greater understanding of each supplier. The next step became to evaluate which data, collected from the various interviews, that deemed most applicable to the solution. The categories that was found most relevant were *delivery types* (fixed or random), *supply type*, *donation vs. discount price preference*, *communication*, *supply identification tools* and *strategies*, and *production and manufacturing behavior in primary markets*. In order to structure findings for research question two, I created tables for each finding, where I measured each company toward the respective categories. As a result, the conclusions of this study are based upon which of the categories provided most salvation to the supply risk problem.

### **4.3 Semi-structured interviews**

In qualitative interviewing, it is important for the interviewer to understand the interviewee's point of view. Where, expansive replies are also highly welcomed for richer data collection. Furthermore, qualitative interviewing does not necessarily follow a strict interview script, by which the interviewer often asks additional questions. Such makes qualitative interviewing by far more flexible than quantitative research. Quite typical for qualitative interviewing is the notion of interviewing the same interviewee multiple times, in difference to quantitative interviewing (Bryman 2008).

For the purpose of collecting data regarding a specific topic, yet allowing the interviewee to share their knowledge, I chose to implement semi-structured interviews in the study. In reference to Bryman (2008), a semi-structured interview allows the interviewer to ask questions regarding specific areas and topics, usually following an interview guide. However, the interview method does not necessarily force the interviewee to reply in a certain way, nor forces closed-ended questions. Furthermore, semi-structured interviews

allow the interviewer to ask non-prepared questions such as follow up questions. Yet, semi-structured interviews generally follow the interview guide quite closely. The major difference between a semi-structured interview and a structured interview is that semi-structured interviews allow for more flexibility. However, the extent of flexibility and the difference in direction highly depends on the conversation between the interviewer and interviewee (Bryman 2008).

### 4.3.1 Interview guide

Bryman (2008) illustrated the process of formulating interview questions (figure 4.2). First of all, certain knowledge of the general research area is beneficial because it leads the researcher to ask more specific research questions. In turns, such stipulates various interview topics. In understanding which research topics that become important, it becomes easier to formulate interview questions as well. Bryman (2008) further suggests that interview questions are continuously revised and reviewed, where new questions are formulated as due to such revisal. Bryman (2008) also suggests that the interview topics might need adjusting too. Furthermore, a pilot guide is created, where a different issue may be identified as a result. As mentioned, interview questions may be revised again, pertaining to an ongoing process. At some point the interview guide is finalized (Bryman 2008).

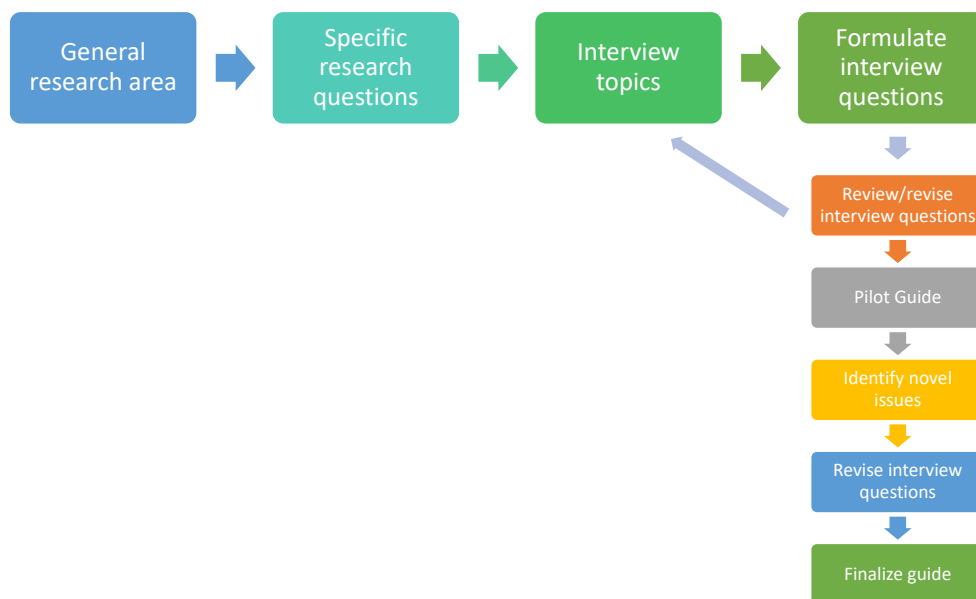


Figure 4.2: Formulating questions for an interview guide  
Bryman (2008) pp. 446

I was inspired by Bryman (2008) whilst creating the interview guide (figure 4.2). When generating the various interview guides, I saw it important to use theory to stipulate interview questions. Whilst creating the interview guide for Matsentralen Vestfold og Telemark, I based the questions upon Tibben-Lembke, Ronald, and Rogers (2002) who compared reverse logistics with forward logistics and the guide was finalized.

In reference to the supplier interviews, I used a continuous process of learning from literature and theory, as well as previous interviews to reshape the interview guide. For example, after interviewing Matsentralen Vestfold og Telemark I realized what problems that were more relevant in accordance to reverse logistics of food waste. One of the problems identified was supply risk, where supply risk is also an issue stated in literature. Therefore, it became clear I should further interview suppliers in order to provide potential solutions to the problem. As a result, the new interview guide had to reflect both theory and the information collected from interviewing Matsentralen Vestfold og Telemark. All in all, the interview guide was finalized once the relevant topics had been covered. Such topics related to communication, deliveries, why the suppliers wished to donate to Matsentralen Vestfold og Telemark, and whether they used inventory identification systems.

#### **4.4 Methodological limitations**

Miles and Huberman (1994) and Tracy (2013) point out the notion of misinterpretation in qualitative research. In qualitative research, observations and spoken words are understood depending on the researcher's individual perceptive views and emotions. In other words, qualitative research is defaulted by the virtue of researchers' presuppositions (Tracy 2013). Thus, due to such potential researcher bias, the validity of qualitative data is sometimes debatable. In addition, Miles and Huberman (1994) states that qualitative methodologies also lack standard analytical tools, often blurring researchers' analytical competencies which can lead to inaccurate conclusion. On the other hand, qualitative methodology is not necessarily without any form of rules or guidelines (Tracy 2013).

In accordance with this particular study, limitations of the empirical study relate to researcher bias, as a result of implementing qualitative research methods. I.e., whether I provided valid responses to the research question or not, and whether my background and understanding of responses diluted results or not. Fortunately, researcher bias can be overcome by triangulation. Triangulation was prominent in this study, whereby literature, observations, and interviews were used as basis for findings and conclusions.

As the research pertained to a very specific example, its application to other scenarios and settings is debatable and therefore a limitation of the study. Other limitations were in regard to the interviewing proceedings. First of all, there was a limitation in terms of the number of available candidates or suppliers to interview. Matsentralen Vestfold og Telemark merely cooperate with 23 suppliers, where only one of the suppliers operated with a fixed delivery day per week and all others operated with random delivery schedules. Second of all, the number of interview candidates whom were willing to be interviewed varied. Thus, I experienced certain interviewee repudiation. Third of all, the level of interviewee trust toward the interviewer was in some cases weak. Such could be due to the fact that all but one interviews were conducted over the phone, where some interviewees perhaps felt uncomfortable speaking to a stranger. Perhaps also regarding potentially providing sensitive information. Lack of trust could also be due to the lack of interviewing-experience on my part. Fourth of all, the interviewees understanding of reverse logistics was limited, where none of the candidates were aware of the concept beforehand. Naturally I explained the concept to them. However, I am not sure whether my explanation provided enough insight regarding the topic or not.

## **5.0 Findings**

### **5.1 How is a food bank network structured and how does it operate?**

This part relates to the findings in accordance with research question one, which is concerned with how a food bank network is structured and how it operates.



### 5.1.1 Supply chain structure

Matsentralen Vestfold og Telemark operates as a closed loop network, where the redistributed food waste enters a new supply chain. The new supply chain, i.e. the food bank network, is structured such that wholesalers, producers, and distributors supply food items to the food bank in which cannot be further distributed to retail stores. The donors are collectively referred to as “suppliers”. Donations made to the food bank are normally the suppliers’ last option before such unsellable food become ingestible food waste where it is gathered for recycling or anaerobic treatment. Furthermore, Matsentralen Vestfold og Telemark merely receive food that have reached the farmer, producer, distributor, or wholesaler in the Supply Chain (figure 5.1), where the food bank does not receive food past this point in the supply chain because it is difficult to redistribute foods that are past expiration dates or highly perished. Food that is donated to Matsentralen Vestfold og Telemark is then stored and further redistributed to cooperating organizations that further redistribute the food (figure 5.2) to end-users. The end-users are often persons in need of charitable action, and not your common Joe at the supermarket. As any other organization, the food bank also produces some food waste, especially due to the high perishability foods. According to the food bank, *Norsk Gjenvinning* handles any waste produced by the food bank (Matsentralen-Vestfold-og-Telemark 2019).

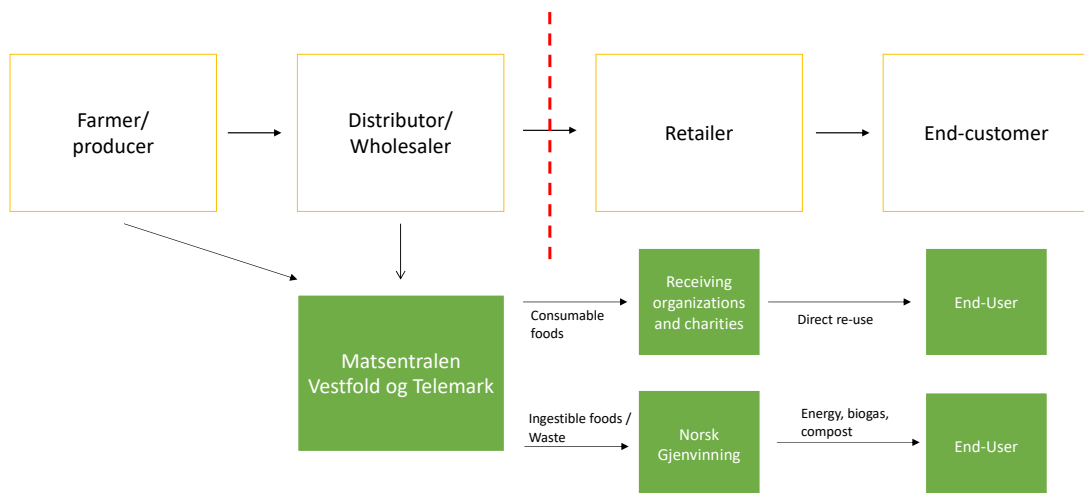


Figure 5.1: Matsentralen Vestfold og Telemark Supply Chain

Reference: My interpretation of Matsentralen Vestfold og Telemark’s supply chain

Matsentralen Vestfold og Telemark operates in a centralized food redistribution network (figure 5.2). Such entails that the food bank is responsible for any decision-making regarding food redistribution among the network members. The network centralization also implies that Matsentralen Vestfold og Telemark alleviates many of the potential troubles and hassles on both ends of the spectrum; suppliers cooperate with one organization and charities collect from one location. TINE and Nortura, suppliers of the food bank, communicated that such centralization made things much easier for them compared to previous years where they donated to multiple charities (TINE 2019 and Nortura 2019).

