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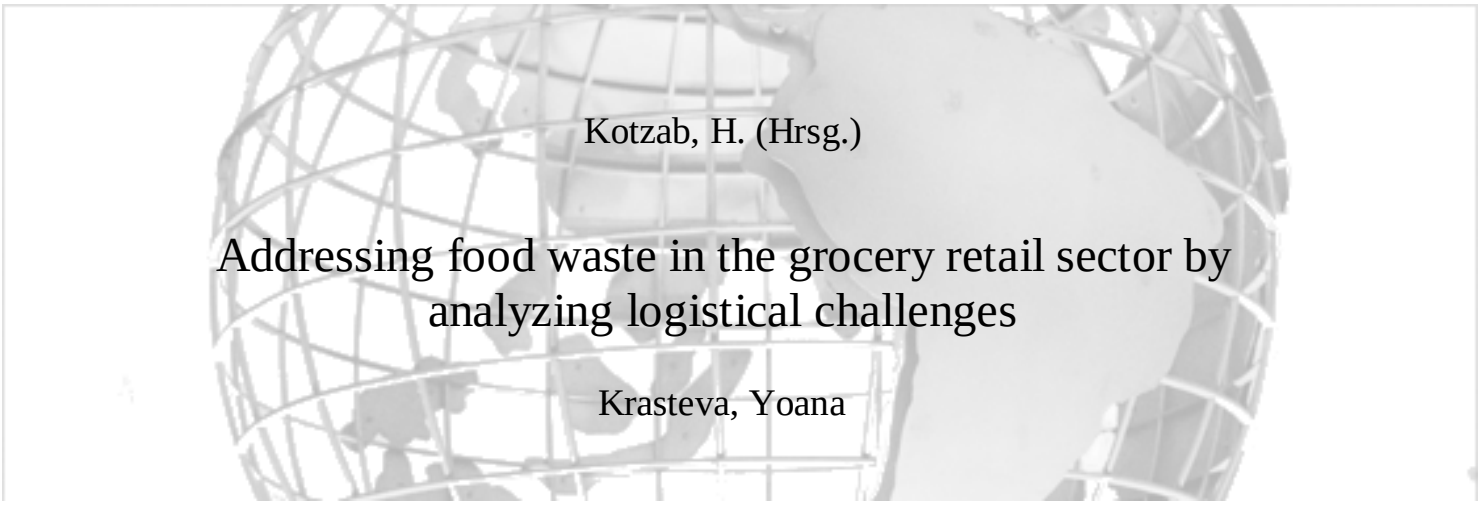

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Addressing food waste in the grocery retail sector by analyzing logistical challenges

Krasteva, Yoana

Table of Contents

List of Figures

List of Abbreviations

ARP	Automatic replenishment program
BWE	Bullwhip effect
FAO	United Nation’s Food and Agricultural Organization
FSC	Food Supply Chain
GPS	Global Positioning System
IoT	Internet of Things
IRPS	(IoT)-based route planning system
kg	Kilogram
NFWI	Nation Federation of Women’s Institutes
RFID	Radio Frequency Identification
SCM	Supply Chain Management
TTI	time-temperature indicator

1 Introduction

1.1 Problem Background

The world's growing population will present challenges to the agricultural sector and the global food supply chain (FSC) in the near future. It is estimated that the global population will reach almost 10 billion by 2050, which will lead to an increase in the demand for food; thus, jeopardizing the availability and access to food (FAO, 2017a, p. X). According to a report by the United Nation's Food and Agricultural Organization (FAO), the rate of advances in the field of agricultural technologies and crop yield will not be able to meet the future demand for food. The ten billion people that will be living on the Earth by 2050 will require 70 to 100 percent more food than the current global food consumption (Godfray et al., 2010, p. 813). One way to answer the growing demand for food will be to grow plants more efficiently and rely more heavily on agricultural technologies. Another way to look at this issue is to identify the stages at which most food waste occurs and attempt to minimize the losses.

Identifying the sources of food loss is not a straightforward process for a number of reasons. To begin with, food is lost during all stages of the FSC – production, packaging, storage, transportation, distribution and consumption (Parfitt et at., 2010, p. 3065). It is arduous to precisely calculate the amount of food waste since the different stakeholders within the FSC cannot or do not keep track of. The inability or reluctance of stakeholders to keep track of food waste can be attributed to a number of reasons. For example, keeping track of food waste will require additional resources that may be currently unavailable or some manufacturers, wholesalers, retailers or distributors might not be aware of the dimensions of this issue. In a nutshell, we currently do not have sufficient information regarding the points at which food waste occurs and its main causes, which challenges further academic research. If there is enough recorded data about how much food is wasted at different stages of the FSC, the academic field can come with various solutions and strategies that aim to diminish this issue.

However, experts calculate that a third of the food produced worldwide is lost throughout the supply chain, amounting to annual losses of more than US $ 1 trillion (HLPE, 2014, p. 11, p. 32). In developing countries 40% of the food losses and waste occur during post-harvest and processing operations, while in industrialized countries, more than 40% of food waste is generated by retailers and consumers (FAO, 2011, n. p.). Lundqvist et al. (2008, p. 4) argue that up to 50 percent of all food is wasted or lost between the manufacturer and the end consumer. For example, more than the half of the food waste in Europe is produced by households, resulting in over 44 million tons of waste, while 5 million tons come from the wholesale and retail sectors (Stenmarck et al., 2016, p. 4). In 2013, Tesco revealed that around 70% of all bagged salads and half of the baked goods are wasted (Press Association, 2013, n. p.). A research, conducted by the US Department of Agriculture shows that Americans

throw away about 150.000 tons of food daily away and, surprisingly, people who eat healthier are more wasteful (Milman, 2018, n. p.). This is because people on healthy diets have high consumption of fruits and vegetables, which are the most thrown away products, followed by meat and dairy products. Consumers generate large quantities of food waste, but so does the retail sector.

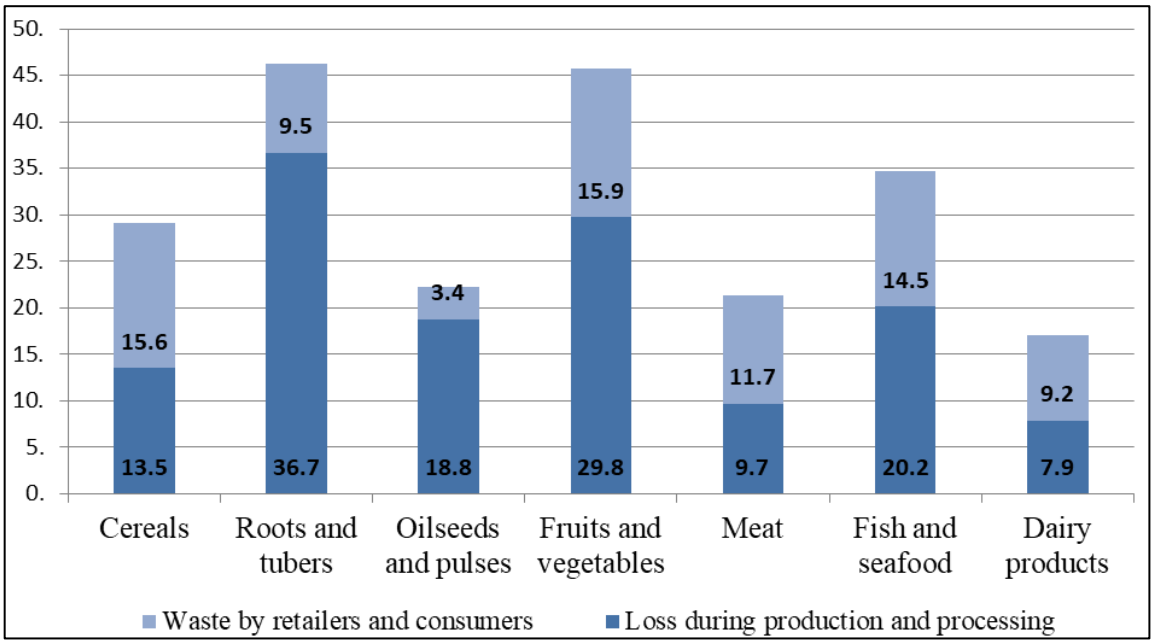

Figure 1: Share of food loss and waste worldwide in 2015, by type (Source: National Geographic; FAO)

Figure 1 describes the food waste caused by retailers and consumers for different food groups and at the same time summarizes food loss for these food groups that occur during production and processing. The data represents the total amount of food waste as percentage of all food produced in 2015. The chart shows that around 45% of all fruits and vegetables end up wasted and 16% of them are discarded by consumers and retail markets (National Geographic, n. d.). Moreover, the figure also depicts that around 12% of meat and 15% of fish and seafood are wasted by retailers and consumers. The retail sector and consumers are responsible for around 15% of all produced cereals, and around 10% for both dairy products and roots and tubers. However, it should be noted that 30% of the vegetables, approx. 37% of roots and tubers and 20% of fish and seafood are discarded during production and processing. In most cases this accounts for the majority of food waste and food loss in each food category. Nevertheless, the focus of this paper is on food waste and loss generated by the retail sector and for that reason data relating to loss during production and processing will not be analyzed further. The graph shows that generally consumers and retailers significantly contribute to worldwide food waste but not as much as food manufacturers do. Consumers and retailers are representatives of the last stages of the FCS and this statistic shows that these participants of the FSC generate serious amount of food waste. To summarize, keeping track of the exact amount of food being

wasted annually worldwide it is a rigorous task; nevertheless, researchers suggest that one third of the produced food is lost or wasted.

A study conducted by the Karlstad University in Sweden found out seven food products that get wasted at in Swedish supermarkets that have the highest climate impact and also monetary costs (Kjørstad, 2018, n. p.). These seven products were bananas, apples, tomatoes, lettuce, sweet peppers, pears and grapes and they were responsible for half of the waste generated at the stores. Lettuce alone adds up to 17 % of the costs of wasted fruits and vegetables.

It is important to realize that food waste in the grocery retail sector is a significant problem because around 50 percent of the food waste occurs in the downstream supply chain which means during distribution and consumption (FAO, 2013, p. 12). Logistical challenges substantially contribute to the amount of food that is lost throughout the supply chain. For example, not choosing the effective replenishment system, the efficient forecasting technique to plan future demand can contribute to food waste in grocery stores. Moreover, insufficient communication between the actors in the FSC can result in an increase/decrease in production as well as order quantity (Taylor, 2006, p. 165). These communication disruptions and inefficiencies are the causes of the so called "bullwhip effect" (BWE). The BWE refers to order fluctuations that are caused by small changes downstream of the supply chain that lead to big changes upstream of the supply chain (Kadivar and Akbarpour, 2018, p. 319). In order for all activities to be run smoothly, all actors throughout the supply chain should be coordinated and well informed about the operations that take place. Despite that, achieving integrated communication throughout all actors in the supply chain is difficult because it requires significant awareness and resources such as monetary costs. The absence of coordinated information could lead to disruptions along the supply chain. For instance, food is often spoiled because of interruptions in the cold FSC that leads to loss of quality or food waste. With this in mind, as the path of food increases, so do the risks for food being lost or wasted by the time it reaches the end consumer. To conclude, an efficient supply chain management (SCM) is required in order to prevent and mitigate food waste and this is directly connected to a number of logistical challenges.

