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Master's Program in Industrial Engineering and Management

Improving the efficiency of fulfilment operations in omnichannel grocery retailing

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Abstract

The industry of grocery retailing has been changing and the COVID-19 pandemic has given online grocery retailing a significant boost. However, omnichannel grocers have struggled with the profitability of the online channel as workload heavy operations of picking and delivering the orders require massive efforts from the grocer. Still, price-sensitive customers are not willing to pay for the service even though they find the service convenient.

Thus, the thesis focuses on the fulfilment challenges of OC grocery retailers and analyzes possible solutions to improve the efficiency of the supply chain. The study conducts an extensive literature review of different fulfilment and distribution methods used in online groceries and discusses the advantages and challenges of each. Furthermore, six online grocers were interviewed for the study to identify the advantages and challenges of each used fulfilment model. Also, the changes in the supply chain due to the pandemic and quickly increased demand are discussed.

The researched models from the literature review were compared to the used fulfilment models and it was noticed that the scalability of the store-based fulfilment model has proven its advantage of scalability through the uncertain demand during the pandemic. Earlier, the focus on the literature has been on the last-mile transportation efficiency but now, the picking operations have gotten more attention from grocers. The physical limits have begun to restrict the picking capacity in stores and increased demand has led to more challenges in the stores. Thus, multiple grocers were focusing on setting up automated picking solutions to improve picking efficiency. However, based on the study, store-based picking is not considered to be replaced completely and thus advanced solutions for the model are needed.

The study also finds out possible solutions on how OC operations could be improved for more efficient online retailing. These solutions were focused on OOS management, online store possibilities and more efficient picking. Picking in the stores has led to an increased number of OOSs when multiple channels consume the same inventories. Thus, stockouts were stated to be one of the main challenges in OC retailing. The study finds that OOS management should be improved by adjusting ARS for replenishing online orders and providing substitute items to the pickers automatically.

Based on the study, the picking software was considered to be inadequate for efficient picking also. Optimized picking routes and up to date data should be provided to the pickers for decreasing the differences in the performance of different pickers. In addition, online groceries could enable more efficient replenishment by utilizing open online orders and batch balances in fresh items.

However, the study did not analyze the specific benefits of the possible solutions and thus further separate research should be conducted for proving the results. Furthermore, the uncertainty of the demand has been hindering down the investments in online grocery retailing. Thus, further research should be done after the pandemic and the online demand has levelled and the solutions can be adjusted accordingly.

Keywords Omnichannel; Grocery; Online; Fulfilment; Picking; Replenishment

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Tiivistelmä
Päivittäistavaroiden vähittäiskauppa on kehittynyt viime vuosien aikana, ja COVID-19-pandemia on kasvattanut ruoan verkkokaupan myyntiä merkittävästi. Monikanavaisilla päivittäistavarakauppiailla on kuitenkin ollut haasteita kannattavuuden kanssa sillä tilausten keräily ja toimittaminen ovat työläitä, ja vaativat yrityksiltä merkittäviä resursseja. Asiakkaat ovat kuitenkin todella hintakriittisiä eivätkä ole halukkaita maksamaan palvelusta, vaikka kokevat sen käytännölliseksi.

Diplomityössä keskitytään monikanavaisten ruokakauppiaiden täydentämisen haasteisiin ja analysoidaan mahdollisia ratkaisuja toimitusketjun tehokkuuden parantamiseksi. Tutkimuksessa tehdään laaja kirjallisuuskatsaus erilaisista ruoan verkkokaupoissa käytettävistä täyttämis- ja jakelumenetelmistä ja käsitellään kunkin menetelmän etuja ja haasteita. Lisäksi tutkimusta varten haastateltiin kuutta eri ruoan verkkokauppatoimijaa, jotta saataisiin selville hyödyt sekä haasteet käytetyistä toimintamalleista. Myös nopeasti kasvaneesta kysynnästä aiheutuneet muutokset toimitusketjussa käydään läpi.

Kirjallisuuskatsauksessa tutkittuja malleja verrattiin käytettyihin toteutusmalleihin, ja huomattiin, että myymäläpohjaisen toteutusmallin skaalautuvuus on osoittautunut eduksi pandemian luoman epästabiilin kysynnän takia. Aikaisemmin kirjallisuudessa on keskitytty ”viimeisen kilometrin” toimitustehokkuuteen, mutta nyt keräilyoperaatiot ovat vieneet päivittäistavarakauppiaiden huomion. Myymälöiden fyysiset rajat ovat alkaneet rajoittaa keräilykapasiteettia, ja lisääntynyt kysyntä on lisännyt haasteita myymälöissä. Niinpä useat päivittäistavarakauppiaat suunnittelevat ottavansa käyttöön automatisoituja keräilyratkaisuja keräilyn tehokkuuden parantamiseksi. Tutkimuksen perusteella myymäläpohjaista keräilyä ei kuitenkaan koeta korvattavan kokonaan, joten myymäläpohjaista keräilyä varten tarvitaan kehittyneempiä ratkaisuja.

Tutkimuksessa selvitetään myös mahdollisia ratkaisuja siihen, miten monikananaisten ruokakaupan operaatioita voitaisiin parantaa verkkokaupan tehostamiseksi. Ehdotetut ratkaisut keskittyivät saldopuutteiden hallintaan, verkkokaupan tuomiin mahdollisuuksiin ja tehokkaampaan keräilyyn. Keräily myymälöissä on johtanut loppuneiden varastojen määrän kasvuun, kun useat myyntikanavat käyttävät samoja varastoja. Näin ollen saldopuutteiden todettiin olevan yksi monikanavaisen vähittäiskaupan suurimmista haasteista.