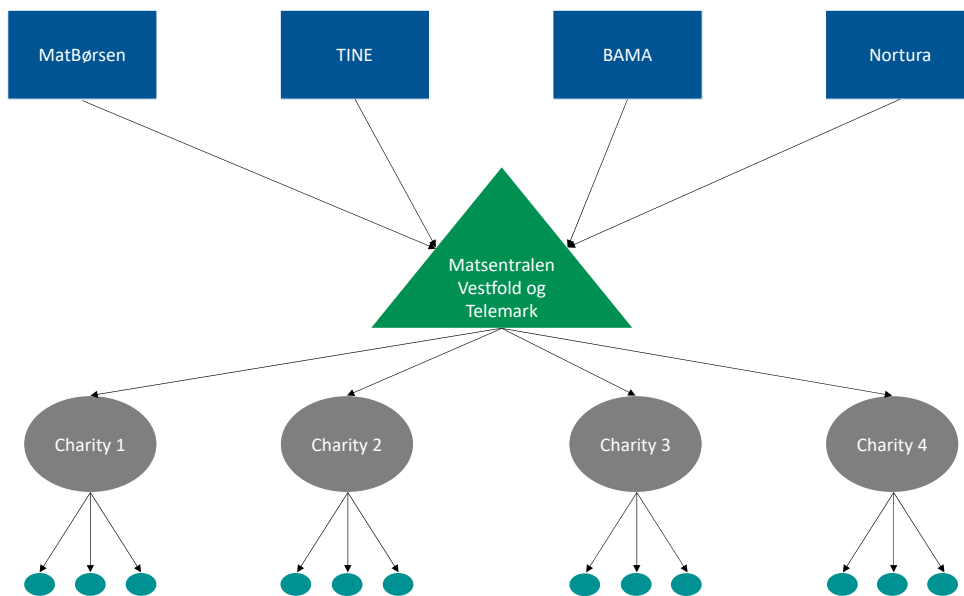
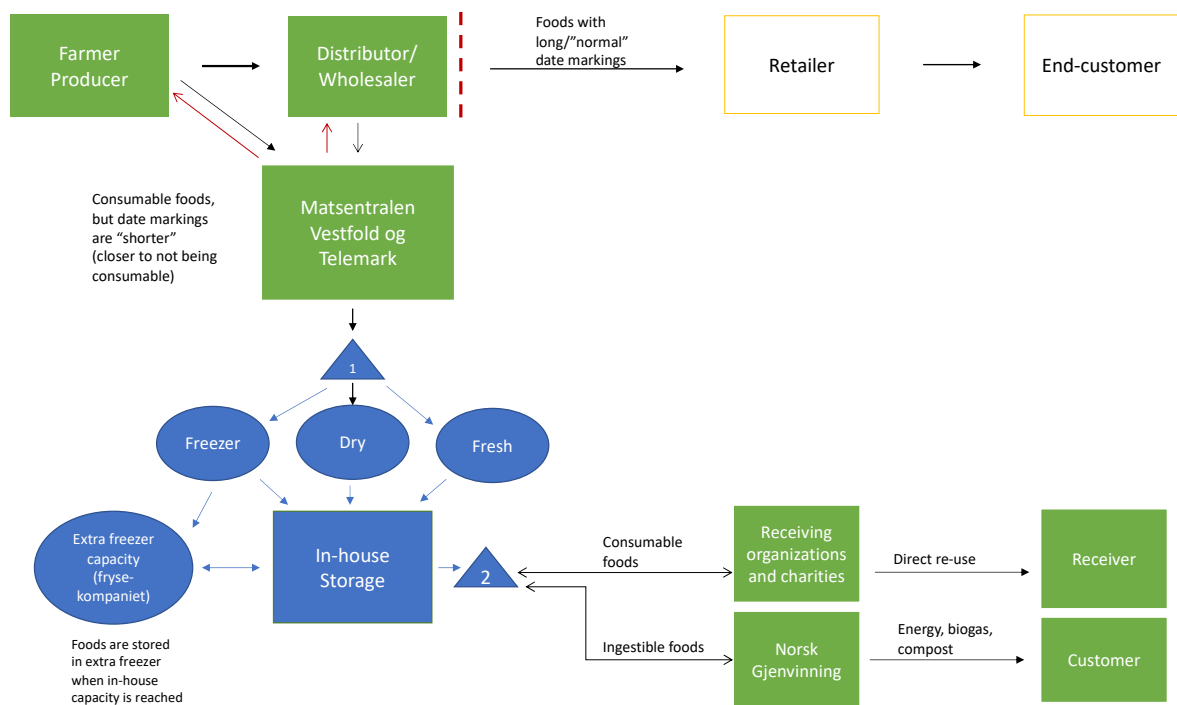


Figure 5.2: Matsentralen Vestfold og Telemark and suppliers' centralized reverse logistics network  
Reference: My interpretation of Matsentralen Vestfold og Telemark's centralized network

According to the food bank manager, Matsentralen Vestfold og Telemark's main operations involve the receipt of food deliveries from collaborating suppliers, ensuring accurate food storage, and in turn proper food redistribution (figure 5.3) (Matsentralen-Vestfold-og-Telemark 2019). Figure 5.3 explains in further detail the network structure, such as the food bank's operations and decision points.



Symbols	Explanations
	Decision point
	Date- and quality threshold for foods
	Matsentralen V og T make pickups
	Supplier make deliveries
	Matsentralen V og T's physical movement of goods
	Downstream supply chain member movement of goods (pick up – delivery)
	Supply chain members
	Matsentralen storage
	Storage method

Figure 5.3: Matsentralen supply chain and reverse logistics activities with explanations

Reference: My interpretation of Matsentralen Vestfold og Telemark's reverse logistics network

Matsentralen Vestfold og Telemark has its own truck for transporting food items when suppliers are not able to. Thus, the food bank is not reliant on the suppliers for delivery (figure 5.3 and 5.4). With that being said, suppliers are often able to make deliveries (figure 5.3 and 5.5) (Matsentralen-Vestfold-og-Telemark 2019).



Figure 5.4: Matsentralen Vestfold og Telemark's truck used for food pick ups

Reference: Matsentralen Vestfold og Telemark (2019)



Figure 5.5: Supplier Delivery

Reference: Matsentralen Vestfold og Telemark (2019)

## 5.1.2 Supply

The date- and quality threshold (figure 5.3) is an important part of the food bank's reverse logistics network. The threshold indicates which foods that are viable for donation (Matsentralen-Vestfold-og-Telemark 2019):

1. The first category of food donations relates to overproduction, where some foods have gotten so close to their expiry dates such that they cannot be sold in retail stores and are therefore donated.
2. The second category relates to food items which do not meet primary markets' quality standards. Labeling errors is an example of such. Also, some processed foods, such as frozen foods or microwave dinners, do not fit the packaging used for shipping or transport, and are rather donated. To clarify, all foods in which enters the food bank are healthy and may be consumed.

The food bank is bound by some of the same supply restrictions as a food distributor or grocer. The *best before* date is the softest among product markings. According to the food bank manager, products marked *best before* should be sold within so and so date but can safely be consumed a while after. *Acceptable until* product markings are as well a softer regulation, where foods are generally safely consumable, but the producer cannot guarantee a normal product quality. Thus, allowing Matsentralen Vestfold og Telemark to redistribute *best before* and *acceptable until* products past their expirations. products. On the other hand, products marked with *use by* dates pose firmer regulations, whereas such products cannot safely be consumed after suggested date. However, if products are kept frozen the food bank can safely redistribute such foods (Matsentralen-Vestfold-og-Telemark 2019).

The food bank is impacted by a regional default that directly affects supply. The Vestfold and Telemark region produce more fresh foods, such as meats and dairy, than dry foods, such as grains. Thus, Matsentralen Vestfold og Telemark's supply abundantly consists of fresh- and frozen- foods. Fortunately, the food bank has extra freezer capacity (figure 5.3). Dairy also keep long even after the expiry dates. The food bank is able to generate some safety stock on items such as frozen goods due to the extra storage space (figure 5.3), as well as receiving such supplies abundantly more than other types of stock. On the other hand, dry goods are scarce in the region which is notable to the food bank's scarce dry goods stock. Thus, safety stocks in terms of fresh and dry goods are not built (Matsentralen-Vestfold-og-Telemark 2019).

As the Oslo region has lower stocks of meats and dairy, a trade between Matsentralen Oslo and Matsentralen Vestfold og Telemark among dry- and frozen- and/or fresh- foods is common practice. Thus far, supply influxes generally follow more of a just-in-time approach with rather frequent several small and medium deliveries. The just-in-time practice is not necessarily implemented by choice, where the food bank is rather constrained by the practice. However, such deliveries are generally from multiple different suppliers and follow random and unscheduled pattern (Matsentralen-Vestfold-og-Telemark 2019).