From the presented analysis it is evident that food waste due to logistical and SCM problems is a significant issue that required academic attention for a number of reasons. Considerable amount of energy, natural resources, water, funds and human labor are needed to produce food. If we were able to isolate the carbon footprint of food waste, it is evident that it represents the third biggest emitter of carbon dioxide emissions after China and the United States (Reuters, 2013, n. p.). It is paradoxical that one third of all food is wasted considering the amount of input factors used for its production. Additionally, another issue that is directly associated with food waste is that there were 815 million people suffering from

undernourishment in 2016 (FAO, 2017b, p. 2); carefully planned food distribution could not only mitigate that problem, but also minimize global food waste.

1.2 Research Question

Given that food scarcity is a major global challenge that will persist in the foreseeable future some important questions have to be addressed. First, what exactly are the logistical and SCM problems in order to diminish food waste and food loss at the grocery retail sector? Second, what solutions have been proposed to alleviate these challenges? Diminishing food losses and waste in the grocery retail sector can be conductive to substantially minimizing food waste in general. Supermarkets can be define as "gatekeepers" of the food system (Fox and Vorley, 2004, p. VI). Grocery stores do not by themselves influence all actors within the food industry; however they serve as a medium between consumers and producers. They signal producers as to the preferences of consumers. In the light of this idea, the following research question results:

What are the problems to overcoming food waste from logistical and supply chain management perspective in the grocery retail sector and how can this issue be alleviated?

1.3 Structure of Argumentation

This bachelor thesis will have the following structure (Fig. 2): First, after briefly introducing the problem of food waste, a theoretical background will be presented that will enhance our understanding of food waste, grocery retail, FSC and logistics. The third chapter presents an extensive literature review that identifies different causes of food waste at the grocery retail sector. Fourth, based on the literature review, different categories of causes of food waste at the grocery retail sector will be examined. Section five of this paper presents and analyzes different methods and approaches that could alleviate the issue of food waste in the grocery retail sector. Finally, conclusions and suggestions for further research will be introduced.

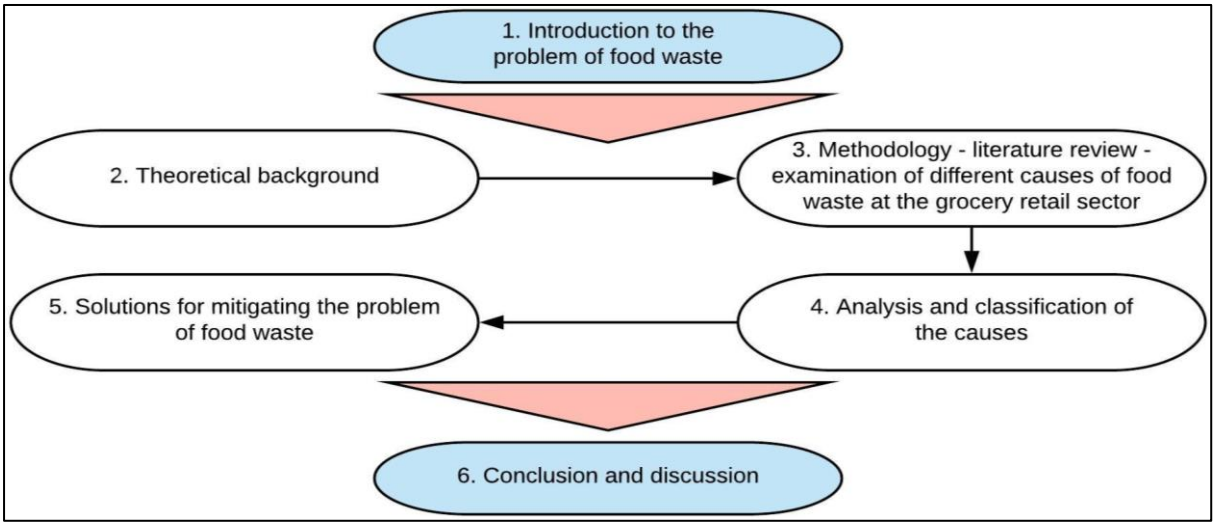

Figure 2: Structure of the thesis (Source: own illustration)

2 Theoretical Background

2.1 Theoretical Framework

This thesis focuses on the topic of food waste and puts this issue into a conceptual framework, by analyzing different causes of food waste at the grocery retail sector. Furthermore, this paper suggests different solutions to alleviate the food waste problem. A hierarchy of food waste will enhance our understanding of the causes of food waste and the possible solutions to alleviate this challenge (Fig.3). The food waste hierarchy depicts actions that prevent food waste and food surplus (Papargyropoulou et al., 2014, p. 108). The first level of the hierarchy is prevention and it is the most desirable one, while disposal is the last stage of the hierarchy and represents the least desirable option. The second most attractive option "re-use" encompasses food that can benefit people in need. Recycling includes food that is no longer good for human consumption, but can be used for animal feed or compost. The fourth stage recovery means that food is used for energy generation, while at the last level it needs to be disposed. This thesis focuses on the prevention of food waste (indicated by the darker blue color in Fig. 3) at the grocery retail sector by not only analyzing the different causes from a logistics and SCM point of view, but also discussing customers' perceptions and preferences as a further cause. The first reason why this stage of the hierarchy is chosen is because it is the most desirable one for minimizing food waste. The second reason is that discussion of the different logistical and FSC management issues will present options for improvement and prevention of food waste.

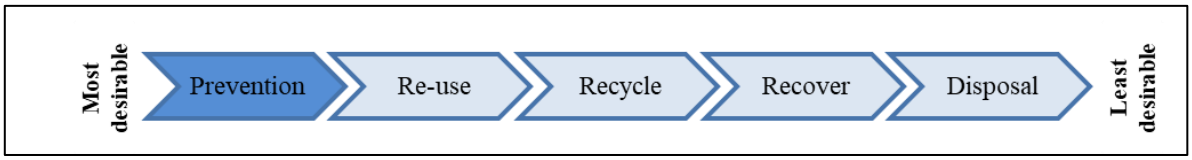

Figure 3: Food waste hierarchy (Source: builds on Papargyropoulou et al. (2014))

2.2 Grocery retail

Retail is the process of exchanging goods and services and can be defined as an institution or as a function (Barth et al., 2015, p. 1). Functional retailing is similar to the term distribution which covers all processes from production to consumption. This means that a market participant buys goods or services from another without the intention to selling them to another market player. From an institutional perspective retailing includes merchandising firms or trading enterprises for which functional retailing is the main activity – selling goods and services (Ausschuss für Definitionen zu Handel und Distribution, 2006, p. 27).

Grocery retail encompasses all enterprises and firms whose main assortment is food products and products that represent daily needs (Overmann, 2008, p. 2). Most of these firms belong to

the institutional retailing, but there are exceptions such as farmers' markets. Depending on the size, scale and range of the offered products there are different types of grocery stores (Xi, n. d., n. p.). Some of them are convenience stores, discounters, deli shops, supermarkets, hypermarkets, etc. The one feature that all these different formats of stores have in common is the logistics activities that take place in the retail store (Kotzab and Teller, 2005, p. 594).

2.3 The notion of logistics and food logistics

Logistics refers to "(...) the process of of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders.", (Christopher, 2011, p. 2). The 7 R's of logistics management are the requirements for successfully organizing supply chain operations and are utilized for identifying the different drivers of food waste in the grocery retail sector (Pfohl, 2018, p. 12). Since the locality of food production and consumption are not the same, there are logistical challenges in order for the right food to be delivered in the right condition, at the right time, at the right place, in the right quantity, to the right people and at the right costs.

Food products, similarly to other goods, undergo a transformation process before they reach the final client (Pfohl, 2018, p. 3). The provision of food products commences with the production process which is when food products undergo qualitative changes. Through consumption food products are also qualitatively changed. The connection between provision and consumption of food products is called distribution, which changes the products spatially through storage and transportation processes. Processes that transform the food products spatially are called logistics processes (Pfohl, 2018, p. 3).

2.4 Food Supply Chain Management

Supply chain management (SCM) is the management of supply chain activities that aim to maximize customer value and attain long-lasting competitive advantage (Bozarth and Handfield, 2016, p. 22). SCM depicts the intentional efforts of a company or a group of firms to design and handle supply chains in the most optimal and efficient way. Bozarth and Handfield (2016, p. 22) use the Supply Chain Reference model, developed by the Supply Chain Council, as a framework that identifies supply chain activities that can be separated in five different categories.

- *Planning activities*, which aim to stabilize demand requirements, inform, and communicate those plans across all actors involved in the supply chain.
- *Sourcing activities*, which involve identifying and contracting suppliers and organizing deliveries of goods and services.

- *Production activities*, which include the actual production of goods or services.
- *Delivery activities*, which cover everything from processing customers' orders and deciding upon delivery times to storing and moving the goods until they reach their destination.
- *Return activities*, which cover returning defective or excess products.

This paper identifies and examines the planning, sourcing and delivery activities that take place at the grocery retail sector. The thesis gives answers to the questions of how and why those activities affect and contribute to food waste at the grocery retail sector. Production and return activities activities will not be discussed by this paper, since the focus of the thesis is on the grocery retail sector.

FSC refers to the processes that food products undergo from production until the final food products reach customers and they can be seen on Fig. 4. The main focus of the thesis is on causes of food waste at the grocery retail sector; however, causes relating to wholesalers and consumers are also included in the analysis of the FSC. The influence of wholesalers on food waste is examined because FSC management differentiates from other supply chains due to handling, rigorous storage practices, and transportation requirements necessary for preserving foods' quality and freshness. Furthermore, consumers' perceptions and preferences are a subject of examination because these factors significantly influence the way in which the FSC operates. It is the combined examination of these factors that gives us a comprehensive picture of the reasons for food waste at the grocery retail sector. Figure 4 illustrates the intertwined nature of these phenomena – this is mostly evident from middle section of the figure which depicts the causes of food waste.