Tutkimuksen perusteella myös keräilyohjelmistojen katsottiin olevan riittämättömiä tehokkaan myymäläkeräilyn kannalta. Keräilijöille tulisi näyttää optimoidut keräilyreitit ja ajantasaiset tiedot tuotteiden saldotilanteesta, jotta eri keräilijöiden väliset erot tehokkuudessa vähenisivät. Lisäksi verkkokaupat voisivat mahdollistaa tehokkaamman täydennysprosessin hyödyntämällä avoimia verkkotilauksia ja tuoreiden tuotteiden eräsaldoja.

Tutkimuksessa ei kuitenkaan analysoitu mahdollisten ratkaisujen yksityiskohtaisia hyötyjä, joten tulosten todistamiseksi jatkotutkimukset ovat välttämättömiä. Lisäksi kysynnän epävarmuus on hidastanut investointeja verkkokauppatoimintaan. Näin ollen lisätutkimuksia olisi tehtävä sen pandemian jälkeen, kun verkkokaupan kysyntä on tasoittunut ja ratkaisuja voidaan mukauttaa sen mukaisesti.

Avainsanat Monikanavainen; Täydentäminen; Ruokakauppa; Verkkokauppa; Keräily

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Abbreviations

ARS	Automatic replenishment system
B&M	Brick-and-mortar
CDC	Central distribution center
C&C	Click and collect
KPI	Key performance indicator
OC	Omnichannel
ODC	Online distribution center
OOS	Out of stock
OSA	On-shelf availability
POS	Point of sales
RDC	Regional distribution center
SC	Supply chain
SKU	Stock keeping unit

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1 Introduction

1.1 Background and motivation

In recent years, sales of groceries bought online have been increasing across the world even though the percentage of online grocery shopping is still low. The highest share of the online grocery retail segment has been in China, where 5.9% of the sales come through online channels (Statista, 2020). In Europe, the UK has the highest percentage of online sales of 4.9% but generally European countries have an online share under 1% (Statista, 2020). However, it has been forecasted that the share of online sales will increase fast in the future and the compounded annual growth rate of online sales will be around 10% in Europe and the U.S. and almost 14% in China between 2020 and 2025 (Statista, 2020). The COVID-19 pandemic has speeded up the eCommerce sales, and the online segment of food and personal care has benefitted the most by increasing the sales by over 20% compared to the pre-pandemic forecast (Statista, 2020). Based on Aull et al. (2021), in the US the share of online groceries had a threefold increase compared to the levels before the pandemic.

In the online retailing business, retailers also operate traditional brick-and-mortar stores often. The simpler way of having multiple sales channels is called multichannel retailing. However, in multichannel retailing, the channels operate parallel to each other so that the channels have no interaction. In a more advanced version of having multiple sales channels, the operations of the distribution are integrated, and it is called omnichannel (OC) retailing (Galipoglu et al., 2018). In omnichannel retailing, the customer can buy the product from either of the channels and decide the delivery method which increases the number of touchpoints for the customer and improves the customer experience (Beck & Rygl, 2015).

These OC retailers can be called “bricks and clicks” because of the offering of both brick-and-mortar and an online option where the online sales are able to be picked by the customer by home delivery, from pick-up stations or at the store (Hübner et al., 2019). Also, in omnichannel retailing the operations, warehousing and logistics in the fulfilment process are shared making the omnichannel replenishment unified (Hübner et al., 2016a).

Even though grocery retailing is still dominated by brick-and-mortar stores, online sales have been creating challenges for the grocery retailers as the picking and distribution of the online orders increase the workload significantly and thus affect the costs (Ring & Tigert, 2001). Despite the workload heavy activities needed for OC grocery retailers, the customers are known not to be ready for paying higher prices for home delivery and also expect full availability (Fernie & Sparks, 2009, p. 33; Colla & Lapoule, 2012). Still, there are multiple alternative delivery methods that all need special operations to distribute the orders to customers and thus OC supply chain needs to take these into account in the replenishment decisions. These are for example click & collect (C&C) from a store or a pick-up station and home delivery (Hübner et al., 2019).

In addition to distributing the orders, the OC sales need to be replenished efficiently. Nowadays the replenishment is often handled with automatic replenishment systems (ARS) to match the inventory with the demand more accurately without losing sales increasing the availability in grocery stores (Kiil et al., 2017; van Donselaar et al., 2005; Horzella, 2005, p. 94). In grocery retailing the replenishment process is extremely workload heavy due to the high number of items and perishability and ARS can help the grocery retailers to save costs in the ordering process by automatically generating orders for the items needed (van Donselaar et al., 2005; Horzella, 2005, p. 94). The effectiveness of ARS has been increasing during the recent decades and has become an essential tool especially for perishable groceries in the world where both sustainability and small margins drive the grocery industry (Kiil et al. 2017; Deshmukh et al., 2008).

In the recent literature, the different distribution methods of OC grocery retailing have been studied and the problem of the costly last-mile delivery has been emphasized (Hübner et al., 2019; Colla & Lapoule, 2012). However, online sales in the OC supply chain are traditionally fulfilled with the same methods as the B&M channel. Thus, the fulfilment methods should be investigated as well to understand if the different sales channels should be replenished differently. According to Hübner et al. (2019), the sales patterns for online and brick-and-mortar demand are different and can lead to mismatching inventory levels in a specific time. Furthermore, it was stated that due to the low availability levels in the online store, the number of replacement products in the basket can be high. When one basket can

contain approximately 60 to 80 items on average, the replenishment and forecasting of replacements become increasingly important (Fernie & Sparks, 2009, p. 218).

These distribution methods can be fulfilled in various ways and the logistics network includes distribution centers (DC), cross points for transshipment and the stores (Hübner et al. 2019). Besides, the DCs can be central for all channels in the large region or only focus on either online or B&M fulfilment. These online DCs (ODC) and so-called "dark stores" are only meant for picking online orders and distributing the goods to the pick-up points. (Hübner et al., 2016a).