### 5.1.3 Suppliers

Matsentralen Vestfold og Telemark are fortunate in that they, so far, cooperate and in contract with twenty-three suppliers (figure 5.5). The contract states whether deliveries are to be made on a scheduled weekly basis, whether deliveries are unscheduled and are to be made when food surplus prevail, or if Matsentralen Vestfold og Telemark is to gather food surplus (figure 5.6). Furthermore, the latter generally require additional communication between Matsentralen Vestfold og Telemark and the food suppliers, generally through sporadic phone calls or emails. Fortunately, in most cases, the suppliers make the deliveries (figure 5.3 and 5.5). Sometimes, companies such as *Miniekspress* and *Asko* make deliveries to the food bank when the supplier cannot make the deliveries

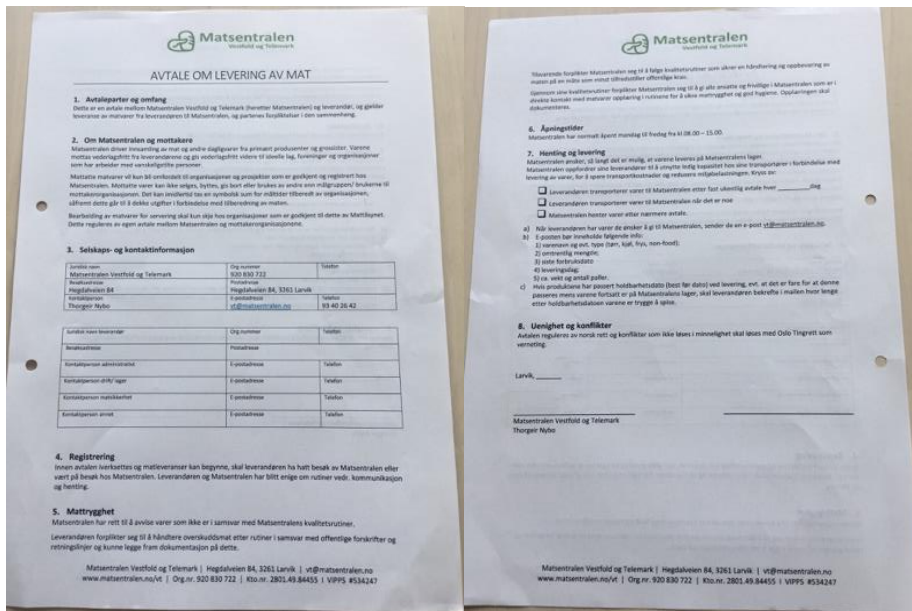


Figure 5.6: Supplier delivery contract  
Reference: Matsentralen Vestfold og Telemark (2019)

As a general practice, before any food items are donated to Matsentralen Vestfold og Telemark, all food suppliers must notify the food bank by emailing a request, specifying the approximate quantity, the type of foods, the last consumable date, the delivery date, the approximate weight, and the number of pallets (Matsentralen-Vestfold-og-Telemark 2019).

As of today, merely one supplier has agreed to operate with a fixed delivery day every week. Therefore, the ample ratio of unscheduled- to scheduled deliveries pose certain supply uncertainty. On the other hand, Matsentralen Vestfold og Telemark reports deliveries to have increased since the food bank opened in January 2019 (Matsentralen-Vestfold-og-Telemark 2019).

#### 5.1.4 Warehousing

Once arriving Matsentralen Vestfold og Telemark, the donations are weighed using single pallets at a time. Upon arrival to the food bank, foods are also labeled dry-, frozen, or fresh goods, marking the first decision point in Matsentralen Vestfold and Telemark's reverse logistics chain (figure 5.3). Once labeled correctly, the foods are stored accordingly, meaning either at fridge temperature storage (5.7), freezer storage (5.8), or dry storage (figure 5.9) (Matsentralen-Vestfold-og-Telemark 2019).



Figure 5.7: Fridge storage

Reference: Matsentralen Vestfold og Telemark (2019)



Figure 5.8: Freezer storage

Reference: Matsentralen Vestfold og Telemark (2019)



Figure 5.9: Dry storage

Reference: Matsentralen Vestfold og Telemark (2019)

The food bank does not follow a standard warehousing or storage method such as FIFO or LIFO. However, the voluntary staff perform daily check of the freezer and fridge space, where the standard is appropriating foods with the shortest shelf lives first. Because some of the foods have long expiry dates and the turnover rate is rather high, careful inventory planning and storage is usually not problematic. The food bank has also been fortunate enough in that they cooperate with the neighboring logistics company *Frysekompaniet*, which specializes in storing and warehousing frozen items (figure 5.3). The extra capacity amounts to approximately thirty additional pallets. The added capacity has served Matsentralen Vestfold og Telemark well, as frozen foods may be kept longer than fresh foods (Matsentralen-Vestfold-og-Telemark 2019).

### 5.1.5 Demand

In the case of Matsentralen Vestfold og Telemark, one cannot label end-users and as “customers.” Customers in this case are referred to as “beneficiaries” because they are merely granted donations. Currently, the food bank has an established network with thirty cooperating charities, where approximately ninety percent are of religious organization. Thus, the immediate receivers are charitable organizations aiding disadvantaged and poverty-stricken persons. Though not frequently discussed, poverty and hunger are also



considerable problems in the Norwegian society. The food bank manager explained that due to his experiences in meeting a significant number of underprivileged individuals, ethics is deemed of high importance when deciding which organization to aid and cooperate with (Matsentralen Vestfold og Telemark 2019).

One of the food bank's main focuses is to generate additional receivers to ensure food waste can be utilized as best as possible. Thus far, in reaching receiving organizations, Matsentralen Vestfold og Telemark utilized the already established network through Matsentralen Oslo that in the past was responsible for the Vestfold and Telemark regions as well. Additionally, the food bank community is rather limited and therefore word by mouth goes a long way. Additional efforts such as newspaper and magazine publications have ensured added exposure. Therefore, several organizations contact Matsentralen Vestfold og Telemark as well (Matsentralen-Vestfold-og-Telemark 2019).

### **5.1.6 Distribution**

Though expected to organize food pickups, receiving charities have no limitations regarding the number of pickups and the quantities gathered. Restrictions are not needed as inventory stocks are sufficient to cover current demand. Thus, the food bank does not categorize receivers in terms of organization size. Where, small organizations may receive as much supply as large organizations (Matsentralen-Vestfold-og-Telemark 2019).

Furthermore, the food bank does not follow standard practices in terms of redistribution, but rather analyze day-to-day situations. The voluntary staff and on-site manager rather have internal understandings of "fair" redistribution. In contrast, certain popular and limited foods carry restrictions, where the food bank will generally indicate such restrictions. One initiative is making available inventories for pick-up easily reachable, whereas inventories not for donation stacked. The food bank made a general rule stating that merely food items obtainable at shoulder-height may be picked-up (Matsentralen-Vestfold-og-Telemark 2019).

Foods are weighed again once redistributed such that the food bank may keep a close look at redistribution history and to keep track of current inventory and current warehouse capacity. Weight is also registered per unique food groups such as meat, dairy, dry goods,

frozen goods, produce, etc. at check-out. All registrations happen electronically, using an internal system for systemized inventorying. The system will in turn generate current inventory levels in order to keep track of capacity (Matsentralen-Vestfold-og-Telemark 2019).

The food is further distributed through the receiving organizations' alliances (figure 5.2 and figure 5.3) (Matsentralen-Vestfold-og-Telemark 2019).

## **5.2 How might a food bank along with its suppliers, operating in a reverse logistics network, improve supply security?**

This part relates to the findings in accordance with research question two. First, I shall provide a short introduction of the suppliers, then continue by presenting the research results.

### **5.2.1 BAMA**

With a turnover of NOK 17 507 million in 2018, BAMA is the largest distributor of produce in Norway. In order to meet the demand of 17,000 customers, BAMA collaborates with farmers all over the world, stretching BAMA's supply chain globally. Yet, BAMA acknowledges consumer preferences in regard to locally produced and sourced foods. Part of the company's promise to customers is the delivery of fresh produce with proper quality (bama.no 2019).

BAMA has taken a commercial route in the farming industry, where the company acts as a distributor (figure 5.11). BAMA purchases produce from farmers, then further distribute the produce to retailers which distribute to consumers (figure 5.11). However, BAMA is present in other areas of business, such as the restaurateur- and catering- industry, the flower industry, the food service industry, as well as presence in industrial settings. Additionally, BAMA takes part in an array of international business ventures (bama.no 2019).

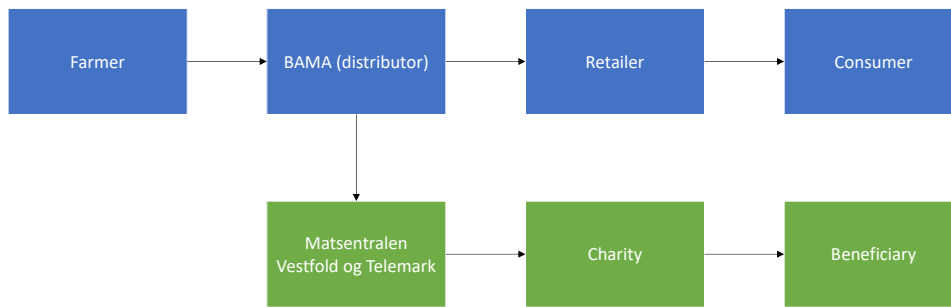


Figure 5.11: BAMA's position in the supply chain

Reference: My interpretation of BAMA's position in the supply chain

Proper planning and forecasting have eliminated a lot of food waste at BAMA. In addition, understanding seasonal changes in terms of weather and consumer preferences help in combating food waste. At BAMA, food waste generally happens due to produce being unfit for sale. When produce is unfit for sale, it is usually due to shape and size. In turn, such foods are redistributed, whereby the procedure eliminates much of the food waste. In general, BAMA does not distribute foods that are about to expire or close to its expiry date. Rather, produce entering BAMA's warehouse must undergo strict quality inspections before being admitted or readied for sale. As a result, certain foods do not pass the quality standards. Such produce is generally healthy, tasty, and therefore perfectly fine to eat, yet unfit for sale due to small imperfections. Even though not appropriate for grocery stores, BAMA can donate such foods (BAMA 2019).

Concerned with efficiency and main operations, BAMA's cooperation with Matsentralen Vestfold og Telemark constitutes of a fixed day per week agreement for donations (BAMA 2019).

## 5.2.2 MatBørsen

Owned by *NorgesGruppen*, MatBørsen is the largest producer in Norway of premade food items and meals (matbørsen.no 2019). Whereby, MatBørsen made an annual turnover of NOK 600,463 million in 2018 (proff.no 2019). The food items and meals include pre-made dinners, cold cuts, cakes, condiments, sides, and finger foods. In turn, MatBørsen distribute these products to grocery stores and catering-type outlets (figure 5.12) (matbørsen.no 2019).

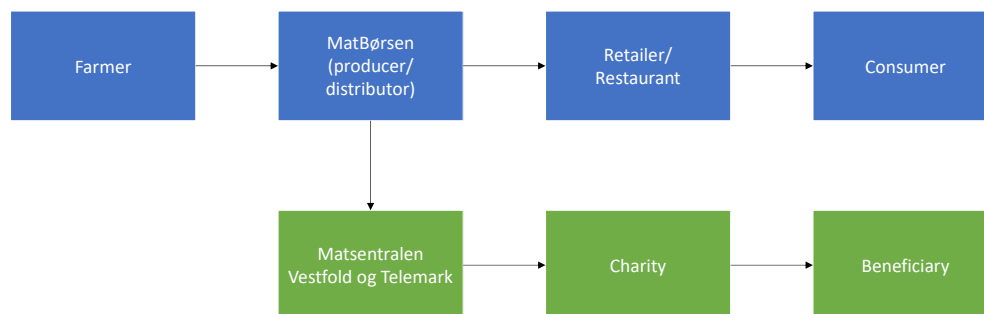


Figure 5.12: MatBørsen's position in the supply chain

Reference: My interpretation of MatBørsen's position in the supply chain

In pursuing zero-waste operations by 2025, MatBørsen continuously works to reduce greenhouse gas emissions from operations. Such reduction initiatives include utilizing more environmentally friendly means of transportation, limiting overall use of plastics, implementing more environmentally friendly products, and reducing food waste (matbørsen.no 2019).