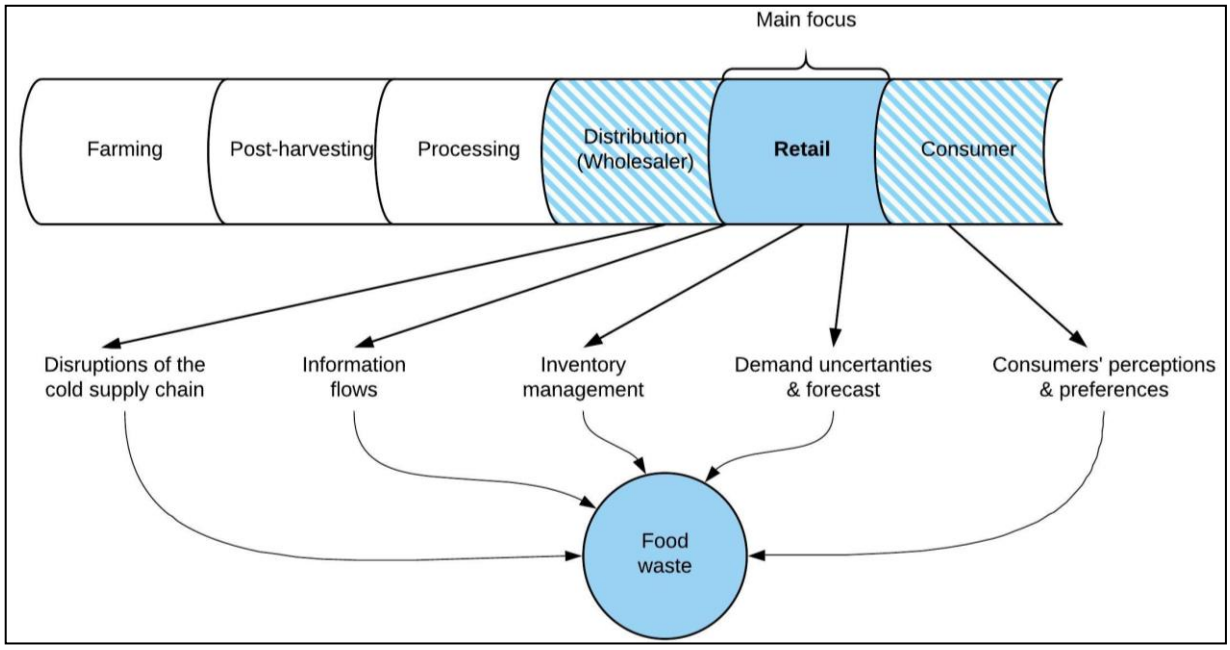

Figure 4: Food Supply Chain (Source: own illustation)

3 Methodology

The initial point of this analysis is an extensive literature review that analyzes papers which discuss the different logistical and SCM causes of food waste at the grocery retail sector. The literature review is based on secondary sources such as textbooks, journal articles and primary sources such as statists. The first step is a keyword search in the following three online data bases: Science Direct, Scopus and the library catalogue of the Staats- und Universitätsbibliothek Bremen (Germany). Four different pairs of keyword were used during the search - "food waste" in combination with "grocery store", "grocery retail" or "logistics causes". To identify specific papers, the search was narrowed down to literature that dates from 2000 until today in order to exclude information that might be outdated and to reflect as current picture of the grocery retail sector as possible. The second step was to look if some of the keywords were contained in the title, abstract or keyword listings. If this was the case, the third step was identifying the relevance of the article. Articles were judged on their relevance by scanning the title and then if needed reading the abstract and finally, skimming the text. Additional literature was gathered by examining the reference list of the relevant papers.

The academic literature differentiates between food loss and food waste. Gustavsson et al. (2013, p. 3) define food loss as the reduction in quality or quantity of food in the early stages of the supply chain before the food reaches consumers. Food waste refers to food material that is still good for human or animal consumption but discarded during the later stages of the supply chain; for example, during storage, packaging or distribution. One can also distinguish between avoidable and unavoidable food waste. Avoidable food waste is food that is thrown away even though it qualifies as still edible by the vast majority of people (WRAP, 2015, p. 19). On the other hand, unavoidable food waste refers to food that cannot be considered as edible under normal circumstances. Cicatiello et al. (2017, p. 273) conducted a study among one Italian grocery retail and found out that 35 % of the food that has been wasted in the researched store was still edible and could be prevented from being wasted. The authors further discuss that the food waste produced by the store for one year was 70.6 tons (valued at nearly 170.000 €), from which only 49 tons were recorded as food waste and the rest 21.4 tons remained unrecorded. This example from Italy depicts two far-reaching issues regarding food waste at grocery stores. The first one is that a large amount of food waste is still good for human consumption and that amounts to a third of food waste generated by the grocery store in this study. The second one is that grocery stores do not have indicators of how much food waste is discarded. Because of that retailers do not know the exact causes of food waste and cannot comprehend the significance of the problem. This can defined as a vicious cycle, in which the lack of information leads to underestimation of the magnitude of food waste thus exacerbating the issue.

The academic literature presents various causes of food waste. Raak et al. (2017, p. 461, p. 470) discuss and identify three main reasons for food waste: consumer perception of quality, loss of quality or spoilage during supply chain operations, and food waste resulting from the production of by-products during food processing. The authors also mention Radio Frequency Identification (RFID) and Global Positioning System (GPS) technologies as possible ways to minimize waste in the FSC and prolong the foods' shelf life. In this regard, Ndraha et al. (2018, p. 13) conducted a review on temperature abuses along the cold supply chain and concluded that negligence of temperature, humidity as well as other requirements at any stage of the supply chain directly contribute to food waste. Yet another reason is pointed out by Gharehgozli et al. (2017, p. 2) who argue that the FSC is changing into a global FSC and because of that the consumption point and the point of food production are no longer identical. This transformation requires the use of various modes of transportation according to the type of food that is transported. For instance, products such as rice and pasta can be transported via cargo ships, but perishable goods such as fresh fish require faster modes of transportation. Gharehgozli et al. (2017, p. 4) give an example that berries need to be transported with planes because they are defined as highly perishable goods. In relation to this, Halweil, (2002, p. 6) estimates that the path of the food from production to the plate increased by 50 percent from 1980 to 2000 in the United Kingdom. Huber et al. (2017, p. 140) say that a precise demand forecast for perishable goods and fresh foods is crucial. The authors of the article point out that an overestimation or underestimation of the demand negatively influences revenues; nevertheless, the idea that inaccurate forecasts lead to food waste remains neglected.

It is paradoxical that such considerable amounts of resources such as energy and water are required for food production and still one third of the final food products are wasted. Furthermore, Filimonau and Gherbin (2017, p. 1184) state that the grocery retail sector is responsible for a significant amount of food waste. They maintain the argument that despite that food waste negatively impacts our society in a number of ways, most prominently environmentally, economically, and socially, insufficient research has been carried out on the issue of food waste in supermarkets. Gharehgozli et al. (2017, p. 4) also highlight that the risks and opportunities of food transportation have been under-researched. Koivupuro et al. (2012, p. 190) describe that further research is needed in the grocery retail sector, since food waste is not only generated by consumers‘ behavior, but also could be connected to the amount of money people spend at the grocery stores. Moreover, Katajajuuri et al. (2014, p. 322) studied food waste in a Finish food chain and concluded that the retail sector is responsible for in between 65 and 75 million kg of food waste per year, while the entire Finnish food sector produces around 335-460 million kg of food per year. The authors further mention that the Finish retail chains are not willing to give away information on the exact amount of food waste. Because of that fact, the authors' research did not include any weighing to establish the precise amount of food waste.

The problem of food waste in the retail sector is not exclusive and limited to a number of countries, such as Finland. A report by the FUSIONS EU Project states that 55 % of the 88 million tones food waste in 2012 were produced by households within the EU and 5 tones resulted from the wholesale and retail sectors (Stenmarck et al., 2016, p. 4). That amount of food waste is estimated to be worth € 143 billion. In 2014 Tesco, one of the largest food retailers in the world admitted that it had caused 57.000 tons of food waste during the last year solely in the UK (Swaffield et al., 2018, p. 43). Swaffield et al. (2018, p. 50) discuss that three years after Tesco revealed that information, grocery retailers continue to engage in the problem of food waste, but there have been no significant results. Teller et al. (2018, p. 981) found out from their root cause analysis that the main causes of food waste in the grocery retail sector are customers' behavior and more precisely fluctuating demand, inefficient store management, in-store operations and replenishment policies. In order for grocery stores to deal efficiently and minimize food waste, they have to comprehend the significance of the problem and then identify and classify the causes of food waste.

It is the combination of various factors that leads to food waste; for instance, not placing the right product or the right amount of it in the distribution channel. Raak et al. (2016, p. 1) conducted 13 interviews with representatives of German food companies (dairy, meet, bakery, fruits and vegetables, confectionary) and concluded that overproduction may be directly connected to consumers' preferences and that products which are still edible, but suboptimal are shunned by customers. Although, having a significant effect on food waste, consumers' preferences cannot be accounted as the sole reason for this phenomenon. The authors also defined processing-related drivers for food waste and classified them in intentional losses, unintentional losses and un-utilized by-products. Some of the process-related drivers Raak et al. (2016, p. 1) establish are human errors, research and development, power blackouts, equipment defects, residues from technical operations, cleaning losses, etc. Mena et al. (2014) studied the main causes of food waste across 15 food networks in the UK and concluded that some of the main causes of waste of meat products in the retail sector are weather changes, forecasting accuracy, promotions, stock rotation policies, quality control (discoloration), and temperature control during storage and supply. Similarly, some of the main causes of waste of fruits and vegetables in the retail sector pointed out by Mena et al. (2014, p. 150) were temperature management during transportation and in stores, product handling in stores (display and back-store) and stock management.

The problem of food waste at the grocery retail sector is not only related to the improper transportation and handling of the products, but also to not meeting demands precisely. A project by the Nordic Council of Ministers found out that a reason for food waste generation at grocery stores is the unstable demand for food products (Stenmarck et.al, 2011, p. 3-5). The unstable demand leads to imperfect forecasting; the resulting gap between the actual sales and the estimated sales create a substantial amount of food waste. Stenmarck et al. (2011, p. 3)

state that the main challenge for grocery stores is to sell food products when they become unsellable because of their suboptimal condition. Products become unsellable because of two reasons. The first one is that retailers tend to order more products in order to deal with demand fluctuations. The second reason is directly correlated to the first one, because these additional products cannot be sold, while they are still in their optimal condition, they stay at the shelves longer, losing their quality and eventually getting wasted. In the light of this idea, Holweg et al. (2015, p. 635) also discuss that food products are influenced negatively by the "problem of unsaleability" because they have short shelf life. Papargyropoulou et al. (2014, p. 108) develop a food waste hierarchy (prevention, prepare to re-use, recycle, recovery, disposal) that aims to minimize food surplus and food waste. The term food surplus refers to food produced beyond human needs that are around 2.000 kcal per person per day (Papargyropoulou et al., 2014, p. 112). The food surplus that is needed to cope with unexpected losses and provide food security should be 30% but the authors of the article estimate that in some high income countries, retailers provide food surplus over 1.000 kcal per person per day, which means that food surplus is around 50%. One of the main tasks of logistics is to provide the right amount of product to the right people. In this case this excessive food surplus and overproduction of food that is way over what a human needs for food, leads to food waste and makes products "unsaleable" at the grocery stores.