The number of multiple distribution methods of online sales and the differing sales pattern of online products with replacement makes the research of omnichannel fulfilment methods needed and will help the OC retailers to adjust their ARS to improve the fulfilment process with different fulfilment models. However, as there are multiple distribution methods to operate omnichannel sales, the supply chain operations need to be analyzed more thoroughly. Thus, this study will focus on comparing different fulfilment methods used in grocery retailing and what to consider with each model.

1.2 Research questions

In this study, the aim is to compile a coherent overview of different fulfilment methods and supply chain planning processes in OC grocery retailing. As online grocery retailing is becoming more popular, but still the retailers struggle with profitability, figuring out the optimal processes to adjust the system to fulfil OC sales will be crucial for the future. This objective will be studied with the following research questions:

- ***What are the different omnichannel fulfilment methods in grocery retailing and what are the advantages and challenges?***
- ***How should the forecasting and replenishment systems setup take the fulfilment methods into account?***
- ***How should grocery retailers improve the efficiency of omnichannel operations?***

To analyze the different fulfilment methods, an extensive literature review of fulfilment and delivery methods will be conducted, and the known advantages and challenges of each method are analyzed. In addition, interviews were conducted to find out what are the attitudes towards current solutions and how the grocers see the future of fulfilling online orders as the demand has increased fast.

The second research question focuses more on the use of forecasting and replenishment systems in the OC processes. The data for answering how the systems are used today is gotten from the interviews. The question will discuss the solutions that might not be in use or methods that should be made available in the forecasting and replenishment systems so that the integrated ordering and fulfilling the online orders could be performed more efficiently.

Finally, the pain points in OC grocery retailing are discussed and analyzed to figure out possible solutions for more efficient grocery retailing in the future. OC grocery retailing has created new operations that are workload-heavy and not performed efficiently at the moment. The question will discuss the arisen challenges from the interviews and possible suggested solutions.

1.3 Scope for the thesis

The scope of the thesis will be restricted to grocery retailing because of the specific needs in the replenishment of fresh products and the unique shopping habits of the grocery customers. Thus, the returns are for example out of the scope of the study because those are not normal in grocery retail. Furthermore, the study focuses on OC grocery retailers due to the specific characteristics of having multiple channels. The analysis and results of the study will concentrate on the fulfilment methods of online orders in OC grocery retailing. However, to analyze the needs of the fulfilment methods, the distribution methods will be reviewed to get a better understanding.

1.4 Structure

To get a comprehensive view of the issue, the study starts with a literature review about grocery retailing and the current trends in the industry, the part of the automatic replenishment systems in the fulfilment process and omnichannel fulfilment methods and challenges. Next, the empirical research design and data

collection will be discussed in chapter 3. The results of the study are analyzed in chapter 4 and finally, chapter 5 interprets the conclusions and the limitations of the study.

2 Literature review

In the following chapter, the literature review is conducted. The literature review begins with an introduction to the trends in grocery retailing with a focus on online groceries. The section with online groceries discusses the most significant characteristics of online groceries and the challenges it often creates. Next, omnichannel grocery retailing is focused on examining the advantages and challenges of different fulfilment and distribution methods. Finally, the role of forecasting and replenishment systems is discussed in omnichannel retailing.

2.1 Trends in grocery retailing

The grocery retailing industry has been growing and especially last year has been very successful for grocery retailers due to the COVID-19 pandemic. For example, in the U.S., the average annual spend on groceries has been increasing in recent years steadily (Statista, 2021a). During the pandemic, people have cooked at home more, which has increased sales even more. Most notably, the online sales of food and personal care products have increased significantly compared to 2019 and the post-COVID-19 forecast for 2020 sales of the category increased 21% according to Statista (2020) which is the largest forecasted increase in all eCommerce segments.

The grocery retail industry has been known for its high competition and customer loyalty in addition to the low margins (Angerer, 2006, p. 1). However, over the past decade, large grocery chains have disrupted the industry by driving down the costs even more to offer the cheapest prices for price-sensitive customers (Kuijpers et al., 2018). In addition, the multiple temperature zones that need to be maintained in storing and transporting different grocery products makes the logistics more challenging and the short shelf life increases the importance of effective inventory management (Hübner et al., 2019). Kuijpers et al. (2018) represent in the report that the economic profit of the grocery sector decreased over 50% between 2012 and 2017 due to the fierce price competition.

Therefore, the supply chains of the grocery retailers have been under investigation to improve the efficiency of the supply chain operations (Begley et al., 2020). The efficiency has been improved with new information technology solutions that help the retailers to reduce workload and increase the availability without spoiling the

inventory (Angerer, 2006, p. 184). Recently, the grocery retailing industry has been moving towards online groceries and the COVID-19 pandemic has increased the speed of the rapidly growing market.

In addition to the increasing online sales, digitalization can be seen in the grocery retail operations as IT systems that help planning, usage of RFID technology or automation in warehouses using machines (Prater et al., 2005; Hübner et al. 2019). Grocery retailing has been able to remain without the high level of digitalization until recently because the consumer habits have not developed demanding more online solutions and because of the thin margins, grocers have not been able or willing to invest in more advanced but extremely costly supply chain solutions (Begley et al., 2020). The increasing share of online groceries has enabled the new fulfilment and picking solutions to be developed which can improve the supply chain efficiency in densely populated areas (Begley et al., 2020).

Still, the tough competition makes the grocers innovate new IT solutions. In 2018 Amazon launched the first Amazon Go, which is a self-service convenience store model which has no cashiers, and the products are scanned when they are set to the basket of the customer. The advantage of having no cashiers is that the shopping will get convenient when there are no queues to wait in and the retailer saves in the wages (Ives et al., 2019).

The research by Martín et al. (2019) studied the recent literature in e-grocery retailing and they found that the last-mile logistics was found to be the most significant key driver for competitive online grocery. Furthermore, in the study, the fulfilment of grocery retailing was found to be a great moderator of the customer experience and affects more in online groceries than in other e-commerce areas.