In order to reduce food waste, MatBørsen sells products that are unfit for sale at discount prices in alternative markets (figure 5.13). However, if these items cannot be redistributed through alternative outlets, MatBørsen donates remaining products to Matsentralen Vestfold og Telemark. Subsequently, making donation to the food bank is MatBørsen's last option before disposing the foods. Due to the ongoing efforts in reducing food waste,

MatBørsen reported that they do not aim for food surplus. Therefore, MatBørsen merely donates foods when supply levels allow it, employing a random donation schedule (MatBørsen 2019).

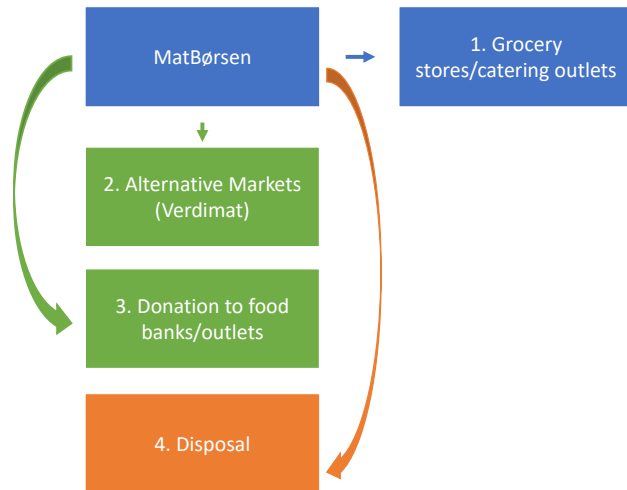


Figure 5.13: Matbørsen food distribution priorities

Reference: my interpretation of matbørsen's redistribution preferences

### 5.2.3 TINE Meieriet Sem

TINE is a leading dairy distributor in Norway with more than 130 years of experience in the industry. TINE is organized as a cooperative and currently owned by 11 400 members and 9 000 cooperative farms (figure 5.14). The magnitude of the cooperative resulted in an annual turnover of NOK 23 000 million in 2018. Today, TINE sources dairy from 10,500 farmers and 8,500 farms throughout Norway. Important to TINE is ensuring that ethical standards are upheld for both employees and consumers (tine.no 2019a).

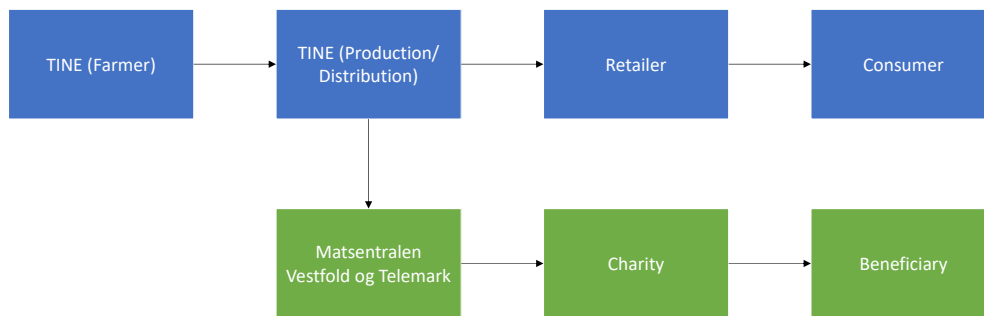


Figure 5.14: TINE's position in the supply chain

Reference: My interpretation of TINE's position in the supply chain

Concerned with the environment, TINE wishes to reduce greenhouse gas emissions from their production with 30% by 2030. In order to reach their goal, transportation, production, packaging, and food waste are areas in which are continuously improved (tine.no 2019a). For example, the dairy producer has the possibility to discard food waste for biogas production. Such accord results in direct return for the company's alternative-fuel-driven vehicles (figure 5.15). Yet, TINE would rather donate excess supply to charitable organizations in order to support the local community (figure 5.15) (TINE 2019).

Whereas the company produces approximately 1,300 different products, food waste is a concern at TINE. The results of producing such a variety of products is that some of the products are never consumed by the customers in which they were intended for. This is especially due to quick changes in consumer preferences. In addition, the national legal restrictions and guidelines *STAND* defers any company from selling products that will expire within 2-3 days, even at discounted prices, often creating supply surplus at TINE (TINE 2019).

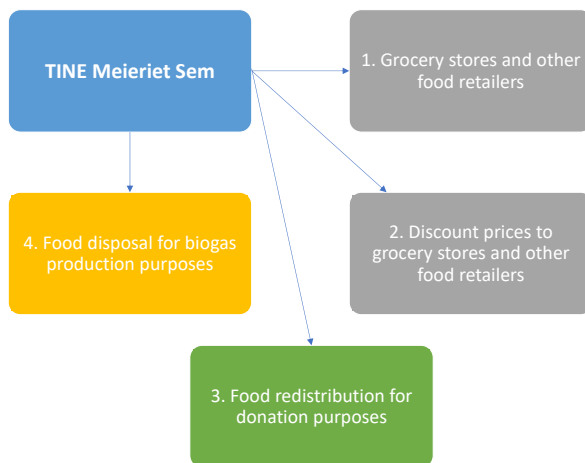


Figure 5.15: Food -distribution and -redistribution at TINE

Reference: My interpretation of TINE's food redistribution preferences

Part of the cooperative, TINE Meieriet Sem is located in the municipal of Tønsberg. The Sem location produces approximately 35 million liters of milk yearly and employ about 200 workers (tine.no 2019b). TINE Meieriet Sem has decided to donate part of their excess supply to Matsentralen Vestfold og Telemark (TINE 2019). As of today, TINE cannot commit to a fixed day per week or month. However, TINE has agreed to make as much as two donations per week when supply allows it (TINE 2019).

## 5.2.4 Nortura

With a turnover of NOK 23 449 million in 2018, Nortura is a large competitor in the Norwegian meat and egg industry (nortura.no 2019). Nortura has more than 30 factories all over Norway, where Nortura Tønsbeg is one of them (Nortura 2019). Quite uniquely about Nortura, is that the company is rather a cooperative owned by 18,300 egg and meat producers, supplying to major players such as Gilde and Prior (figure 5.16) (nortura.no 2019).

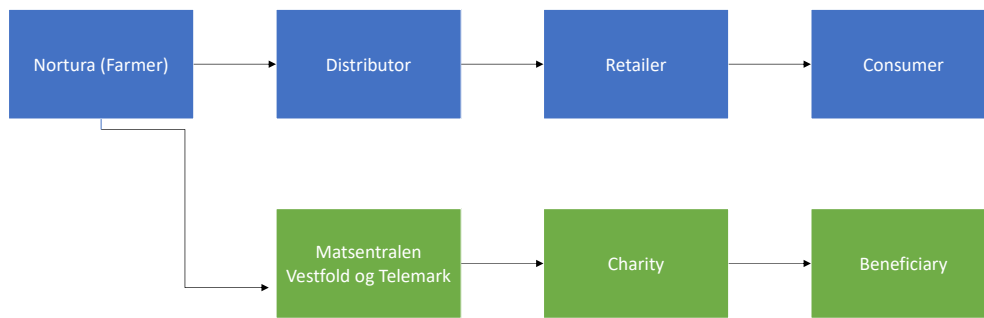


Figure 5.16: Nortura's position in the supply chain

Reference: My interpretation of Nortura's position in the supply chain

Particularly concerned with food waste, Nortura is avidly working toward limiting excess supply. Part of Nortura's food waste reduction strategy is that each factory must decide how they wish to allocate food surplus. Where, Nortura in Tønsberg has decided to donate any unsold foods to Matsentralen Vestfold og Telemark. Yet, due to limited surplus some weeks Nortura has little or nothing to donate. Nortura states it would be difficult for the cooperative to commit to a fixed delivery day per week or month, as a result. However, some products such as fresh foods are produced based on demand estimations and not in terms of purchase orders, where sometimes projections deviate from actual demand and a surplus is created (Nortura 2019).

The cooperative has a long tradition concerning donating excess foods to charity, where Nortura was part of founding Matsentralen Vestfold og Telemark. Such work included providing guidance and funds during the food bank establishment. The establishment of the food bank also means Nortura Tønsberg merely has to deal with one agency. The cooperative sees this as highly positive as Matsentralen Vestfold og Telemark understands the food redistribution market much better than Nortura (Nortura 2019).



### **5.2.5 Supply uncertainty and risk**

The research problem acquire attention to supply uncertainty and risk. First of all, it is important to understand how Matsentralen Vestfold og Telemark view this problem. Even though not a significant issue as of today due to the current steady supply rate, the food bank still experiences certain problems regarding supply. These problems are identified as:

- not all products are redistributed from the food bank due to their perishable nature, such expiration or perish before redistribution, and are therefore rather discarded (Matsentralen-Vestfold-og-Telemark 2019);
- not all products are redistributed from the food bank due to their characteristics, such as their size, quality, and type (Matsentralen-Vestfold-og-Telemark 2019);
- supply donations to the food bank are lacking in terms of dry goods, which are also goods easy to store and redistribute (Matsentralen-Vestfold-og-Telemark 2019);
- not all suppliers of the food bank make frequent donations, where merely one supplier donates weekly (Matsentralen-Vestfold-og-Telemark 2019).

Thus, we find problems related both supply characteristics in terms of their quality and their characteristics. As well as challenges in terms of supply -contingency and -quantity. Such problems especially correlate with literature as stated by Tibben-Lembke, Ronald, and Rogers (2002), Fleischmann et al. (1997), and Gou et al. (2008). Accordingly, it is important to understand the supplier side of this specific food redistribution equation. Most of all, understanding what efforts suppliers make in terms of ensuring supplies for further redistribution become important.

From interviewing the various suppliers, it is apparent that certain factors heavily affected the food bank's overall supply risk, such as:

- whether supplies utilized deliveries are fixed or random;
- type of foods supplied/donated;
- whether suppliers preferred donating excess supplies over selling excess supplies at discount prices;
- the degree to which communication is immersed;
- what strategies and systems suppliers uses to identify donatable supplies;
- and whether production and manufacturing in primary markets affects supply security in the food redistribution market.