Technological advancements can be used as a starting point to mitigate the problem of food waste at grocery stores. Technologies become essential for improvements in the supply chain logistics management. They enable operations such as product traceability, security, and also reduction of food waste (Tanner, 2016, n. p.). In relation to this, Kiil et al. (2018, p. 106) conducted a study analyzing a large Norwegian grocery retailer in which they compared the amount of food waste in the grocery stores when food replenishment orders are placed manually and when they are completed by an automatic replenishment programs (ARP). The results showed that food waste can be reduced by to 20% by implementing ARPs. Moreover, foods' remaining shelf life can be prolonged by up to 5.2% when automated replenishment programs are used in comparison with placing orders manually to wholesalers. Technology can also be used for managing the inventory age of perishable goods (Haijema and Minner, 2018, p. 1). Kummu et al. (2012, p. 477) evaluate that a quarter of the produced food in terms of kcal is lost along the FSC and more than 20% of the total use of water and fertilizers are used during food production. In their study, the authors estimate that half of all food losses can be avoided through improvements in the SCM; thus, if this is achieved, one billion extra people can be provided with food.

After conducting the literature research it can be concluded that the only article that focuses on logistical causes of food waste is the one from Chabada et al. (2014). The authors discuss logistical planning and handling activities among six Norwegian companies as contributors to food waste and classify them in four groups: panning decisions, data utilization, execution of

plan and damaged products. They found out that the two main causes of food waste for wholesalers are “insufficient quality”, associated with the mishandling of products, and “short remaining shelf life” that represents the “planning failures” of food products with fixed shelf life. Identifying logistical causes regarding food waste at grocery stores, is not a topic that is extensively discussed by the academic literature. Nevertheless, there are academic studies that examine the causes of food waste at the grocery retail sector.

4 Causes of food waste at the grocery retail sector

4.1 Introductory part

In order to suggest strategies for addressing food waste globally, we have to first identify, classify and analyze its main causes. It has been estimated that the grocery retail sector is responsible for ten to twenty per cent of food waste (Kiil, et al., 2018, p. 106). The following chapter will examine the main causes of food waste at the grocery retail level that are derived from the examined literature in the literature review. Table 1 in the Appendix represents the 22 resources that were identified as relevant for the topic of food waste in the grocery retail sector. Based on the content of those 22 literature resources the following five main categories of causes of food waste at the grocery retail sector were established. The first four categories depict logistical and SCM flaws that result in food waste, while the fifth category explains the impact of customer's choices on the issue. Analyzing customers' food preferences and perceptions is necessary because these influence how the FSC is organized and indirectly contribute to food waste.

The first main category is "information flow" that includes information disruption and inaccuracies and the bullwhip effect. The second and the third categories are the demand uncertainties and the demand forecast that include safety stock and inventory management. The fourth main group of causes is from the perspective of the cold chain management that is sectioned in temperature abuses, disruptions along the cold chain and storage. The last category that influences the generation of food waste at grocery stores is customers and their preferences and perceptions for food.

This thesis does not focus exclusively on food waste at grocery stores but also analyzes causes of food waste occurring at earlier stages of the FSC, which is before products reach the grocery stores. Such focus is important because disruptions in the cold supply chain result in reduced shelf life and ultimately food waste. Simply put, any slowdown, delay or disruption in the cold supply chain during transportation, handling, and storage negatively affects foods' quality, reduces shelf life and ultimately leads to food waste. Furthermore, this is significant because the effects from such disruptions are cumulative, meaning that the effects of any inconsistencies will accumulate.

4.2 Information Flow

There are four different types of flows within a supply chain. The material flow depicts the movement of products or input factors throughout the supply chain. The next two flows are payment flow and ownership flow. Most importantly, the last flow is the information flow which is crucial for the other three. Without the information flow the processes and activities within the supply chain cannot be efficiently managed or synchronized and inaccuracies will

occur. In this way, the 7 R's of logistics cannot be fulfilled because without the right information on the right time supply chain activities could be disrupted or delayed. Disruption and delays are acceptable only if they add value to the products. Delayed deliveries that result from insufficient information throughout the FSC can have a significant impact on the quality of perishable goods or fresh products. Additionally, delays mean that food products get closer to their expiration date, which is directly connected to food waste.

4.2.1 Information Disruptions and Inaccuracies

The significant importance of information flow could be seen in the grocery retail sector. The most common reason for food waste at the grocery store level is that the expiration date of the products has passed (Hanssen et al., 2012, p. 350). One of the causes of that is overstocking that does not reflect the actual demand for the product. Inaccurate predictions about the demand result in products that stay longer on the shelves at the grocery store and eventually get discounted or wasted. Another cause of food waste at the grocery store level that is interrelated with information flow and expiration day is when food products are delivered at the grocery stores later than planned. In this case, they lose some of their time during which they have their optimal quality and reach the grocery stores at a point of time closer to their expiration day. A possible cause of this may be, when the wholesaler delays the delivery of products to the retailer. This can be prevented if efficient exchange of information is in place between the parties in this particular example. To illustrate this argument, the wholesaler should inform the retailer in advance that there will be a delay with the delivery. In this way, the retailer can cancel the order and the wholesaler can deliver the food products to another store branch, while the food products are still fresh and in optimal condition. This example shows the significance of information flow in the FSC and how it can affect the quality of the food products. That is why the information flow should flow in both ways within the FSC in a coordinated manner that minimized distortions (Hull, 2002, p. 8). To conclude, when information flows in both ways of the FSC, disruptions and implication along the FSC can be avoided.

4.2.2 The Bullwhip Effect

Sufficient and accurate information flow is essential for SCM and managerial neglect of information within the FSC can be a cause of food waste. Mena at al. (2011) conducted a research with identifying the main causes of food waste in the stage between supplier and retailer. The authors of the article point out that the problem of food waste is significant because a great amount of energy for transportation, packaging and resources such as water have already been used for the production of food. Moreover, by the time food products are close to reaching the shelves at the grocery stores and most of the value added services had already taken place because the order has already been processed and the products have been packaged or labeled. Mena at al. (2011, p. 648) conducted more than 40 interviews during

2008-2009 with wholesale and retail managers from the UK and Spain and classified the root causes of food waste. Most importantly, this research stressed out that insufficient communication between the various actors in the FSC can result in food waste. This is clearly demonstrated by the bullwhip effect (BWE), which is characterized by overproduction by producers and overstocking by retailers due to inefficient communication between the actors (Mena at al., 2011, p. 654; Taylor, 2006, p. 163).

The BWE refers to order fluctuations that are caused by small changes downstream the supply chain that lead to big changes upstream the supply chain (Kadivar and Akbarpour, 2018, p. 319). An example for this is when food products are close to their best before or expiry date and the grocery store manager discounts the product. According to the law of demand, when the price of a product decreases, the demand increases and consumers buy more of that good/food product (Mankiw et al., 2012, pp. 80-84). The grocery store manager decides to place a bigger order for that particular product, but does not provide information to the wholesaler that the product in question is on sale. The wholesaler overstocks on that products based on the increasing demand from the grocery store manager. Logically, the producer of the good wants to make sure that he or she will be able to satisfy the increased demand downstream the supply chain and in turn produces more of the food product. This results in overproduction that does not match the real, long-term demand, but rather reflects a momentary increase in the demand stimulated by the reduced price at the retail level. The resulting excess supply contributes to food waste, because the products stay longer on the food shelves or are not bought by the customers, who perceive that the products are in suboptimal state. This example clearly shows how the lack of efficient communication leads to food waste throughout the supply chain; from the retailer downstream, who orders more of that food product to compensate for the temporarily increased demand, to the producer who fears potential missed revenue due to greater demand. The example depicts that when information regarding demand and supply is not shared throughout all actors of the supply chain, a bullwhip effect and distortions occur which lead to food waste.

4.3 Demand Uncertanties

Another reason for food waste resulting at grocery stores is demand uncertainties. Demand uncertainties differentiate from BWE and lack of information flow by the following aspect. BWE and lack of information flow can be influenced positively by a more efficient management of the supply chain operations, while demand uncertainties a difficult to predict and to influence. Taylor and Fearne (2009, p. 381) estimated that uncertainties in the demand can be explained by factors such as changes in the weather condition or seasonality, but mostly those demand uncertainties are the result of promotions at grocery stores. Moreover, customers' preferences for food products can change over time – for example, by demanding new products or bigger packages of the existing food products. These changes represent a

significant challenge and require sustainable information systems along the actors in the FSC, so demand uncertainties could be detected earlier and minimized. Furthermore, if those changes are not accounted for in the demand forecast and it not updated accordingly, this can lead to food waste at the grocery retail sector.

4.4 Demand Forecast

Some of the main causes of food waste should be examined together as they are usually interconnected. As previously discussed in the last section, an effective forecasting technique is crucial for predicting the demand for food products. The foundation for an adequate forecast is information and in order for any supply chain to run efficiently a smoothly operating information system is needed (Hull, 2002, p. 8). In order for the activities within a supply chain to run uncomplicatedly, they should be well synchronized and coordinated so that delays or disruptions can be avoided.

Predicting the future demand for food products has a significant impact on the amount of food waste at grocery stores. "Forecasts are always wrong", but the main function of a forecast is to attempt to predict the future as accurately and precisely as possible (Kotzab, 2017). This means minimizing the forecast error that represents the difference between the forecasted amount and the actual demand. The central task of demand and supply management is as much as possible to precisely forecast customers' demands. Highly perishable goods have a short shelf-life and an incorrect forecast leads to food waste (Mena at al., 2014, p. 151). Retail managers choose the appropriate forecasting technique for the stores they manage based on the availability of the data (Bozarth and Handfield, 2016, p. 270). If quantitative, historic data is available, quantitative forecasting techniques can be used such as moving average, weighted moving average, exponential smoothing, linear regression, etc. (see Bozarth and Handfield, 2016, pp. 270-283). The forecasting technique that results in the smallest forecast error should be determined on a case by case basis after taking into account the specifics of the food products. These specifics include product's seasonality, weather this is a new product on the market or if it represents a new trend on the market, etc. In order to diminish the forecast error there should be sufficient information between the actors in the FSC. A well-integrated information flow throughout the supply chain is crucial for the quality of information and the forecast. In their root cause analysis Mena at al. (2011, pp. 654-655) mention that some retailers would demand monetary compensation to disclose information regarding their business practices; for example, information concerning the point of sale of the products. The base of a good demand forecast is sufficient and high quality information. For these reasons, cooperation and information sharing between the actors along the FSC is essential for minimizing uncertainties and their impact on food waste.