2.1.1 Online groceries

As stated before, online grocery has been the fastest growing eCommerce segment in recent years. In this chapter, we are going to dig more into the characteristics of the advantages and challenges online grocery retailing has. Online groceries have existed a long time already, but due to the obstacles of consumer habits and workload heavy operations, online grocers have not been able to turn the returns positive (Tanskanen et al., 2002).

Due to the challenges and consumer habits, the market size of the traditional grocery retailing industry does not implicate the performance in the online grocery market. For example, even though the UK is only the ninth-largest grocery retail market in the world, the online grocery retailing market is the second-largest in the world due to the significantly higher share of online sales (Institute of Grocery distribution, 2019; Statista, 2020). Conversely, large grocery markets like India, Russia and Brazil do not fit in the top ten largest online grocery markets (Institute of Grocery distribution, 2019; Mkansi et al., 2018). Similar effects can be seen in the leading online grocers as in the U.S. Amazon was clearly the most popular online grocery retailer even though Walmart has been the larger grocery retailer (Statista, 2021a; 2021b).

The share of the online sales is very regional, and China is leading the online groceries with a share of 5.9% of total grocery sales in 2019 (Statista, 2020). In Europe, the general level is around 1% but, in the UK, the share of online groceries was 4.9% which is significantly higher than elsewhere in Europe (Statista, 2020). The reason for the higher share of online groceries is the early competition that happened in the online grocery business and grocers rushed in investing in online capabilities (Herring et al., 2017).

Despite the share of online sales is still low, it is projected to increase fast with almost 14% compounded annual growth rate in China and a 10% compounded annual growth rate in Europe and U.S. until 2025 (Statista, 2020). As the share of online sales increases, the retailers face new challenges of low margins, workload heavy operations, perishable products and securing availability that decrease the profitability even further. Furthermore, the customers are very price-sensitive in grocery retailing and are not willing to pay higher prices from the delivery even though it has been experienced convenient (Fernie & Sparks, 2009, p. 33).

Because grocery retailing is not similar to other retailing industries, the share of online sales has been lower compared to other retailing categories. For example, the average number of items in the basket can be over 60 for a grocery retailer, which increases the importance of the availability of the products (Fernie & Sparks, 2009, p. 218). However, because of the perishable goods, the grocers cannot increase the inventory level significantly to improve the availability because the excess inventory would spoil. Reducing the spoiling of goods will help the grocers to improve the

efficiency of the supply chain and reduce costs. The spoilage can be reduced with more accurate replenishment using ARS (Kiil et al. 2017). In addition, reducing spoilage improves the sustainability of the grocers giving them a competitive advantage in the industry by improving the brand (Günday et al., 2020).

The effect of COVID-19 on online groceries

Due to the COVID-19 pandemic, the total grocery retailing industry has increased because people are cooking more meals at home when they have more time and restaurants have been closed (Günday et al., 2020). More notably, online grocery shopping has become more popular than it has been because it decreases the possibility of exposure to the virus in public places and gives people better access to the assortment even with a high level of movement restrictions (Günday et al., 2020). While all the online retailing segments have gotten a boost by the COVID-19 pandemic, the category of food and personal care products was expected to have a 21% increase in the forecasted revenue compared to the pre-COVID-19 forecast (Statista, 2020). Furthermore, this led to the estimated growth of revenue by 53% in 2020 compared to 2019 in the food and beverages segment (Statista 2021c). However, Aull et al. (2021) report that in the US, the share of online grocery sales had a threefold increase during the pandemic and similar results were noticed in France and the UK.

The effects of a virus on online groceries have been studied earlier too. For example, Foster and Tang (2005) studied the online shopping behaviour in Hong Kong during the SARS epidemic in 2003. They found that the demand for online groceries was closely related to the number of infections during the period. Because online grocery shopping was not developed to be a habit, the increased demand for online groceries flattened after the crisis. However, the level of online sales remained higher than before SARS and grocers were forced to scale up the infrastructure and thus be able to provide better services after the crisis (Foster & Tang, 2005).

According to Grashuis et al. (2020), the increasing fear of the virus has made people more flexible with the delivery time windows and delivery fees of online groceries, but still have a strong preference towards low delivery fees and short time windows for the delivery. Therefore, after the pandemic is over, online grocery retailers need to find ways to provide shorter delivery times and decrease the costs of online orders

to lower the fees to remain competitive. Based on a survey, Günday et al. (2020) state that consumers are willing to increase their online grocery shopping by 5% in the UK after the pandemic. In other European countries the net intent was to decrease online grocery shopping, but only by -1% in France, -10% in Germany, and -14% in Italy, for example. Thus, the level of online grocery sales would remain higher than it was before the pandemic (Günday et al., 2020). During the pandemic, 15% of the respondents had bought groceries from an online retailer that they had not used earlier and over 50% of those stated to continue shopping from the new retailer (Günday et al., 2020). Therefore, providing attractive online grocery options for customers is extremely important at the moment to capture the mass that is moving towards online groceries.

Convenience of online shopping

Traditional grocery shopping has been recognized to be inconvenient as it is time consuming, stressful, and considered to be a chore (Aylott & Mitchell, 1998; Roberts et al., 2003). Aylott and Mitchell (1998) recognized that the stress of shopping resulted from the time-consuming activities of shopping and crowded grocery stores where other shoppers make congestions in the aisles and form long queues at the cashiers. Switching to online groceries would decrease the stress created by grocery shopping by eliminating the slow picking by the customer, queueing and other shoppers crowding the activity. Still, online grocery shopping has not been adopted well in the modern world. Roberts et al. (2003) suggested that these inconveniences of grocery shopping should be used to show the advantage of online groceries.