### 5.2.6 Delivery types (fixed or random)

One of the major expectations during the pre-research was that random deliveries creates large barriers for operators in the food redistribution industry. Thus, it is important to classify whether the food suppliers utilize random or fixed delivery methods. MatBørsen (2019), TINE (2019), og Nortura (2019) report that they use random delivery measures (table 1). The main reason for this is, as reported by all interviewees utilizing random deliveries, is that they wish to limit excess supply as much as possible in order to reduce food waste. Thus, the suppliers do not plan on excess supplies either. As a result, such a food waste reduction strategy makes it difficult for suppliers to promise Matsentralen Vestfold og Telemark donations, as supplies might not exist (MatBørsen 2019; TINE 2019; Nortura 2019).

BAMA, however, reported to be using a fixed delivery schedule (table 1). BAMA wished to use fixed deliveries for two main reasons. According to BAMA (2019), written contracts generally make all parties involved willing to cooperate and communicate better, as more is expected from both or all. BAMA (2019) further states that a contract based upon fixed and scheduled deliveries/pickups lessens the planning, general logistical hassle, and overall communication with Matsentralen. Whereas, a fixed day and time assures both parties' expectations. A well-written contract does not only ensure potentially more supply security and strengthened planning for Matsentralen Vestfold og Telemark, it implies less redundant work for both parties (BAMA 2019).

<b>Delivery type</b>	<b>Reasoning</b>	<b>Supplier(s)</b>
Random	1. Food waste reduction strategy	TINE, Nortura, MatBørsen
Fixed	1. Contractual benefits: better communication and cooperation 2. Lessens logistical hassle and communication, but improves planning	BAMA

Table 1: delivery type

### 5.2.7 Supply type

An important factor regarding supply risk is whether the food supply is fresh, frozen, or dry. According to Matsentralen Vestfold og Telemark, a problem in which the food bank experiences is the degree to which dry goods are hard to come by. Such supply restrictions are due to geographical and local restrictions, as most producers in the area specialize in producing mostly meats and dairy. The organizational structure of Matsentralen Norge indicates that each food bank location is restricted such that they may only receive supply from suppliers in their respective areas (Matsentralen-Vestfold-og-Telemark 2019).

Another point in the food type discussion is that dry goods are exceptionally easier to handle, store, and redistribute compared to fresh goods, such as dairy and produce. In turn, frozen goods are somewhat easier to handle, store, and redistribute. Therefore, the expiration date as well as the general organic decomposition matter in terms of redistribution considerations.

Findings show that all suppliers donate fresh foods, where two suppliers additionally donate frozen foods. Under the fresh category, we find the largest assortment of food types, where frozen goods mainly pertain to meats and precooked dinners and products (table 2).

Category	Type	Supplier(s)
Fresh	1. Produce (fruit/veg.), 2. Dairy 3. Meat 4. Precooked meals/products	MatBørsen, Nortura, BAMA, TINE
Frozen	1. Meat 2. Precooked meals/products	MatBørsen, Nortura

Table 2: supply category

### 5.2.8 Donation vs. discount price preference

Another important aspect in ensuring that excess supplies reaches Matsentralen Vestfold og Telemark, as well as the charities and lastly end-beneficiaries, is the notion by which the suppliers utilize alternative markets and discount selling. Alternative markets, in this particular discussion, may be defined as *markets where products are sold at discount*

prices, such as *holdbart.no*. In this particular case, suppliers sell products at discount prices to discount retailers, and in turn the discount retailers sell products at discount prices. If a supplier prefers selling excess supplies in alternative markets, such implies the excess supplies do not necessarily reach Matsentralen Vestfold og Telemark. However, it can further imply that such excess supply reaches the food bank, but their expiration dates and perishability are pushing the limits. General discount pricing implies that a supplier merely uses discount prices whilst selling to a primary market, which are players in the traditional food supply chain (figure 2.4).

Findings show that two of the suppliers prefer donation options as opposed to selling excess supplies at discount prices in alternative markets (table 3). Conversely, the remaining two suppliers prefer discount selling over donation as the primary strategy for food redistribution (table 3). The motivations for each strategy were quite polarized (table 3). Nortura (2019) reports that donating excess supply is preferred over selling in alternative markets because financially speaking the returns are very insignificant. Where, donating become the easier- and more ethical- option. BAMA (2019) does not report of utilizing alternative markets at all. MatBørsen (2019) announces that they prefer alternative markets and due to the extra financial gains. TINE (2019) also notes financial motivations for selling at discount prices over donation, where the company prefer selling excess supplies at discount prices to operators already in primary markets.

<b>Preference</b>	<b>Motivations</b>	<b>Supplier(s)</b>
Discount selling	Financial	MatBørsen TINE
Donation	Ethical Less hassle	BAMA Nortura

Table 3: discount selling vs donation preference

## 5.2.9 Communication

Communication is an important benchmark in deciding whether overall reverse logistics is effective and/or efficient. Therefore, measuring the means of communication, extent of communication, reasons they wish to utilize little/much communication, and the overall outcome of the communication is relevant to the discussion. Importantly, the measurements are based on the supplier's action which in turn affects overall communication on both sides (supplier and receiver).

In defining the effects of communication, communication is presented as *efficient* and/or *effective*. If the results of communication pertain to effective, it means that the communication is effective in terms of understanding food bank supply preferences/needs and warehouse/storage capacity. Such communication involves that both parties, supplier and the food bank, are willing to engage in ongoing and extensive communication. For example, Matsentralen Vestfold og Telemark notes that certain donated items are simply too weird, where people simply do not want to consume them. Or, that the size of some food items is too large for a private person to handle. Understanding these needs can help reduce food waste, but also ensure more appropriate products are donated and redistributed. Efficient outcomes, on the other hand, means logistics in terms of speed and planning remain relatively productive. Such allows the supplier to focus their efforts on main operations. However, if communication is neither effective or efficient it does not matter whether the extent of communication is much or little.

Table 4 presents the results of the communication measurements, where:

- The extent of communication is reported as either *little* or *much*. Little communication pertains to minimum efforts and much communication relates to more than required efforts from the supplier. What is required is emailing Matsentralen Vestfold og Telemark regarding what the supplier will supply, how much of it, and when.
- The explanations column clarifies why the communication method was efficient or effective.
- The reason(s) column explains why the supplier wished that type of communication.

Supplier	Extent of communication	Efficient or effective?	Explanation(s)	Reason(s)
BAMA	Little	Efficient	1. Minimum communication due to set delivery parameters	1. More time on main operations 2. Easier/better planning Regarding donations / deliveries
MatBørsen	Much	Effective	1. Understands needs and capacities of the food bank 2. Shared transportation and supply system, where bulk items go to Matsentralen Oslo	1. Better understanding of food bank needs 2. Assurance of compliance with food donation laws/regulations/expectations 3. Centralization of food bank; easier to communicate with 1 centralized location opposed to multiple → stronger business relationship
TINE	Much	Effective	1. Wishing to understand food bank preferences and capacities 2. Increased communication due to food bank compliance of legalities 3. A centralized food bank location results in added communication	1. Better understanding of food bank needs 2. Assurance of compliance with food donation laws/regulations/expectations 3. Centralization of food bank; easier to communicate with 1 centralized location opposed to multiple → stronger business relationship
Nortura	Little	Neither efficient nor effective;	1. reports communication to be limited because most products are well received at the food bank, thus communication is reported to not be needed. (did not see why communication regarding preferences was needed) 2. Mentions a centralized food bank location makes it easier to communicate, but effective communication has still not been immersed.	1. Centralization of food bank makes it easier to communicate; yet communication was not wished. 2. Products are well received; resulting in limited communication

Table 4: communication outcome per supplier

### 5.2.10 Supply identification tools and strategies

The “supply identification tools and strategies” category relates to how the various suppliers identify which supplies are to be donated. The category is important because companies that redistribute excess supply to food banks, usually donate foods that are about to expire. The *use-by dates* may encourage higher food waste rates as companies are simply restricted by policies and laws in terms of how close to the expiry dates products may be distributed. Another point to this particular discussion is whether foods are donated with long shelf lives left or with short shelf lives. Where, such naturally affects the food bank’s redistribution process of these items.

The various suppliers utilize and prefer rather different supply identification methods and strategies (table 5). The suppliers, on an overall basis, identify these methods:

1. Early quality inspection performed before admittance to warehouse, which ensures products in which cannot be sold in main markets to be donated quickly.
2. Managerial decision-making regarding expiration dates, which makes the basis for decision of donation/redistribution.
3. Identification early of errors and deviations, where such products are sold as quickly as possible in alternative markets first, then donated.
4. Warehouse system for date-marking identification, where such products are sold as quickly as possible in alternative markets first, then donated.

<b>Supplier</b>	<b>Method(s) utilized</b>
BAMA	1
MatBørsen	3, 4
TINE	2
Nortura	2

Table 5: supply identification methods used by each supplier

However, TINE and Nortura differ in that:

- TINE sells products at discount prices and donates such products if not sold, pushing expiration dates sometimes to as close as 2-3 days before expiry (TINE 2019).
- Nortura donates products once the date threshold for normal distribution has passed, where generally the expiration dates are as long as up to a few weeks. This is due to the fact that Nortura has internal threshold dates to comply with, where each member of their supply chain has respective date thresholds to comply with. As Nortura is classified as a producer rather than distributor, once supplies are donated the supplies are still left with relatively long expiration dates (Nortura 2019).

Table 6 explains each individual supplier's donation strategies:

<b>Donation Preference</b>	<b>Discount Preference</b>
<u>BAMA</u> Identify early which products that will not be sold in main market and donate quickly. Such products are therefore left with longer expiration dates and overall high quality.	<u>MatBørsen</u> Products are sold in alternative markets first, pushing the expiration dates.
<u>Nortura</u> Products that do not make the date thresholds are donated, and usually left with long expiration dates.	<u>TINE</u> Products are sold in alternative markets first, pushing the expiration dates to as much as merely 2-3 days.

Table 6: supply identification strategies based on discount selling vs. donation preference

Noticeable is that the suppliers that prefer donation over selling excess supplies at discount prices generally donate excess supply whilst it is relatively far from expiry or perish. In turn, such practices increase the overall supply security, as the urgency of further redistribution to the charities decreases (table 6). On the other hand, the suppliers that prefer selling excess supplies at discount prices over donation, donate excess supplies closer to their expiration dates, which also results in lower supply security (table 7).

<b>Redistribution preference</b>	<b>Expiration/perishability</b>	<b>Supply security</b>	<b>Supplier distribution</b>
Donation preference	Foods donated have longer expiration dates	Stronger	BAMA Nortura
Discount preference	Foods donated have short expiration dates	Lower	MatBørsen TINE

Table 7: Supply security based on donation vs. discount selling preference

### 5.2.11 Production and manufacturing in primary markets

It is known that both anticipated- and real demand affect firms' general production planning and forecasting. Demand shifts and other more unforeseen events generally affects supply chain members production and inventory management. In turn, such generally affect the entirety of the supply chain, where generally the more upstream supply partners are vulnerable in taking the largest hits. Moreover, food banks and outlets are indirectly affected by demand shifts and other more unforeseen events in primary markets. This is because the supply in secondary markets is contingent on the excess supply of primary markets. For example, if there is general supply shortage in the primary market, the secondary market is much likely to be affected by that same shortage. Conversely, the



same concept is applied to supply excess, where the secondary market may in theory experience larger donations.