Before evaluating the accuracy of the forecast, the four basic "laws of forecasting" from Bozarth and Handfield (2016, pp. 268-269) should be mentioned. The first law of forecasting

is that no forecasting technique can predict the future demand exactly, since there are too many unpredictable factors that can affect the demand forecast. The second law stipulates that forecasts of the nearer future are more accurate than those of the further future. For example, it is more reasonable to predict the demand for avocadoes in a grocery store in two weeks in advance than in a month, since this is an exotic fruit that is susceptible to temperature shifts and can overripe or lose quality, which causes food waste. The third law states that the forecasts for a group of products are more precise than those that try to predict the demand for each product separately. For this reason, food products that are associated with specific times of the year such as Eastern or Christmas should be forecasted together in order to minimize the forecast error and avoid overstocking. The fourth law explains that forecasts should be used if there are no better approaches to determine future demands. To conclude, food waste at a grocery retail level can result if the forecast is inaccurate, but another reason for this could be, if the grocery retail manager is not familiar with the "laws of forecasting" and as a result misinterprets the forecast.

Food products have different characteristics that influence when and how much of them customers demand. Specific products that are lighter and cooler tend to be frequently consumed during warmer months (Herman, 1993, p. 187). It is understandable that more beer and ice cream are sold during summer months and grocery stores have to answer such seasonal demand fluctuations. It is important to take these specific characteristics into account when forecasting the demand for food products. The demand for products can be linked to the four time series forecasting models (Bozarth and Handfield, 2016, pp. 271-273). A time pattern consists of randomness, seasonality, trend or a constant. Randomness is something that cannot be predicted; a constant is something that is always there, while seasonality and trend are phenomena that change over time. A trend can be defined as a long-term upward or downward movement of the demand. Seasonality is associated with certain drops and peaks of the demand that are linked to specific times of the year – for example, Eastern or Christmas. Mena at al. (2014, p. 152) discuss that promotions are planned in advanced and are linked to events such as Christmas. To forecast this demand a seasonality forecasting method could be used. The authors mention that in order for promotions to be successful a good forecast is needed. If the additional products are not sold, they are either discounted, or end up being wasted.

4.5 Safety stock and inventory management

Food waste is a major challenge at the retailer stage because of the fact that food products overall have a low profit margin and at the same time high operating and handling costs inside the store (Teller et al., 2018, p. 982). Some high-end retailers may be unwilling to sell fresh produce that is of a lower quality for two reasons. First of all, this means lower profit margins and second of all, selling discounted products does not match with the image of a high-end

grocer (Lee and Tongarlak, 2017, p. 945). In order to avoid selling suboptimal products, retailers tend to overstock because they assume that customers buy more from fully stocked displays (Gunders, 2012, p. 10). Unfortunately, by doing so, products are damaged by both staff and customers because of the accumulated weight on the bottom, resulting in food waste.

Having excessive amount of food products on stock and having too little can have a significant impact on how a grocery store operates. If there are too few products ordered, this means lost revenues due to customers that entered the store to buy those specific products, lower service level and the risk of running out of stock (Kiil et al., 2018, pp. 106). But if the grocery retail manager orders too many products, there is a chance for overstocking and increased storage time, reducing products' remaining shelf life, and ultimately food waste. Lee and Tongarlak (2017, p. 944) state that grocery stores produce food waste because retailers stock up inventory in order to handle the problem with demand uncertainties. For that reason, grocery retail managers are faced with the challenging tasks of aligning demand and supply, while taking into account that different perishable products with restricted shelf life require meticulous planning mechanisms that reflect their characteristics. Grocers usually replenish their inventory with new and fresh products before selling out old ones because they want to provide a high service level and satisfy the customers' demand (Ferguson and Koenigsberg, 2009, p. 306). Chabada et al. (2014, pp. 1-2) state that when retailers are having promotions of perishable products, they set stock levels high so they can prevent stock outs and deal with demand unpredictability. This high inventory and safety stock levels[1] of products with fixed shelf life results in food waste. To conclude, over-ordering, wrong inventory rotation, stocking too much inventory are also some of the logistical causes that contribute to food waste at the retail level.

4.6 Cold Chain Management

Cold chain management refers to the undisrupted temperature-controlled transportation and storage system between suppliers upstream of the supply chain and consumers (Ndraha et al., 2018, p. 20). The cold chain must be designed in a way, in which the products preserve their quality and safety. Food safety refers to the proper handling, storing, chilling or heating food, so it does not get contaminated or cause food poisoning (Santacruz, 2016, n. p.). Smith and Sparks (2004, p. 180) define different types of food groups according to their temperature levels: frozen (-18°C or below), cold chilled (0°C to + 1°C) for fresh meat such as pork or poultry, medium chilled for dairy products (+5°C) and exotic chilled for eggs or exotic fruits such as bananas (+10°C to +15°C). When the supply chain is handling products of the same

[1] Safety stock is additional inventory that has the task to deal with unexpected demand.

temperature category, the temperature will be identical across the supply chain in accordance with the transported food group. On the contrary, when handling and transporting different perishable products across the supply chain a number for factors such as temperature, humidity should be taken into account; as a result, it is arduous to consolidate different products in one shipment. A significant challenge is represented by the organization of pallets inside trucks with frozen or chilled products. If the products are temperature sensitive and are placed between two temperatures zones or on the outer wall, this can lead to excessively low or high temperature and diminish products' quality (Chabada et al., 2014, p. 6.). Since different products have different temperature categories, they also have different handling requirements. The following subsection will answer of how and why mismanagement of the cold supply chain results in food waste at grocery stores.

4.6.1 Temperature abuses

There are numerous factors across the cold food chain that affect products' quality. Fresh food is extremely sensitive to external conditions. The period during which food remains edible depends on temperature, humidity and other factors that influence the speed of food spoilage (Hammond et al., 2015, p. 758). Food spoilage is caused mostly by microorganisms such as bacteria and fungi, which spread at a fast rate and make food inedible (Hammond et al., 2015, p. 758). Temperature that is too low causes freezing or damages the food, while on the contrary, temperatures that are too high increase the rate of microbial activity (Badia-Melis et al., 2018, p. 171). A mismanagement of temperature requirements can occur at every stage of the FSC and the grocery retail sector is not an exception. In light of this idea, a study of the temperature of fresh fish, minced meat and different vacuumed or ready-to-eat products in Finish grocery stores found out that 50% of the food products were not in their specific temperature range (Lundén et al., 2014, p. 109). Significant temperature violations in retail freezers were reported in Spain, especially, for products located on the top shelf during summer time (Zubeldia et al., 2016, p. 614). Due to these temperature mismanagements reduction in the shelf life has been estimated to be at 40% for smoked salmon and at 57% for cooked chicken breasts. Across the studies it is noticeable that grocery retailers often do not follow strictly the temperature requirements for perishable products and disregard the positioning of products at stores. Ultimately, this results in losses for some of the most vulnerable groups of food products – poultry and pork meat. The main reason for such practices is that employees at the stores do not have sufficient knowledge or have not undergone trainings how perishable products should be stored and handled, so the food cold chain remains intact.

Exposing perishable products to unexpected temperature changes throughout the cold food chain leads to loss of food quality and endangers the safety of the transported food (Ndraha et al., 2018, p. 13). Ndraha et al. (2018, p. 13) define such exposure to unexpected

temperature changes as temperature abuse. This definition explains the deviation from the optimal temperature for a food product for a certain period of time and takes into account factors such as the ambient temperature as well as additional conditions and activities that the products undergo during handling and transportation. Temperature abuse results in food waste by not following the requirements for properly refrigerating and handling the food products across the FSC, which is crucial for maintaining the food fresh as long as possible. Perishable products that have undergone temperature abuse experience loss in quality; as a result, customers are not willing to buy them and this results in food waste. Even when food products are handled according to their temperature requirements at the grocery stores, it is fundamental that the cold chain had not been disrupted before the products reach the retailer. The long preservation of the freshness and quality of food products is directly correlated to the exposure to the optimal temperature and humidity for the given food group (Taoukis et al., 2016, pp. 285-309). As mentioned in the previous section, the path of food has increased substantially in the last two decades, which in most cases requires different modes of transportation for the food products to reach the shelves at the grocery store. Ndraha et al. (2018, p. 17) discuss that because of the internationalization of FSCs the likelihood food waste rises as the length of the supply chain increases. The longer the FSC is, the higher the chances for a product to be mishandled. Moreover, the quality of products diminishes when different perishable products are transported in the same truck or container without taking into account that they have different temperature requirements.

4.6.2 Broken cold food chain

Before food products reach the grocery store, it must be ensured that they have not been exposed to conditions that can endanger their safety or diminish their quality. Otherwise such food products reach the grocery stores with suboptimal shelf life, which means that they must either be discounted or wasted. During transportation temperature is the most important factor that affects the food shelf life. For this reason, disruptions in the cold chain can result in excessive ripening, weight loss, color and texture changes, softening, bruising or physical degradation (Jedermann et al., 2009, p. 145). If products experience such changes, they cannot meet consumers' expectation at the grocery stores and as a result cannot be sold, but only wasted. The cold chain of food products is often mismanaged, resulting in products that are exposed temperature and conditions above or below their optimal ones, which results in food waste (Mercier et al., 2017, p. 647). The fact that different products are often transported in the same truck or cargo container is among the causes of food waste resulting from disruption of the cold food chain. It is important that perishable products are handled from the producer to the retailer according to their requirements. If there is a temperature abuse upstream the supply chain, products will probably be wasted downstream the supply chain. That is why it is important that the cold chain remains undisrupted from production until the final distribution.

4.6.3 Storage

Adequate storage before products before products reach grocery stores and during transportation is crucial for their quality, since improper storage conditions negatively affect foods' remaining shelf life. Accurately handling and storing food products at grocery stores is essential since the handling costs at stores represent 38% of the operational logistical costs in the retail supply chain (van Zelst et al., 2009, p. 621; Broekmeulen et al., 2004, pp. 5-8). A study of Saghir and Jönson (2001, p. 22) found out that 75% of the handling time takes place at the grocery store. These studies show the significance and importance of how food products are handled and stored at the grocery stores. The personnel that is responsible for unloading the food products from the trucks, storing and placing them in the shelves at the supermarkets needs to have the required skills and knowledge how to execute these operations efficiently and correctly, so food products do not lose quality or their remaining shelf life.