However, online grocery shopping has its own downsides which have made people continue traditional shopping. The price of the delivery service of online groceries or paying for the picking has been experienced to be a threshold and price competition drives the grocery industry more and more (Fernie & Sparks, 2009, p. 33; Kuijpers et al., 2018). According to Chintagunta et al. (2012) consumers were not willing to pay for the delivery service even though the benefits of online grocery shopping were measured to be larger than the cost of the delivery. Also, long lead times or delivery windows have been noticed to decrease the attractiveness of the online grocery service. To reduce the delivery costs and solve the delivery window problems, grocers are offering multiple channels to receive the orders (Hübner et al., 2019). For example, a C&C service from the store reduces the delivery cost for

the customer and still makes grocery shopping more convenient compared to a B&M store.

Due to the low margins and costly operations that the online grocery needs, the grocers are not able to drive down the price of the service significantly to remain profitable. Still, because the grocers compete in getting the customers, grocers might need to provide online services to maintain the customer base even though it would decrease the profitability temporarily (Mortimer et al., 2016). According to a study, 80% of the grocery shoppers stated to be more likely to buy online from retailers that offer more convenient and flexible delivery options compared to the competitor (Sharma, 2019).

Furthermore, in the fresh products, for example, vegetables, the threshold of buying them online is larger than in products with a longer life cycle (Kang et al., 2016). In the study, Kang et al. (2016) stated that the reason for the barrier of online shopping of fresh products was that people did not trust the quality of the products bought from the online store and wanted to select the products themselves to ensure the quality. However, Mortimer et al. (2016) have discovered that people that have used online grocery shopping services more frequently, do not perceive as much risk and have more trust in the grocers than the less frequent shoppers. Also, the trust gained by good experiences of the quality of the service and products led to a larger probability of repurchase from the online retailer (Mortimer et al., 2016).

To increase the share of online grocery shoppers, customers need to be assured of the convenience and quality of the service. Furthermore, the quality and freshness of the products have been noticed to be the most important concern about online groceries (McGrath, 2019). According to a survey, when different online grocers are compared together, the price plays the role of the most affecting factor (McGrath, 2019).

Thus, online grocers need to provide a guarantee of the quality of fresh products while being competitive with the pricing. The quality of the service also relates that the accuracy of the delivered orders is excellent and there are no missing products from the orders due to a stockout or a mistake. In a stockout situation, the product needs to be substituted with a suitable product to maintain the quality of the service (Harris et al., 2017). The customer service from the beginning of the order to the

receiving of the products is all considered in the customer experience. According to Singh, and Söderlund (2020), customer service was a significant factor in the customer experience and especially bad service caused distress and made customers think to find a better retailer.

Online grocers have been able to ease the shopping experience by offering features that traditional grocers cannot provide. For example, shopping in an online store can be made faster by providing personalized shopping lists that can be saved for future shopping (Melis et al. 2016). In the UK, Amazon Fresh has offered same-day deliveries to improve their attractiveness and Ocado has focused on ensuring quality and reliability (Harris et al., 2017).

Costly operations

As the price has been a significant factor in online groceries, driving the cost down in the supply chain operations will enable more affordable solutions for the consumers (Mkansi et al., 2018). The costs have been noticed to increase due to the deliveries and picking of the orders. Aspray et al. (2013) found that in grocery retailing the last-mile delivery of online orders creates the largest challenges due to the complex fulfilment and delivery needed. In picking, the products for the store and customer orders are collected. Especially manual picking of the orders can cause around 25% of the cost of the supply chain (Hübner et al., 2019). If the picking of the orders is done in the store, the travel distance of the pickers increases significantly compared to warehouse picking and thus increases the workload of the task. However, manual picking at stores is the easiest way to start online retailing for a traditional grocery retailer and needs the smallest investment (Hübner et al., 2019). If the share of the online orders increases significantly, the in-store picking cannot be scaled up to be efficient and crowds the aisles of the store which decreases the customer satisfaction of brick-and-mortar shoppers.

As the share of online orders increases, retailers can scale up the supply chain operations to reduce the costs of online sales by automating the fulfilment of the orders (Begley et al., 2020). Nevertheless, the higher the level of automation is, it requires larger initial investments and thus needs a higher level of online sales to be profitable. In-store picking has also a disadvantage of more complicated inventory

management and higher safety stocks at the stores which should be taken into account when the picking process is planned (Hübner et al., 2019).

In addition to the picking costs, the delivery costs form a great share of the online grocery retailing and the home delivery with short time slots is the most expensive option (Tanskanen et al., 2002). Because of the high costs, it is also the most expensive option for the customers. Still, because it reduces the time customers use for shopping significantly, it has been noticed to provide customer satisfaction and is the most popular delivery method for example in UK and Netherlands (Morganosky & Cude, 2000). According to de Polignac et al. (2015), the delivery fees that the customers pay are significantly lower than the actual delivery costs which make the home delivery models not so attractive for the grocery retailers. However, the variety of delivery methods has been noticed to increase the attractiveness of the online grocers and thus give a competitive advantage (Chintagunta, Chu & Cebollada, 2012; de Polignac et al. 2015).

The high delivery costs of online groceries are based mainly on the delivery time, delivery window, distance, and density of the population in the area (Punakivi & Saranen, 2001; Hübner et al. 2019). The delivery time affects the price by forcing the delivery to happen during the rush hour or at the same time with other deliveries when extra capacity should be added. Hays et al. (2005) studied that rush hour delivery can increase the delivery costs to be 2.5 times higher compared to times with less traffic. The delivery windows similarly affect the transportation costs significantly as narrow delivery slots make route optimization harder and complicate the operations. Punakivi and Saranen (2001) found that attended home deliveries with a short delivery window of one hour had over double the delivery costs compared to unattended home deliveries with longer delivery windows (6 hours) that could be delivered during the daytime. It was discovered that only increasing the delivery window to two hours reduced the delivery costs by over a third (Punakivi & Saranen, 2001).