In conversation with the various suppliers, discoveries show that production and manufacturing in primary markets affects the food redistribution market in that:

1. No supplier reports to be producing extra goods in order to carry safety stock for potential donation purposes. The reason is generally due to the limiting overall food waste.
2. All suppliers report supply -excess or -deviations to be the main reasons why their products are donated. Hence, donation of supply is not something suppliers intend to do unless forced to.

Yet, whether supplier actions in primary markets actually limit the supply level in the food redistribution market or not is up for debate. Findings show that with each production strategy, supply is affected in different ways, even though none of the suppliers necessarily purposefully opt for excess supplies (table 8).

<b>Supplier</b>	<b>Do production in primary markets limit supply in secondary markets?</b>
BAMA	Not as much; usually excess supply due to several supply deviations even though uses forecasting as much as possible to limit supply excess
MatBørsen	Not as much; usually some supply errors/deviations regardless, which means almost always excess supplies
TINE	Some; difficult to estimate demand with the number of products offered. Therefore, some supply excess is bound to happen.
Nortura	Yes; does not aim for supply excess at all. Production is based on forecasting, but demand can deviate at times, which affects the supply excess/shortage.

Table 8: production in primary markets' effect on secondary market, per supplier

## 6.0 Discussion

This section discusses the results for research question one (chapter 6.1) and research question two (chapter 6.2).

## 6.1 How is a food bank network structured and how does it operate?

Findings show that the food bank network is structured in ways that corresponded to reverse logistics networks but also traditional networks. First of all, Matsentralen Vestfold og Telemark operates as a redistributor of unwanted food and function as an intermediary agent or wholesaler between the food producers/distributors and charities. Meaning, the food waste supply chain pertaining to Matsentralen Vestfold og Telemark is highly similar to the traditional supply chain. According to Christopher (2011), a supply chain is a network of upstream and downstream entities or suppliers in which must cooperate in order to create most value for the firms and ultimately for the end-users. Each member of a supply chain is dependent on one another; therefore, it is important for the overall supply chain to operate smoothly (Christopher 2011). An example of a supply chain: Supplier 1 – Supplier 2 – Supplier 3 – Supplier 4 – End-Customer. Or more specifically: “Producer – Distributor – Wholesaler – Retailer – End-Customer:” The supply chain partners of Matsentralen Vestfold og Telemark have similar tendencies:

Food waste suppliers – farmer/producer/distributor  
Matsentralen – wholesaler function  
Charities – retailer function  
End-benefactor – end-customer

However, there are some major differences with the food bank network compared to the traditional supply chain. What distinguishes the reverse network from the forward network is where the food bank network corresponds with reverse logistics-, food waste-, and food bank- literature. Firstly, the general food bank work is motivated by ethical reasons, which differs from forward logistics where profit is generally considered the goal (Nair, Rashidi, and Dixit 2017). Secondly, findings show that the food bank contracts are generally less straight forward compared to forward logistics networks, aligning with Tibben-Lembke, Ronald, and Rogers (2002). Supply is never a guarantee, where suppliers holds most of the power regarding the donation of supplies. Therefore, the contracts are based on trust as well as mutual agreement between the food bank and its suppliers. Thirdly, because Matsentralen Vestfold og Telemark has limited power regarding supply quantities, types, or delivery times, the food bank is prone to potential supply -scarcities and sometimes -

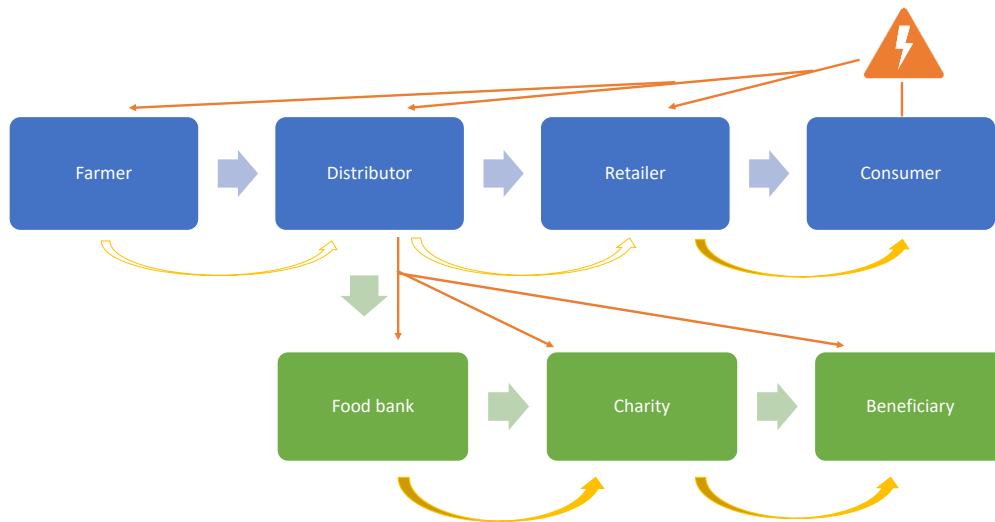
excessiveness and general supply uncertainties. Such uncertainties are typical for reverse logistics networks (Fleischmann et al. 1997), but make forecasting and supply planning very challenging (Tibben-Lembke, Ronald, and Rogers 2002). Lastly, suppliers of Matsentralen Vestfold og Telemark's donate foods due to date markings and production flaws. Such corresponds to Stenmarck et al. (2011) who claims that food waste is a result of supply chain activities as well as the usage of *best-before* and *use-by dates*. It also conforms to Bonev (2012) who explains that reverse logistics apply more cost-efficient solutions as reverse logistics aid higher materials utility. Such clarifies why suppliers might donate excess food as opposed to choosing other methods, like recycling or recovery, where costs are often associated.

Yet, certain findings confirm these pre-existing ideas about reverse logistics are challenged. First of all, though less straightforward, reverse logistics may be better planned than expected through supplier contracts, in difference to Tibben-Lembke, Ronald, and Rogers (2002). The food bank pushes standard contracts with its suppliers, which ensures more supply security. Though, merely one distributor has agreed to fixed delivery dates. Matsentralen Vestfold og Telemark are also notified before any delivery which enables the food bank to plan ahead. And even though not stated in literature, the general on-site operations are also well structured with warehouse-worker schedules and an onsite manager. Second of all, Tibben-Lembke, Ronald, and Rogers (2002) see general inventory management in reverse logistics operations as challenging. Yet, the food bank keeps a careful inventory analysis, such as analyzing overall weight, type, and placing of inventory, as well as electronic registering of overall inventories. Third, Tibben-Lembke, Ronald, and Rogers (2002) also establish transportation to be rather inefficient in reverse logistics, where the vehicle routing can never be pre-planned. Even though supply influxes follow random patterns, the food bank are fortunate in that most suppliers make the deliveries. In addition, the food bank mostly receives donations from local suppliers, where transportation efficiency is not a significant problem. Fourth, literature states that reverse logistics of products in open loop networks implies these products to be generated from an end-customer and then returned to a reprocessing facility and in turn find new customers (Ene, Seval, and Öztürk 2014). However, food donations made to Matsentralen Vestfold og Telemark never reach farther downstream than the distributor node, challenging the theoretical implications in regard to returns in open loop networks.

Also debatable is whether Matsentralen Vestfold og Telemark's supply chain corresponds to centralized- or decentralized decision-making. Centralized networks operate on the basis of a single supply chain member making decisions on behalf of all the members (Duan and Warren Liao 2013). The food bank operates independently from Matsentralen Norge following a centralized approach in deciding what to store, how to store it, and how much of it to redistribute. In turn, such decision-making affects the entire network. On the other hand, Matsentralen Vestfold og Telemark has no power regarding supply influxes. Considering the suppliers hold much of the decision-making power, the food bank can potentially be part of a decentralized network as decision-making in such networks is rather based on individual members' accords (Giannoccaro 2018). Yet, suppliers of Matsentralen Vestfold og Telemark note that they believe the centralization of the food bank, functioning as a single redistribution center and in charge of such redistribution, has improved the overall redistribution efficiency (TINE 2019 og Nortura 2019). Perhaps the most accurate explanation is that Matsentralen Vestfold og Telemark follows a hybrid network strategy, where they have part control of their inventories and how it is redistributed. Yet, lack of power in regard to how much inventory is generated before redistribution.

## **6.2 How might a food bank along with its suppliers, operating in a reverse logistics network, improve supply security?**

Food banks are, in theory, affected by the primary market demand uncertainties and general production errors. Meaning, the forward logistics of the for-profit market affects the alternative markets because the supply in secondary markets is contingent on the supply of primary markets. Thus, the secondary markets must not only worry about the supply uncertainties in their supply chain, but in the for-profit market supply chain as well (figure 6.1). If production discrepancies as due to deviations in demand estimations affects the primary market, then in theory such discrepancies will most likely affect the secondary market additionally. Discrepancies resulting in overstocking generally affects secondary markets in positive ways; whereas, if demand increases to the point of demand > supply, then the secondary markets suffer (figure 6.1). The problem is directly related to Matsentralen Vestfold og Telemark's supply chain as none of the suppliers report to be producing extra inventories in order to carry safety stock for donation purposes.






- Demand noise 
- Demand noise reaching supply chain node 
- Supply movement with potential for scarcity or excess 

Figure 6.1: How we expect customer demand in primary markets to affect supply in secondary markets with explanations

On the other hand, authors have written about the topic in order to provide solutions to the uncertainty problem. Bonev (2012) points out that classifying the uncertainties is helpful in combating the challenges. Such classifications may entail specifying the extent of the uncertainty, such as “low”, “medium”, or “high.” Additionally, it is useful to classify whether it is an internal or external uncertainty (Bonev 2012). Another suggestion pertains to Mohan, Gopalakrishnan, and Mizzi (2013) who suggest that supply chains with high supply uncertainties should look at the decoupling point where customer or downstream demand meets upstream supply or push, for better food redistribution and logistics.

In interviewing the suppliers of Matsentralen Vestfold og Telemark, it is apparent that factors such as the type of food donated, food date-markings and perishability, donation

vs. discount pricing preferences, communication, whether delivery was fixed or random, and supply identification methods affects the degree of supply uncertainty. Where, especially effective communication, contracting, warehouse centralization, and the implementation of effective supply identification strategies help combat such uncertainties. The discussion will therefore pertain to the areas that can help improve supply security.