How much of each product will be stored at the grocery store depends on the safe stock amount. But the quality, the nutritional value and the appearance depend on the storage conditions. Some grocery stores have back storage areas, while others do not and that is why sometimes the food shelves itself represent storage areas. Food should be moved as quickly as possible to the storage areas that are defined at the stores for that particular food type. Leaving high perishable products on ambient temperature even for a short period of time can diminish foods' quality drastically. Especially, when there is serious temperature difference between the previous storage area of the products (truck) and the ambient temperature outside; for example, fruits can experience temperature injuries, which cause discoloration, surface pitting, loss of color, etc. Depending on the type of food that is getting delivered, food products should be moved as quickly as possible to the storage areas defined for that particular food type. In this way the chance for food getting contaminated or experiencing temperature abuses can be minimized. For example, dry food must be stored at areas without humidity, because it could cause bacterial growth or cross-contamination. Canned fruits and vegetables, pasta or cereals get wasted because of damaged packaging due to crushing or denting (Scott Kantor et al., 1997, p. 5). If food products are not handled or stored in a careful way, there is a possibility that the food package gets damaged and as a result, the food must be discarded. In 1995 around 237 million kg of processed fruit and vegetables, including juices, were wasted and this represents around 10% of the total retail food loss in 1995 (Scott Kantor et al., 1997, p. 5). Most of those losses took place during handling, storage or inventory control. Another interesting fact is that, 21% of the waste is due to spoilage; fresh food and vegetables are responsible for around half of it (Myers, 2016, n. p.). Potential spoilage of fruits and vegetables can occur during storage due to high temperature or moisture. Additionally, vegetables present another problem because of the large quantities of soil they may bring with themselves. For example, at Wal-Mart produce is sometimes placed on shelved without being washed and in this way the possibility for food getting contaminated

and wasted rises (Doolin, 2016, n. p.). That is why clean fruits and vegetables should be separated from ones that have not been washed, displayed at areas with good air circulation and be expected regularly.

Different storage areas in the stores must also have different temperatures, so the food products can remain optimal as long as possible. A study in Spain showed that products located on the top shelved in the retailer freezer cabinets experienced temperature abuses during summer time and that led to a reduction in the remaining shelf life of smoked salmon by 40%, almost 60% for cooked chicken breast and 25% for fresh cheese (Zubeldia et al., 2016, p. 614). This example shows that not only the different temperature areas are important for keeping the food products fresh, but also external factors such as the time season must be taken into account, since they negatively impact the storage areas and are a reason for food waste at the grocery stores. Food products should be stored in a way preventing mixing of products that negatively impact their shelf life. In case of some fruits and vegetables this can result in overrippening and spoilage.

4.7 Customers' preferences, their influence on retail operations and food waste

Grocery stores are the point of the FSC where demand meets supply. The previous sections and subsections discussed how logistical challenges and supply chain operations lead to food waste at the grocery retail sector. This subsection will discuss the following two topics: the first one is how consumers' food preferences influence logistics and operations along the FSC and how this leads to food waste at the stores. The second one is why customers' perception contributes significantly to food waste at the grocery retail sector.

Today food in the United States travels between 2500 and 4000 kilometers from the field to the consumers' plates which means that the food mile has increased by 25 percent in the last two decades (Halweil 2002, p. 6). The term food mile refers to the distance that food travels from the place where it is produces to the place of consumption (Macmillan Dictionary, n. d., n. p.). In the United Kingdom the path of food has increased by 50% between 1980 and 2000. The reasons behind this phenomena is that people tend to buy less regional products and have preferences for fruits and vegetables that are out of season. For example, nowadays one can find blueberries from Peru or lamb from New Zealand all year long at the local grocery store. Food products travel long distances, flow through a complex series of warehouses, distribution centers and most times this requires the use of various modes of transport. Because of that logistics faces many challenges in order for food products to arrive at grocery stores with enough remaining shelf life and optimal features. In order to preserve foods' features optimal and ensure products' optimal shelf life, store managers have to make sure that information reaches every relevant actor across the FSC. For example, delayed transportation connection leads to quality loss of perishable food. In such case, express communications are vital for products to remain in fresh and optimal condition by the time

they reach the grocery stores. If problems are communicated and discussed quickly, additional transportation can be organized.

Consumers play an important role in how the FSC is designed and managed. Their perception of optimal and edible goods significantly contributes to food waste. For example, in 2015 more than 3 billion kg of fruits and vegetables remained unharvested by grocers in the U.S. because they did not succeed to meet customers' expectation (DeLoatch, 2017, n. p.). Customers do not tend to buy products that are bruised, blemished or misshaped, even if they still taste and smell good, which results in food waste. Moreover, high-end grocery stores do not sell fruits and vegetables that are bruised or blemish because this practice does not correspond to the stores' marketing policy.

Poor understanding of the terms "best before" and "use by" dates is another issue that is directly correlated to food waste. A study conducted by the European Commission concluded that 10% of the 88 million tons of food waste accumulated in Europe is caused by date marking which can be found on products packages under "best before" or "use by" dates. Another problem that is connected to customers' perception and education and that contributes to food waste is the difference between "best before" and "use by" (European Commission, n. d., n. p.). The "best before" date indicates that food remains at its best quality by that date, which does not mean that the food is unsafe to be consumed after that point; the product may not taste as it is expected to, but it is still safe to be used or consumed (Huen, 2017, n. p.). On the other hand, the "use by" date informs that food products must not be eaten after it, because there is a safety risk. A study among more than 4000 consumers indicated that less than half of them correctly understood what the meaning of "best before" date is (NFWI, 2016, p. 4). After this study, one of the largest retailers in the world – Tesco announced that it will remove "best before" labeling from 70 fruit and vegetable products as an attempt to reduce food waste, since those two groups of food products are among the most wasted ones (Morrison, 2018, n. p.).

To wrap it up, consumers' food choices and preferences have evolved over time. Customers demand seasonal food during the whole year, which present some challenges for logistics and supply chain operations. Children raised in the 1970s or in the 1980 ate frozen vegetables during the winter months (McCluskey, 2015, p. 2). Nowadays, consumers do not want to feed their children or themselves with food products that are highly processed or high in sodium (McCluskey, 2015, p. 2). This increasing demand for organic food and products that have as few ingredients as possible influences the FSC. Grocery stores need to provide fresh fruits and vegetables during the whole year because of consumers' preferences, which makes the food mile significantly longer. Additionally, misunderstanding of food labels by customers generates unnecessary food waste.

Figure 5 classifies and summarizes the causes that were identified as contributors to food waste in the grocery retail sector. It also shows the connection between customers' preferences for food and how these influence the ways in which operations within the FSC are designed and managed.

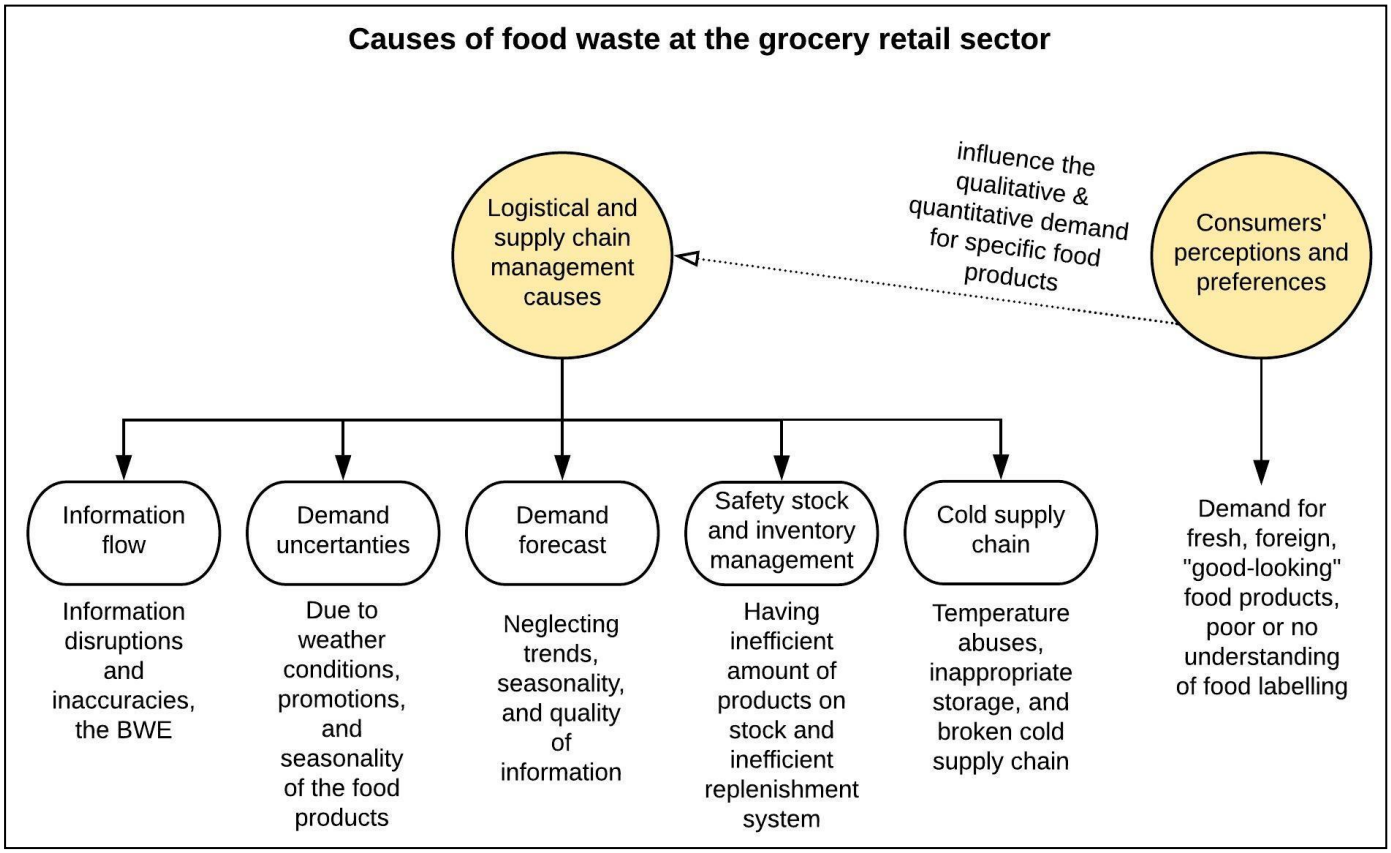

Figure 5: Summary of the causes of food waste at the grocery retail sector (Source: own illustration)

5 Mitigating solutions

5.1 Improving forecast accuracy

From the presented research it has been demonstrated that one of the main reasons for food waste at grocery stores is insufficient and inaccurate demand forecasting. Naturally fruits and vegetables grow in cycles and get ripe during a particular time of the year. Meat products require between 42 days and 36 months, so they can be consumed (Mena et al., 2014, pp. 150-151). Cheese ripens between a couple of weeks and three years, as most types of cheeses usually require two years (Mirafzali et al., 2014, p. 148). Forecasting and planning are crucial factors for keeping supply and demand in equilibrium between and months of production, harvesting and processing, especially, when such activities require months as shown in the examples of cheese and meat production. A possible way to improve forecast accuracy is to implement collaborative schemes such as Efficient Consumer Response (ECR) and Collaborative Planning, Forecasting and Replenishment (Mena et al., 2014, p. 152). ECR stands for "(…) strategic partnerships in the distribution channels of the grocery industry to increase the performance of the customers" (Kotzab, 1999, p. 366). ECR strategies do not only lead to a better consumers' satisfaction, but also efficiency in replenishment, reduction of inventory, promotions and products assortment (Kotzab, 1999, pp. 367-372). A more precise understanding of what customers demand, can confine the BWE and by doing so, diminish unnecessary food waste. The study of Mena et al. (2014, p. 152) found out that those retailers that have implemented such technologies have achieved improvements in forecasting and were also able to share information faster. In this way, waste can be reduced and operations within the grocery stores can be managed more efficiently.