Also, Kämäräinen et al. (2001a) found that the time used per delivery and the need for delivery vehicles increase with attended home deliveries and the shorter delivery slots leading to more expensive deliveries. However, for unattended home delivery reception boxes with suitable temperatures are needed and the solution requires large investments at the beginning of providing the service. Nevertheless, if the

culture of remote work due to COVID-19 is here to stay, people are staying more at home during days and are able to receive daytime deliveries with longer delivery windows and the reception boxes are not needed and the delivery windows can be longer.

Even though the long lead times can decrease customer satisfaction, the fastness of the delivery increases the costs significantly through more inefficient picking and delivery operations. To increase the attractiveness, grocery retailers need to be able to provide faster deliveries with optimized fulfilment and delivery methods without increasing the picking and delivery costs. This challenge will be discussed more later.

Availability

Finally, the availability of products creates challenges but also opportunities in online grocery retailing. Angerer et al. (2006) stated that out-of-stocks (OOS) has been the most customer satisfaction decreasing issue in grocery retailing. In online grocery, the retailer is able to provide a larger assortment for the customer as the shelf space of the convenience store is not limiting the assortment range and the picking can be done in the central warehouse (Hübner et al. 2019).

However, online retailers might exclude some of the products from the online assortment to reduce the problems that the temperature differences might create (Hübner et al., 2019). Also, if the picking is done in a store, the inventory management gets a lot more complicated as offline shoppers might buy the product before it gets picked. If an OOS occur during the picking, the product in the order should be substituted by the grocers with a product of similar or better quality to keep the customer satisfied (Colla & Lapoule, 2012). Because of the perishability of many products, the inventories cannot be increased to guarantee availability without increasing the spoilage of the inventory. Furthermore, because of the needed quality of the perishable products, the grocers cannot deliver products that are near spoiling to the online customers to maintain customer satisfaction and reduce the complaints (Mkansi et al., 2018).

The availability information is thus extremely important for grocers to have up to date and the online channel should be able to inform the customer if some product is not available at the time of the purchase (Colla & Lapoule, 2012). Thus, the customer will be able to select a substitute product from suggested substitutes to the

basket. As the basket size is large in grocery shopping, it is probable that all the products are not available at the time of the purchase and thus substitution management in online shopping will play a significant role in customer satisfaction.

Also, because the grocers need to minimize the number of OOSs in online sales, Mkansi et al. (2018) suggested that online sales could be fulfilled with different replenishment cycles to improve the availability of the products when the picking is done in the stores. As online sales follow a different pattern than brick-and-mortar sales, different replenishment cycles might help the grocers to reduce the OOSs if the online sales will be replenished and forecasted separately (Hübner et al., 2019).

The risk for OOSs can increase the inventory and planning costs but needs to be done to remain competitive in the online grocery field. De Polignac et al. (2015) state that even a small decrease in sales can affect profitability significantly due to the high fixed costs in grocery retailing. Based on the study, a 5% decrease in sales can lead to a 20% loss in earnings before interests and taxes. If consumers constantly get disappointed with the service due to the OOSs at the online store, they easily switch shopping to a competitor (Colla & Lapoule, 2012). Therefore, efficient inventory management and suitable fulfilment methods need to be investigated more thoroughly when online grocery retailing is wanted to be set up.

2.1.2 Emerging fulfilment and distribution models

The replenishment of the grocery retailers has been changing due to the changing needs and increased focus on efficiency. Efficient SC planning needs to be integrated into the company's operations and will affect the profits significantly and give a competitive advantage (Lummus et al., 1998). Thus, new solutions to the supply chain operations are needed to solve the issues that the complex distribution methods create. In the traditional model, a central distribution center (CDC) distributes the products to all the stores in the network (Kuhn & Sternbeck, 2013). This is demonstrated in Figure 1. For larger discounter chains, also a network of multiple regional distribution centers (RDC) without a CDC that delivers to all stores was used (Kuhn & Sternbeck, 2013).

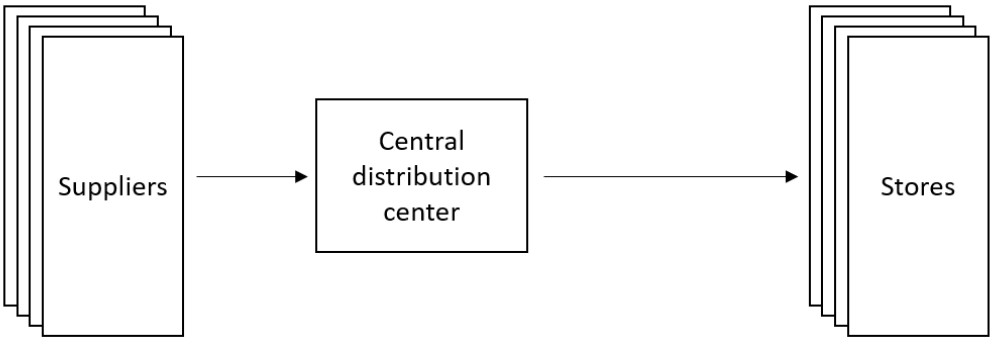

Figure 1: Traditional supply chain network with one CDC (based on Kuhn and Sternbeck, 2013)

To cover the new needs from increased customer needs, larger grocery store chains have created more complicated networks of multiple RDCs and CDCs with internal consolidation points (see Figure 2). Furthermore, Kuhn and Sternbeck (2013) found that the RDCs can be set up in the network on multiple stages to enable collecting and bundling SKUs along with the network from the CDC to the store to smooth the product flow and decrease the last mile logistic costs to the store. A more complicated SC network needs more active planning, and each product category needs to have its optimized path from the suppliers to the stores.