### **6.2.1 Communication**

The first and most important aspect in improving supply security is effective communication, as opposed to efficient communication. Effective communication helps suppliers understand which supplies the end-beneficiaries most needed. In turn, such understanding helps limit food waste on both sides. Also, such understanding ensures that the food bank will know more precisely that they are receiving foods in which they can appropriately store and redistribute. Effective and ongoing communication is also reported as positive in terms of learning what quantities Matsentralen could handle. For example, Matsentralen Vestfold og Telemark does not handle all bulk-products, whereas those kinds of products should rather be sent to other locations that can handle bulk items (MatBørsen 2019). Efficient communication, on the other hand, is perhaps more beneficial for the supplier than for the food redistribution network as a whole, seeing that the network's needs might be inaccurately understood. Therefore, effective communication is a better method as opposed to efficient communication, when it comes to the overall food bank supply chain in mind.

Communication is also discussed in literature, where Lambert, Riopel, and Abdul-Kader (2011) write that the reverse logistics system to includes four fundamental steps. These steps are entry, collection, sorting, and disposal. In order to successfully implement the reverse logistics steps, the partners and parties involved must effectively communicate.

Furthermore, Nair, Rashidi, and Dixit (2017) state that when supply information is not readily available to an organization or business, decision-makers cannot easily minimize operational costs. Supply uncertainty rather bring about vehicle re-routing, more significant operating costs, and increased food wastage (Nair, Rashidi, and Dixit 2017).

According to Dinu (2014), information sharing in supply chains is highly beneficial in order to properly plan future and current supply needs. Such information sharing should be from upstream partners to downstream partners. The more information being shared, the stronger are the end-results in any supply chain. Especially benefitting from such information sharing are the end-customers whom benefit from well-produced/manufactured products and services. Most critical in a supply chain opting for added competitive advantage is the level of which accurate communication is adopted by supply chain partners. Having partners communicate vertically and horizontally is crucial for efficient information-sharing. Sharing of wrong or inaccurate information usually leads to the bullwhip effect (Dinu 2014).

Huscroft et al. (2013) explain that communication ranked high on the priority list of any firm operating in the reverse logistics environment. In a reverse logistics context, communication implies stakeholders' abilities to share timely and correctly information regarding the supply characteristics and their status (Huscroft et al. 2013). Similarly to Dinu (2014), Huscroft et al. (2013) also confirm that communication among supply chain partners helps alleviate problems and, in turn, rather boosted end-users' needs. Thus, working towards collective unified goals using communicative measures increases the supply chain to meet end-beneficiaries needs (Huscroft et al. 2013).

Nair, Rashidi, and Dixit (2017) suggest an implementation of different forecasting techniques in order to effectively project and manage both storage and further redistribution better and with less overall wastage. Forecasting methods may help food banks understand supply and demand patterns better, which in turn will improve overall efficiency.

However, as Matsentralen Vestfold og Telemark is run as a charity and without forecasting tools and knowledge, forecasting becomes rather difficult. Therefore, the question is if information-sharing and continuous effective communication could work as an alternative to forecasting? Where, effective communication aids suppliers' overall understanding of end-user needs. Suppliers might also improve upon other areas of their operations in order to provide more and better products to the food bank network. In turn, Matsentralen Vestfold og Telemark receives greater understanding regarding what they may or may not expect in terms of future supply. It also allows the food bank to redirect donations because

certain donation types are not appropriate for the food bank's end-users. For example, Matsentralen Vestfold og Telemark communicates they are not able to handle bulk items meant for restaurant large-scale cooking. Therefore, such bulk-supplies are in turn sent to Matsentralen Oslo (MatBørsen 2019). By such, communication increases logistical efficiencies which would have otherwise not existed whilst ensuring the right kind of supplies end up at the food bank's warehouse. On the contrary, mere effective communication does not secure timing or general assurance of supply.

### **6.2.2 Contracting with a fixed delivery schedule**

Formalization through appropriate contracting is a big factor in terms of supply security. For example, Huscroft et al. (2013) noted that reverse logistics can benefit from strengthened formalization. Whereas, communication is a reverse logistics tool that has much potential in being formalized. Thus, providing a set of rules to suppliers and customers can be beneficial. Findings from the supplier interviews show that formalization especially through the means of communication helps the food bank engage in smoother business-to-business relationships. BAMA (2019) states that in formalizing the business-to-business relationship also ensures that both parties engage and keep their words. In addition, BAMA (2019) mentions that formalization of a contract helps both parties run more efficient logistics such that their efforts are spent on main operations rather.

In theory, utilizing a fixed delivery day per week/month contract can help mitigate uncertainty in terms of when supplies arrive. On the other hand, a contract employing a fixed delivery schedule does not help the food bank network in terms of what is supplies in terms of quantities and types. Furthermore, a fixed contract might motivate communication to be kept at a minimum level; thus, remaining more efficient than effective. This is seen as BAMA (2019), the only supplier with a fixed delivery contract, communicates with the food bank as little as possible in order to focus efforts on main operations. Such behavior begs the question; perhaps contracts with fixed deliveries are not the best in the dynamic reverse logistics environments, as more communication allows for better planning and less waste rather? Initially, one expects scheduled deliveries to allow for better planning. However, can random deliveries, granted communication remains effective, result in higher supply security? The answers to these questions, unfortunately, remain unanswered. It is, however, important to understand the dynamics of contracting and how it might affect



communication which in turn affects suppliers' capabilities in understanding end users' needs.

### **6.2.3 Centralized network approach**

According to theory, centralization of a network implies that one unit or node makes network decisions on behalf of all network members (Duan and Warren Liao 2013).

Suppliers of Matsentralen Vestfold og Telemark note two main reasons for why centralization is positive:

1. Centralization increases overall logistical efficiency, which works as a mechanism in ensuring even better communication between the food bank and its suppliers, as it is easier for suppliers to merely communicate with one food redistributor as opposed to deal with multiple charities (TINE 2019 and Nortura (2019).
2. Centralization limits logistical hassle in that logistical efficiency increases when deliveries are made to one location as opposed to multiple. (TINE 2019 and Nortura 2019).

But how does centralization help in terms of supply security? First of all, limiting logistical hassles ensures smoother donation and food redistribution, which in turn acts as an incentive to donate supplies as opposed to utilize alternative outlets. Second of all, merely cooperating with one food bank works as an incentive to communicate and share information more. Such may positively affect supply redistribution because the suppliers gain greater understanding of what and how much to donate.

However, going through an additional node may potentially hurt the survivability of the donated foods. Foods must now be transported not only once but twice and perhaps three times before ending up with the end-beneficiaries. It is known from food waste literature that mishandling of foods, such as moving foods between different temperatures, is a contributor to food waste and quicker perishability (Stenmarck et al. 2011). Besides, if donated foods must go through the food bank's warehouse, it might prolong the redistribution process and potentially enable food to perish before reaching the end-user. In addition, the centralized warehouse approach does not solve problems in regard to when deliveries are made and what type of foods that are donated. Thus, the centralized warehouse approach rather ensures added supply amplitude more than anything.

## **6.2.4 Supply identification tools and strategies**

Supply identification tools and strategies, as mentioned by the interviewed suppliers, may:

1. The identification of foods helps suppliers and the food bank in terms of planning of the redistribution process.
2. Through early identification of which foods that are up for donation, redistributed food might be consumed earlier by end-beneficiaries.
3. Early identification of foods up for donation ensures that fresher foods and foods of higher qualities are redistributed.

However, findings further show that the suppliers' respective supply identification systems vary in terms of their effectiveness. Where some suppliers, such as Nortura (2019), merely depend on date-markings and use no specific identification tool. On the other hand, as Nortura (2019) functions as a producer, the producer generally donates foods due to missing date thresholds and not for reaching the consumer advised expiration dates. Therefore, the expiration dates of the donated products are generally within adequate realms; where, in some cases several weeks. Diversely, BAMA (2019) conforms to identification methods for early identification of farming errors. Such allows BAMA (2019) to donate foods early. Yet, supply identification tools merely ensure supply endurance, quality, and quantities, and not the timing of deliveries which is also a significant problem.

## **6.2.5 Donation vs. discount selling**

When a supplier chooses to donate as opposed to sell at discount prices, such helps improving supply risk for a food bank. According to Persson (2016), food banks must carefully consider the health and perishability of foods. Davis et al. (2014) also point out that a food bank's success lies in the suppliers' abilities to redistribute foods.

Findings confirm that suppliers in which donate food items early, rather than late, are more willing to donate before discount selling. Oppositely, suppliers that prefer discount selling over donation donate foods that are much closer to their expiry dates. For example, even though MatBørsen (2019) and TINE (2019) prefer much communication with the food

bank, these suppliers also donate products that are closer to expiration due to a preference in discount selling over donation. Therefore, there are contradictions and tradeoffs regarding the various methods used when limiting supply uncertainty

Preferring donation over discount selling also suggests more bounteous supply flow, since all products are now donated as opposed to some being sold in alternative markets.

Considering the suppliers of Matsentralen Vestfold og Telemark are expected to maximize profits, it is difficult to ask a company to choose donation methods. The donation preference helps ensuring supplies in terms of quantities and to some degree more diverse foods. Yet, the donation preference does not fix the supply arrival problem.

## **7.0 Conclusions**

The empirical study concludes that the food bank's supply chain is highly similar to the traditional supply chain because the respective functions of each member coincide with traditional network structures. The food suppliers are upstream partners, such as farmers, producers, and wholesalers. Matsentralen Vestfold og Telemark functions as a distributor, redistributing foods to charities which function as retailers.

The study concludes that certain aspects correlate to reverse logistics theories. First of all, the food bank supply chain is mostly organized by a centralized network approach. Which means, Matsentralen Vestfold og Telemark makes decisions on behalf of the network as a whole. However, as the suppliers hold much of the supply power, it is debatable whether the supply chain is centralized or decentralized. Secondly, the analysis demonstrates that the food bank supply chain operates as an open loop network, where donated foods enter an entirely new supply chain. Discoveries further confirm that the general food bank work is motivated by ethical reasons, which differ from forward logistics where profit is generally considered as the goal. Furthermore, data show that supply ambiguity is prominent, such as uncertainty quantities, types, or delivery times. Foods are also generally donated due to date markings and production flaws. Including, suppliers donate to the food bank as due to choosing less costly solutions for elimination of unsaleable foods.

The study confirms that some findings do not conform to reverse logistics. Firstly, reverse logistics can be better planned than expected, through supplier/distributor agreements and contracts. Inventory management is challenging, but through an electronic warehouse system the food bank oversee inventory without too many hassles. Transportation is rather efficient as the food bank is in close proximity to most suppliers, where suppliers also mostly make deliveries. Lastly, donations to the food bank never reach farther downstream than the distributor node, challenging the theoretical implications in regard to returns in open loop networks.