Better collaboration between customers and supplier can also minimize food waste. By understanding customers' demands and preferences as well as by taking into account food products' promotions and seasonality, grocery stores can significantly improve their forecasting models (Walters, 2015, n. p.). In this way the BWE, unnecessary inventory and excess production can be prevented. Improvements in information sharing throughout the FSC can swiftly satisfy demand changes and avoid disruptions. Additionally, the possibility of generating food waste at the grocery store is also reduced.

5.2 Raise awareness among retailers

Another way to minimize food waste at the grocery store level is to first of all, raise awareness of this problem. Grocery stores tend to operate at small profit margins. For example, the average profit margin of a supermarket is around one percent (Huebsch, n. d., n. p.). That is why grocery stores try to cover customers' demands because if they do not this means loss of customers or revenues. For that reason, grocery stores strive to satisfy every customer's demand; otherwise, they risk losing customers and potential revenues. As a result,

they overpurchase; thus, generating food waste, which they neither keep track of nor record. A study by Cicatiello et al. (2017) found out that there is a serious amount of unrecorded food waste and numerous gaps in the food waste recording procedure inside an Italian grocery store. Additionally, in an informal conversation, the head of the warehouse of a leading discounter in Germany shared information that the managers of the company's distribution center did not have accurate information about how much food in discarded at the stores and what are the causes behind it (Anonymous, 2018).

These examples show that grocery stores do not pay much attention to how much food they waste and the reasons for it. If grocery stores keep track of food waste by type and the causes of it, they can use such information for planning and SCM purposes. Furthermore, this will enable managers to place more accurate orders and in this way minimize food waste generated from products that stay at warehouses for long periods of time, which shortens foods' shelf life (Katajajuuri et al., 2014, p. 324). Recording the food waste at grocery stores gives an insight about the problem. The accumulated data can be used to manage logistics systems and forecasts more accurately, and ultimately diminish food waste.

5.3 Implement Automatic Replenishment Program (ARP)

Shelf availability is considered as a key performance indicator at grocery stores (Mena at al., 2014, p. 153). As mentioned earlier, grocery stores maintain high levels of safety stocks because they fear dwindling revenues due to loss of customers. It is interesting to note that grocery stores prefer to overstock and incur losses due to food waste rather than to lose customers. Some of the retailers, who were enrolled in the study of Mena et al. (2014, p. 153), shared that they preferred to waste products rather than have stock outs.

Replenishment decisions are difficult because they involve products that have limited shelf life, which requires expedient transportation throughout the supply chain, in order to ensure a maximum shelf life by the time they reach customers at stores and prevent food waste. An approach that can modify such situations is using automatic replenishment program (ARP). ARP provides an increase in the shared information between the FSC actors in a way that creates transparency, so that replenishment decisions can be synchronized and managed more efficiently (Kiil et al., 2018, p. 107). ARPs can be connected to the Efficient Consumer Response systems or can be added to assist the process of replenishment. ARPs suggest order quantifies for each item in the store. These suggestions are based on information from the stores, such as point of sale, waste data, review periods or batch sizes and can be accepted or declined by the retail manager (Kiil et al., 2018, p. 107). The important point here is that this process generates more transparency for the wholesaler and he or she can use this information to calculate an assessment for future orders.

The study of Kill et al. (2018) concludes that ARP can diminish the problem of food waste at the grocery stores, while increasing remaining shelf life of some food products. The shelf life can be prolonged up to in between 51 and 110 days and food waste can be reduced by 20 percent. To sum it up, ARP prolongs remaining shelf life and stores can reduce their food waste by implementing it.

5.4 Temperature control during transportation and implementing smart sensors

If the supply chain consists of food products that are from the same food group, this means that the supply chain can be set to a temperature that is optimal for this particular food group (Smith and Sparks, 2004, p. 180). However, if there is a vast range of food products that need to be transported together, this represents a challenge because a failure in the temperature management can reduce foods' quality, shorten the remaining shelf life and contribute to food waste. A retailer cannot be sure, that the products have been under the correct or optimal temperature requirements during transportation (Smith and Sparks, 2014, p. 180). A possible way that can solve this issue is to develop a real-time product monitoring system during transportation (Tsang et al., 2018, p. 81). Tsang et al. (2018, p. 84) present a model of an Internet of Things (see Morgan, 2014, n. p) (IoT)-based route planning system (IRPS) that can optimize the route for multi-temperature food distribution using a genetic algorithm and enabling real-time product monitoring. The information about the ambient temperature and humidity during the distribution process can be collected by wireless sensor network. The authors conducted a case study in a third-party logistics service provider in Hong Kong that handles different varieties of foods such as seafood, frozen meat, fruits and vegetables (Tsang et al., 2018, p. 90). The authors share that this particular company has experienced the problem of food freezing and chilling injuries because food products are often exposed to temperatures that are too low. This case study found that when IPRS is implemented, food spoilage during transportation is reduced from 22.6% to 7.9%.

Furthermore, products' quality of different food groups that have different temperature requirements can be maintained during the entire food distribution. Equally important, using IPRS and real-time food monitoring reduces food waste and the chances for food to get spoiled. At the same time, this approach increases operations efficiency by getting more orders delivered on-time. This will also mean that food products can reach the retailer with maximum shelf life and with no quality loss caused by temperature abuses during transportation. Tsang et al. (2018, p. 95) estimate that the investment costs in this case will be HK$ 380 000 (€ 41 340) and will generate annual savings of around HK$ 550 000 (€ 60 000). To conclude, IRPS and real-time food monitoring can solve the problem of temperature abuses during the cold FSC, deliver food products at the grocery store in their optimal condition and on-time and in this way minimize the chance of food waste generation at the stores.

Another way to detect, if there is a loss in food's quality is during the cold chain is by using time-temperature indicators (TTI) (Hsiao and Chang, 2016, p. 1). TTIs are smart labels that record the temperature history of a product along the cold chain. Hsiao and Chang (2016, pp. 6-7) conducted a study in which they used fish fillets stored under fluctuating temperature conditions that may occur during the cold chain. The TTIs indicated fish spoilage, change in the pH and microbial activity by changing the label's color from yellow to red, with the red color representing appropriate spoilage organisms. The range of colors can show, if the fish is very fresh, fresh or spoiled. With this in mind, the probability of food reaching store shelves at its suboptimal condition can be reduced; ultimately reducing food waste at the retail sector.

5.5 Lower temperature at grocery stores and remove "best before" dates

Another way to reduce food waste is to lower the temperature at the grocery stores. Since one of the main causes of food waste at the retail sector is the expiration date, this issue can be alleviated by prolonging the shelf life of the products by reducing the temperature at the stores (Eriksson et al., 2016, p. 73). As cited in Eriksson et al. (2016, p. 74), in Sweden, there is a campaign that aims to "reduce storage temperatures from 8℃ to 4-5℃ in the whole FSC". This campaign by the Stockholm Consumer Cooperative Society found that the stores representatives welcomed this idea, but the study was inconclusive on the costs associated with reducing the temperature and the effect this has on food waste. In their study, through analysis of three years of data, Eriksson et al. (2016, p. 76) found out that meat products that are usually stored at 4℃ can prolong their shelf live by around 30% when stored at 2℃. Furthermore, adjusting the temperature from 8℃ to 4℃ can contribute to a 44% longer shelf life. This study highlights the possibilities for food waste reduction at grocery stores by decreasing the temperature in cheese, dairy, deli and meat departments.

Removing "best before" on some products at stores can have monumental impact on how much food a store wastes. A recent example is Tesco, which is first supermarket to remove "best before" dates from more than 70 fruits and vegetables lines (Blake, 2018, n. p.). Some of the products that are no longer labeled are apples, lemons, and potatoes. The purpose behind Tesco's action is that perfectly edible fruits and vegetables are thrown away because of "best-before" dates. As a lot of people are confused by the term "best-before" and "use-by" (see subsection 4.5), this leads to unnecessary food waste. By removing the "best-before" label it is up to the customers to decide, if the products are good to consume or not.

5.6 Modifying customers' behavior

Last but not least, retailers can start to offer produce that has blemishes and does not look perfect. An example for this would be curvy carrots, bananas that have brown spots or pears that are slightly blemished. These products represent unsalable grocery products that end up wasted (Holweg et al., 2016, p. 635). In 2008, the European Commission removed precise

requirements for the appearance, weight, and size of 26 types of fruits and vegetables (Waterfield, 2008, n. p.). With this action curvy carrots and cucumbers, wonky eggplants or "ugly" produce can be sold at grocery stores. Nevertheless, EU marketing standards still regulate marketing requirements for apples, pears, peaches, nectarines, strawberries, grapes and tomatoes (Waterfield, 2008, n. p.). Furthermore, retailers are not willing to include "ugly" or "imperfect" produce to their assortments, because they are afraid of "negative customer reactions" (Hermsdorf et al., 2017, p. 2532). Customers need to change their perceptions and preferences for food and stop expecting full shelves at the stores. Customers' whims contribute significantly to food waste at stores, as they expect only shiny and well-shaped products. Throwing away food products at grocery stores that are perfectly edible is unethical and waste of resources.

"Nudging" customers at grocery stores

A solution to influencing customers' behavior is offered by the "nudge theory" developed by the Nobel Prize winner and the "father" of behavioral economics Richard Thaler. The nudge theory is a concept that is based on policy that inspires people to make decisions that are good for them and in their interest (Chu, 2017, n. p.). Thaler and Sunstein offer a model of libertarian paternalism on how to influence personal choices regarding investments, consumption, education, and many others in a non-intrusive and implicit manner. Nudge is a theory in behavioral economics which offers indirect suggestions that aims to influence people's behavior and decision-making practices without giving direct instructions or enforcements (Thaler and Sunstein, 2008, pp. 1-14).