While the increased possibilities of distributing the goods create the opportunity for improved SC performance, it needs to be configured thoroughly before. Kuhn and Sternbeck (2013) stated that the grocery retailers mentioned the following five points to affect the decisions related to the distribution strategy of a product:

- SKU turnover rate
- Requirement of freshness
- Value density of the SKU
- Error of the forecasted demand of SKU
- Sourcing conditions

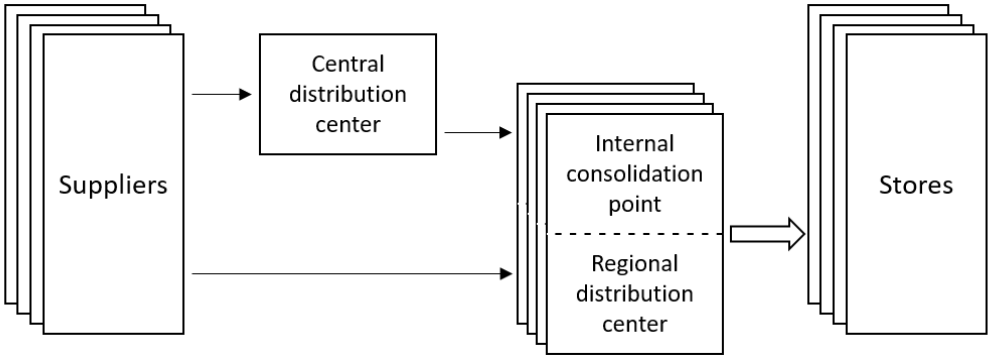

Figure 2: More advanced distribution network with multiple levels and internal consolidation (based on Kuhn and Sternbeck, 2013)

For example, if products need to be replenished often due to the high rate of SKU turnover or needs to have short lead times due to the perishability or uncertain forecasts, it should not be fulfilled from the central warehouse with long travel distance (Kuhn & Sternbeck, 2013).

Furthermore, online grocery creates extra challenges in the SC planning as online channel introduces new needs in the distribution network. Online sales have multiple fulfilment options where the picking can be performed. In addition to the option of picking in CDC, smaller RDCs, a separate online DC or stores, a new type of consolidation points have been introduced. Dark stores support online sales and are smaller warehouses that imitate a store but are only used in fulfilling the online orders, and the customers cannot enter the "store" (Hübner et al., 2016a). This will enable more efficient picking of the orders which improves the profitability of the online channel and shorten the lead time with a closer location to the customer (Hays et al., 2005; Naveo Commerce, 2021). Micro-fulfilment centers (MFC) are small-scale but more advanced warehouses for order picking that have semi-automated fulfilment of the orders but still need the help of manual labour (Ladd, 2020; Naevo Commerce, 2021). MFC can be placed in the same building as a store or dark store to automate the fulfilment process (Ladd, 2020).

Grocery retailers with a wide distribution network can utilize the existing facilities to deliver the orders to the customers and at the beginning of online retailing, a major part of the retailers deliver the online sales from the existing point-of-sales (POS) (Saskia et al., 2016). Thus, large investments in new warehouses are not usually used by traditional grocers when the share of online groceries is still low. However, because a 5% loss in total sales in stores can lead to a decrease of 20% in

the earnings before interest and taxes, investments for more efficient and faster deliveries are considered to be crucial to maintain the customer base (de Polignac et al., 2015). As the picking capacity in the store can limit the delivery rate and be inefficient, fulfilling and picking the orders from as DC can drive down the costs with large enough demand.

Based on the study by Saskia et al. (2016) grocers need to decide which options the retailer offers for the last mile delivery. In practice, there are two options of delivery, C&C, and home delivery (Saskia et al. 2016). If the retailer decides to provide a home delivery option, it still needs to choose if the orders are delivered by its own fleet or if the delivery is outsourced to a third-party transportation service provider, e.g., DHL (Saskia et al., 2016; Hübner et al., 2019). When the orders are delivered through a pickup station, the locations for the pickup need to be well analyzed to be most convenient for the customers without increasing the transportation costs significantly. These pickup points can be inside the store (C&C), in the parking lot of the store, in a separate pickup facility or in a location that is owned by a third party, for example, a gas station (Galante et al., 2013).

The preferred option of the last mile delivery can vary regionally a lot as consumers have gotten used to some of the services already. For example, Galante et al. (2013) found that in the UK, the home delivery option is significantly the most preferred option by the users with 88% while 50% of the current users preferred the home delivery in France.

McKinnon (2016) also discusses the possibility of utilizing crowdsourcing options that are becoming more common in the transportation industry. The crowdshipping could turn a regular shopper from the store to a courier which drops down the order to the home of the other customer while back to home. This could solve some of the problems of high delivery costs in the online business (McKinnon, 2016). Hübner et al. (2019) state that online grocery retailer Amazon has already tried crowdsourcing in the home deliveries of the orders. However, the crowdshipping model still has multiple legal challenges as the cold chain needs to be maintained throughout the shipping by law and the reliability suffers due to a possibility of fraud or theft (Hübner et al., 2019).

According to Kuhn and Sternbeck (2013), almost 80% of the retailers they interview believed that logistics will affect their competitiveness in the future more than it has affected in the past. While the majority have been racing towards shorter lead times of the orders, Picnic in the Netherlands has decided to focus on the cost reductions and deliver the orders only on a specified schedule to the specific area, like a milkman model (Kuijpers et al., 2018). This way, Picnic has been able to increase the drop density to 14 deliveries per hour which were about three times higher than the typical drop rate of below five deliveries per hour in the UK (Kuijpers et al., 2018).

Pure online players however have been able to change the fulfilment logistics to serve the needs of online retailing as efficiently as possible. For example, Ocado in the UK has overcome the profitability challenges of pure online groceries and has been able to make the supply chain simpler by providing only home delivery options (Mason, 2019). Thus, Ocado can have CDCs that are purposely designed to support efficient picking at the warehouse instead of picking with trolleys at stores. These CDCs can have more efficient picking to decrease the costs of online orders (Mason, 2019). After the picking, the orders are delivered from the CDC to smaller, optimally located "hubs" that will distribute the orders to the customers in the area (Mason, 2019). Having this type of large, specified CDC for online orders requires significant initial investments which is why it has not been a popular option to start online grocery sales when the profitability has been proved to be hard already (Mason, 2019; Tanskanen et al., 2002).