Another finding is that the food bank supply chain is especially impacted by its regional aspects, where Matsentralen Vestfold og Telemark mainly receive and redistribute meat-, dairy-, and frozen products. Luckily, the food bank has extra freezer capacity at an offsite location, in addition to ample onsite storage for frozen, fresh, and dry foods. Further, the food bank has an onsite manager and a team of scheduled volunteer workers, making onsite operations rather efficient. Additionally, the food bank keeps track of all inventories, both current and historic, using an electronic warehouse system. Where, the food bank manages regional challenges by additional storage space and proper inventory management.

Reverse logistics- and food bank literature especially mentions supply security as one of the most crucial aspects of reverse logistics and food bank success. Findings through interviewing and observation confirm that supply uncertainty is a risk-factor in food bank operations. Conclusively, supply risk is in relation to uncertainties regarding when supply arrives, what is supplied, and how much of it is supplied.

The study concludes that effective communication provides greater supplier understanding in terms of the food bank's capacities and supply preferences. Effective communication, however, fails to ensure fixed delivery schedules. However, effective communication does not necessarily ensure proper delivery timing/planning.

The study constitutes that contracting with fixed delivery schedules ensures supply influx and provide more supply reliability, in addition to easing the overall planning of logistics. Yet, a mere contract does not promise certain supply types or quantities. It is further debatable whether a fixed delivery schedule limits the overall communication among

supplier and the food bank, which reduces the supplier's understanding in terms of food bank supply preferences.

Findings affirm that a centralized network approach may potentially offer additional supply quantities, as the suppliers reported the ease of working with merely one organization as opposed to multiple. On the other hand, a centralized network approach does not secure supply in terms of types or timing of influxes.

Research conclude that supply identification tools and strategies ensure that more appropriate supply is donated. This is in regard to supply -types and -quantities. Nonetheless, supply identification tools and strategies does not help the delivery timing problem.

Findings establish that donation preference over discount selling is more preferable because more supply is up for donation and to some degree ensure more supply diversification. In contrast, the donation preference does not arrange fixed delivery schedules.

## **7.1 Real implications**

As food bank networks generally operate with ethical inclinations, the level of trust between network partners matter because negotiations are limited by the absence of financial transactions. Thus, implementing well formulated supplier-receiver contracts can help relieve certain trust issues. In addition, supplier contracts set parameters and boundaries in place, where both parties know more of what to expect.

Findings suggest effective communication, fixed delivery schedules, utilizing a centralized network approach, proper supply identification, and choosing donation over discount selling as the most prominent solutions to the second research problem. However, none of the solutions provide salvation to the supply risk issue as a whole and merely parts. Thus, I suggest implementing a mixture of the different elements, such as effective communication methods, fixed delivery schedules, centralized network approach, and proper supply identification tools, and suppliers' donation preference over discount selling in alternative markets.

Findings additionally state that certain principles commonly found in forward logistics and supply chain management are also applicable in reverse logistics settings, such as effective communication, fixed delivery schedules, and useful inventory systems. In addition, a food bank network operates similarly to a forward logistics network in terms of partners' functions. By which, food banks are distributors and must adhere to typical distributor strategies, especially in terms of proper storage of foods such that they last as long as possible.

On the other hand, as food bank networks are bound by erratic supply and demand changes, the network might need to follow more agile supply chain strategies. For example, the study concludes that food banks should implement effective communication measures as opposed to efficient ones because effective communication may reduce some of the supply risk. Therefore, contracting should not eliminate the need for continuous communication. Whereby, rigorous information sharing between suppliers and food banks can help food banks in adapting to- and handle- the continuous changes in supply and demand.

## **7.2 Limitations of the study**

One limitation regarding the empirical study is in relation to the food waste pyramid. As prevention is found at the top of the hierarchy, meaning prevention is the most regarded option, I am unable to use this perspective. Because, without food waste there is no reverse logistics. As a result, the tradeoff presented an ethical paradox.

There is a limitation regarding the nature of food waste. Food's organic disposition makes it difficult to store and resell such products in the reverse flow. Also, because most of the firms that donates to Matsentralen Vestfold of Telemark are distributors and producers, the food waste never reaches the end-consumer before entering the opposite logistical flow. Such makes the reverse flow of these goods less clear; i.e. whether the supply chain truly corresponds to the open loop network as suggested by theory or not.

### **7.3 Suggestions for further research references**

I recommend studying in closer detail whether a food bank's ability to store and redistribute foods depends on the nature of food products or not; and whether different foods require different delivery methods or not. For example, due to the food bank's freezer capacity, it is able to store food items for longer periods of time as long as foods can be kept at freezing temperature. MatBørsen is one of the suppliers that donates large amounts of frozen items, as a result of the food bank's freezer capacity. MatBørsen encompasses JIT practices because MatBørsen deliver rather frequent than bulking items (MatBørsen 2019). Yet, the food bank is able to keep these products longer. Therefore, the food bank is able to practice more lean methods for redistribution in terms of freezer items. On the other hand, BAMA makes weekly donations of fresh produce. In turn, the produce should be redistributed as quickly as possible, where perhaps JIT practices should be implemented. Therefore, would frequent JIT deliveries be a better practice, in terms of fresh items? The challenge is that Matsentralen Vestfold og Telemark naturally has little control over which items that are donated to their food pantry and when the items are donated. With that in mind, how might a food bank deal with foods', potentially, different needs when it is already strapped for resources and limited in power?

There is also competition within the food redistribution sector. There are both indirect and direct competitors of food banks, such as food retailers and apps selling at discount prices and retailers that are willing to accept foods from distributors and producers at discount prices. According to Nortura (2019), discount selling is a less favorable option because the actual profits made on sales are minimal if anything at all. Where, donating is ethically a better option (Nortura 2019). Whilst, other suppliers TINE (2019) and MatBørsen (2019) claim they have fiduciary responsibilities. With that in mind, how might a food bank compete with alternative outlets? Such would also be noteworthy in researching further, because it says something about a food bank's capabilities in redistributing foods and charities' abilities to donate foods.

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## 9.0 Appendices

### 9.1 Appendix A

#### “Interview template for Matsentralen Vestfold og Telemark”

- 1) Ditt navn:
- 2) Din stilling:
- 3) Din tilhørende organisasjon/firma:
- 4) Fortell om arbeidet deres og hvordan dere «behandler» matsvinn:
- 5) Fortell om logistikk nettverket deres og hvilke typer aktører dette består av:
  - Hvilke typer leverandører samarbeider dere med og hvorfor?
    - *Hvor mange leverandører samarbeider dere med?*
    - *Hvordan påvirker antallet leverandører deres arbeid? (feks med tanke på standardruter eller om det er tilfeldig ruter, kan påvirke effektiviteten)*
    - Bruker dere på matsentralen vestfold ett varehus eller har dere flere?
      - i. tematikk i forhold til decentralized vs. centralized warehouse
      - ii. Fungerer matsentralen Norge/Oslo som hovedkontoret og er dere lokale/regionale varehus?
  - Hvor ofte får dere matsvinnleveringer og/eller hvor ofte kan dere hente mat?
    - er leveringene/hentingene tilfeldige eller har dere en avtale på faste tidspunkt dere kan hente/få levering?
    - Hvordan påvirker dette arbeidet deres?
  - Hvilke typer leveringer får dere?
    - *Hvilken type mat har/får dere mest av?*
    - *Hvilken mat ønsker dere helst å motta? Hva er lettest å oppbevare?*
  - Hvordan blir maten oppbevart?
    - Noen spesielle systemer (FIFO, LIFO, etc)
    - Har dere noen lagrings-kapasitet/restriksjoner?
    - Hvordan planlegger dere for denne eventuelle kapasitetsproblematikken?
      - i. Ekstra antall personer på jobb? Eventuelt personer som kan tre inn fort om nødvendig?
      - ii. Ekstra plass/kapasitet?
  - Hvem (privat person eller firma) er en typisk kunde/sluttbruker av dere?
    - Er disse kundene de samme som kunder av like firmaer/organisasjoner?
    - Hvorfor er de en kunde av dere?
  - Hvordan når dere «kundene deres»?
  - Hvordan blir maten distribuert videre?
    - Hvilke aktører består dette av?
    - Har dere ordninger på hvem som kan hente og når? Og eventuelt kvote på hvor mye de kan hente?
  - Har dere spesifikke kontrakt med leverandørene/kundene deres?
  - Hvilke andre typer aktører/organisasjoner/firmaer samarbeider dere ellers med?

- Hva er de høyeste kostnadene dere står overfor?
    - F.eks.: transport eller arbeid?
- 6) Ranger begrepene herunder etter det du/dere verdsetter høyest:
- a. Deponi av matsvinn
  - b. Forbrenning av matsvinn der energien fra forbrenningen blir til strøm og varmtvann
  - c. Forhindring av matsvinn og overproduksjon
  - d. Resirkulering av matsvinn der matsvinn blir brukt til nye produkter (f.eks. jord, organisk gjødsel, som næring/for til husdyr)
  - e. Direkte gjenbruk av matsvinn (mat som er frisk og ikke gått ut på dato, men som likevel er uønsket)
- 7) Forklaring rangeringen ovenfor:
- 8) Står dere overfor/foran noen spesifikke logistikk utfordringer?
- 9) Hvordan samarbeider dere med matsentralen Norge?

## 9.2 Appendix B

### “Interview template for suppliers”

- 1) Hvilken type avtale har XX med Matsentralen (f.eks. en fast dag i uken eller litt mer tilfeldig ang. levering av varer?)
- 2) Hvorfor ønsker XX en slik avtale med faste/tilfeldige leveringstidspunkt?
  - a. Om en avtale med tilfeldige leveringer benyttes per i dag, hadde det blitt utfordrende for XX s å inngå en avtale med faste leveringer?
  - b. Hvorfor/hvorfor ikke?
- 3) Hvorfor ønsker XX å donere overskuddsmat til Matsentralen, og hvilken verdi gir dette XX?
- 4) Varierer mengde og type varer per levering til Matsentralen, samt. tidspunktene? I så fall, hvorfor det?
- 5) Bruker XX noen systemer eller strategier for å kunne identifisere hvilke matvarer som ikke kan selges videre, og som heller doneres til Matsentralen?
  - a. Når skjer dette i prosessen (f.eks. ved ankomst til lager eller nærmere produktenes utløpsdato)?
- 6) Hvor viktig er det for XX å ha dialog med Matsentralen og hvor ofte eller hvor mye ønsker dere å ha kontakt med Matsentralen?
- 7) Og hvorfor ønsker XX denne typen kontakt/dialog (mye eller lite)?