There are more than enough areas in which the nudge theory has been proved to be helpful such as organ donations, pension policies in the UK, etc. Another field in which the nudge concept can be applied is at grocery stores with the aim to minimize food waste generated by customers. A possible way to encourage people to start buying food that is not visually appealing, such as curvy carrots, and to reduce food waste is by providing them with important information at stores and implicitly influencing their decisions. Such suggestions may present information about the distance food products have travelled from the producers to the stores and how many resources have been expanded – how many liters of water or units of energy. In this seemingly insignificant fashion, this information will have immense impact on customers' behavior. The nudge theory defines such policies as "choice architecture" that preserves customers' freedom of choice while at the same time nudging them in a direction that will reduce food waste (Thaler and Sunstein, 2008, pp. 83-102). Simply put, effectively presenting information about food production and waste to customers can incentivize a behavioral change and a long-term solution to food waste generated by customers.

Figure 6 represents the interaction between the causes of food waste and how they are addressed by the proposed solutions in in chapter 5. The solutions that are illustrated in the right hand-side are situated directly opposite to the causes they aim to mitigate. The main point of such allocation is to show the causal link between solutions and causes. Since the causes contribute to food waste generation, a plus sign depicts the resulting increase in food waste while the minus signs next to the solutions stand for the expected decrease in food waste at grocery stores. It is important to keep in mind that for a solution to effectively challenge the underlying causes there must be a direct correlation.

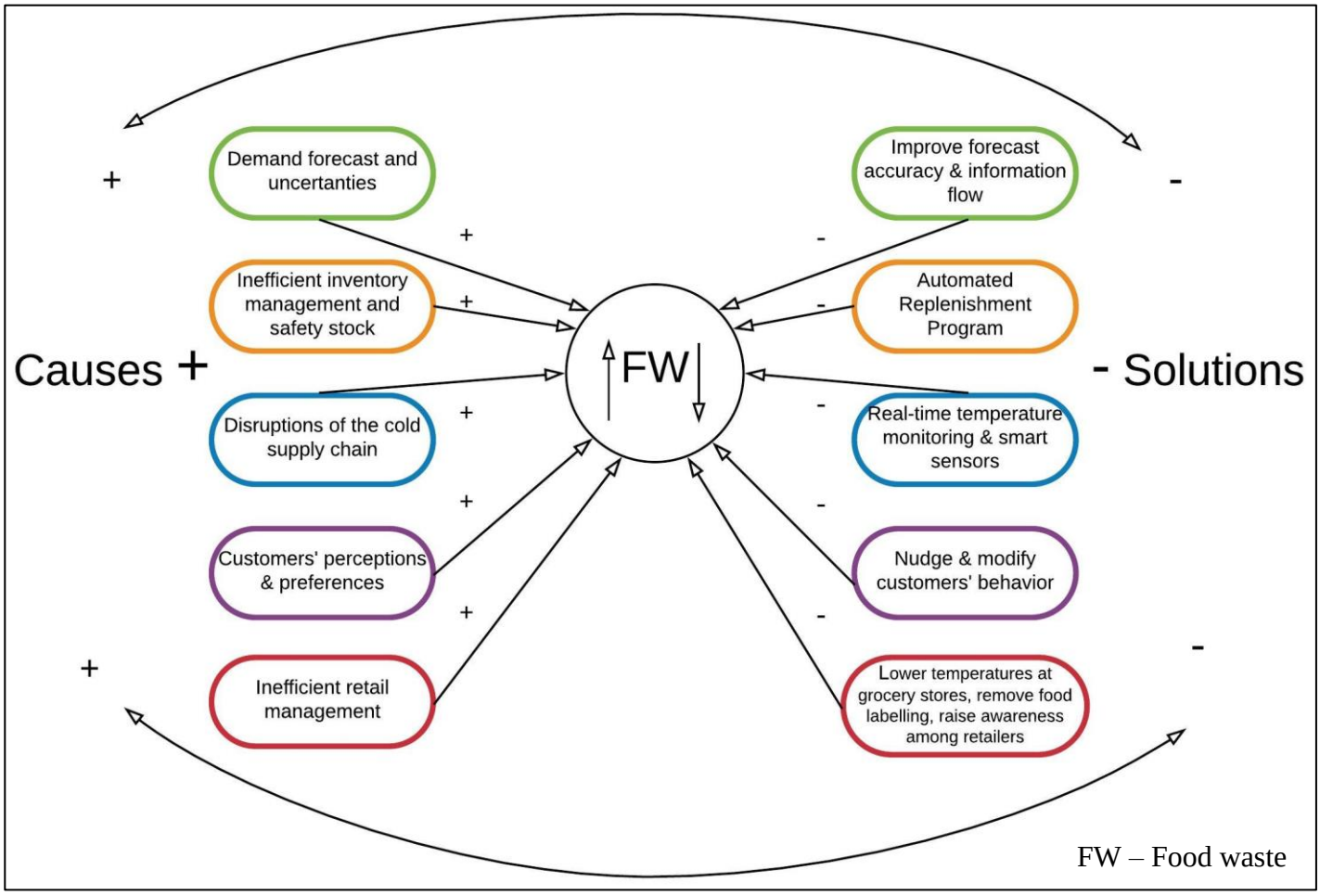

Figure 6: Effects of causes and solutions on food waste (Source: own illustration)

6 Discussion and conclusion

Discussion and suggestions for further research

The findings of this research shows that logistics, SCM issues, and customers themselves significantly contribute to food waste at grocery stores. These findings are important because they show where and how food waste occurs at grocery stores. However, this thesis suggests suitable solutions that alleviate and minimize the issue of food waste at grocery stores. In order to achieve this, logistics tasks and SCM operations must be organized more efficiently. Stores serve as a medium between consumers and producers and can influence all actors along the FSC. Unfortunately, because of the fact that grocery stores operate at small profit margins, managers mainly concentrate on maintaining and improving profits by offering vast varieties of perishable goods at the expense of excessive amounts of food waste – a model that is not sustainable and arguably not profitable.

Academic literature fails to provide enough information about how much food waste is generated, what are the reasons for that and how it is generated. There is also insufficient information about how retailers deal with food waste and the steps they take to mitigate this issue. Another limitation identified by this research is the lack of insights on the possible pitfalls of widely suggested solutions in literature and practice for minimizing food waste at stores.

Subjects that remain to be explored are food packaging and their optimal features in order to minimize food waste at stores and prolong foods' shelf life. The approach of this thesis can be used to examine the causes and solutions of food waste upstream the supply chain and namely from producers to wholesalers. In this way, a possible correlation between the causes can be achieved and additional proposals for improvements can be derived.

Conclusion and answer to the research question

The purpose of this bachelor thesis was to answer a research question of to the topics of food waste and grocery retail sector. The research question was:

What are the problems to overcoming food waste from logistical and supply chain management perspective in the grocery retail sector and how can this issue be alleviated?

In order to answer this question the food waste hierarchy by Papargyropoulou et al. (2014) was presented and used to put the conceptual work of this thesis into a theoretical framework. The tasks of logistics and a definition of SCM were introduced in order to achieve systematic understanding of problems relating to food waste resulting from logistics and SCM challenges. Chapter 3 of this thesis represents a vast literature review, on which basis different causes of food waste at the grocery retail sector were established.

The main focus of this thesis was the grocery retail sector and problems from logistics and SCM perspective that result in food waste at the stores. Distribution and customers' preferences and perceptions were examined in as much as they relate to and influence the operations of grocery stores. If there are disruptions, inefficiencies, mishandling of products, and exposure to suboptimal temperatures directly influences foods' quality and shelf life which contributes to food waste.

This thesis discussed different causes of food waste at the grocery retail sector. The first cause was disruptions and inaccuracies of information flow which causes quality loss, overstocking and delayed deliveries, when actors along the FSC are not coordinated in their operations. Another phenomenon that results from inefficient information flow is the bullwhip effect (BWE), which leads to overproduction and excessive food waste. Inaccurate demand forecasts, demand uncertainties and ignoring foods' specifications such as seasonality generates food waste at the stores because of the differences between the actual demand and the forecast.

Overstocking and keeping excessive safety stocks mitigates the problem of demand uncertainties but at the same time represent a serious problem because food products stay longer at the warehouses, lose their quality and shelf life, and are wasted in some cases. Additionally, disruptions of the cold supply chain illustrate another cause of food waste. When products are exposed to inappropriate or suboptimal temperature conditions and stored and handled incorrectly, they reach grocery shelves in suboptimal condition. This means that food products have lost some of their shelf life by such disruptions of the cold supply chain and this lead to higher chances of food being wasted at grocery stores.

Last but not least customers' preferences is an additional cause that is not related to logistics or SCM activities, but that influences how FSC is organized and operated. Customers often buy less regional products and demand food products that are out of season. Because of that food products travel long distances, flow through a number of warehouses and distribution centers and this requires the use of different modes of transport. This creates a challenge for food products to reach stores in optimal condition. Customers' whims for "beautiful and good-looking" produce generate extreme amounts of food waste. In a nutshell, customers' ignorance about food labeling ("best before" and "use by" dates) is another serious cause of food waste.

Having analyzed the causes of food waste at grocery stores, appropriate solutions are offered. The proposed solutions were connected to the causes as a possible way to alleviate and minimize food waste at stores. Improving the forecast accuracy minimizes fluctuations resulting from inaccurate forecasts in comparison to actual demand; thus, improving the demand forecast and minimizing demand inaccuracies. Using software for replenishment decisions prolongs foods' shelf life, minimizes unnecessary inventory and in this way

diminishes the problem of food waste. Disruptions along the cold supply chain can be prevented or detected by using temperature control systems that enable real-time food monitoring and in this way detect and avoid food spoilage. Moreover, smart sensors that record temperature history can be useful to detect quality loss during the cold chain transportation. These suggestions prevent food spoilage, loss of quality, prolong shelf life, and respectively reduce food waste at the grocery retail sector.

Last but not least, customers and their preferences and perceptions seriously contribute to food waste at the stores. Many customers do not know what the terms “best-before” and “used-by” dates mean and for that reason removing them on some products such as fruits and vegetables drastically reduces food waste at stores. Another action that grocery retailers can undertake is to lower temperatures at grocery stores and in this way achieve longer shelf life and respectively reduce food waste. Additionally, effectively presenting information about foods’ production and waste at grocery store, can nudge customers to buy products that are not good-looking. In this way consumers can further contribute to food waste minimization.

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