As online grocery has gotten more popular, it will be easier for pure online players to be profitable. In Finland, a new player Oda will start to provide pure online grocery service by the end of 2021. Like Ocado, Oda will focus on home deliveries only and thus be able to simplify the distribution network and use CDC for picking the orders (Helsingin Sanomat, 2021). While online groceries have created new demand, the grocers need to adjust their SC networks accordingly to support the service they are providing to the customers and enable more efficient operations in the industry of low margins.

2.1.3 Automation and picking efficiency

Furthermore, automation of processes with robots and IT systems has become more popular in the grocery industry and technology has helped the grocers to reduce the costs of operations. For more efficient picking operations automated warehouses have been built to enable faster delivery and reduce the picking costs of workload-heavy online groceries (Hübner et al, 2016; Begley et al., 2020). For example, Ocado in the UK has a thousand-robot warehouse for picking and Amazon in the US has invested in automated picking systems to have a significantly higher picking rate compared to manual picking (Mason, 2019; Begley et al., 2020). Still, automated warehouses need huge initial investments which is why most traditional grocers have not modified their DCs to support automated picking (Mason, 2019).

Based on a study by Kämäräinen et al. (2001b) automated picking at DCs will become profitable with a sufficient number of online orders mainly due to the increased picking speed. According to de Polignac et al. (2015), these fully automated CDCs become profitable after around 30 000 weekly orders but after that, the profitability increases when the number of weekly orders increases. However, Kämäräinen et al. (2001b) also emphasize the need for levelling the demand from the peak hours and creating a responsive warehouse for the changes in the business before significant, fixed investments to automation are made. New players, like Oda, are investing too in the automated warehouses to have a competitive advantage in picking costs and delivery speed compared to traditional grocers that use in-store picking (Helsingin Sanomat, 2021). With a lower online order rate, MFCs can provide enough automation to the picking process without as huge investments as fully automated DCs. de Polignac et al. (2015) state that the automation of MCFs can lead to improved performance of the fulfilment of the orders in the speed and costs compared to manual picking at stores. Sill, as the replenishment of the MFC is done manually, the labour costs are not so low and dark stores can outplay MFCs in cost efficiency (Naveo Commerce, 2021).

In addition to the automation, the picking can be improved with IT systems too. According to a study by Naveo Commerce (2021), in-store picking can be optimized similarly to the routing of delivery vehicles and with helping software the picking speed can be increased to be 33% faster (200 items/hour) than the fastest reported picking (150 items/hour) in the study by de Polignac et al. (2015). Based on their

own measurements, Naveo Commerce has been able to reduce the time used in picking by 50% for their clients (Naveo Commerce, 2021). They also state that efficient pickers can be almost four times more efficient compared to the slowest ones and thus maximum assistance and guidance should be performed to improve the efficiency of the picking operation.

Mkansi et al. (2018) suggested that as the substitutions are needed quite often due to OOSs, experienced pickers should be used to select the best substitute items that match the standard of the original item. However, IT solutions can be also used to help the pickers in substituting OOS products to an equivalent one so that the pickers do not need as much tacit knowledge of the products and the customers remain satisfied (Naveo Commerce, 2021). OOSs, however, can be reduced with ARS and automated ordering will improve the availability for both the online and brick-and-mortar customers (Kiil et al., 2017; van Donselaar et al., 2005; Horzella, 2005, p. 94). Thus, the importance of robust demand and replenishment planning systems even increase with online retailing.

While the home delivery of the order is as costly as picking, it should be optimized as well. Mkansi et al. (2018) point out that the delivery windows are usually too short and traffic congestions can make the delivery even slower. With longer planning time and delivery windows, routing software can optimize the routes to maximize the delivery drop rates and helps the grocers to keep the deliveries on time with more transparency (Mkansi et al., 2018; Mason, 2019). With advanced routing software that considers updated traffic information, Ocado has been able to promise a delivery window of one hour with 95% accuracy (Mason et al, 2019).

Furthermore, when technologies improve autonomous deliveries with self-driving cars and drones can disrupt the costly home delivery industry and probably will be adopted in the future (Hoffman & Prause, 2018; Begley et al., 2020). However, the regulation and reliability still restrict the option for automated deliveries as traffic laws forbid autonomous vehicles and crashes have occurred (Hoffman & Prause, 2018).

2.2 SC planning processes and systems in omnichannel grocery retailing

The online channel has created new problems for grocery retailers but also creates opportunities to provide improved services for customers and streamline internal processes. In recent years, studies related to omnichannel management have emphasized the requirement for grocers to meet customer expectations of fast deliveries with great quality and multiple delivery options but still be able to cut the service costs (Hübner et al., 2016a). Murphy (2003) found that picking and distributing online orders from a DC enhanced the replenishment planning process and improved the flexibility which increased the service quality. However, similarly separate DCs for online sales was noticed to have issues with the scalability and high investments made online retailing hard to be profitable with low order quantities (Murphy, 2003).

When traditional grocers decide to expand online, utilizing the current store network enables the grocers to provide online groceries in a wider area more quickly and thus gain customer loyalty at the beginning (Fernie et al., 2010). Even though in-store picking has its flaws of decreasing customer satisfaction at the store, harder inventory management and costly operations, it does not require huge investments and it will be easy to implement (Murphy et al., 2003). Thus, store-based picking is often how traditional grocers decide to expand online too.

When grocers expand online, they need to create a new logistic model for managing the supply chain. This type of developed supply chain is usually called omnichannel which improves customer service by enabling the customers to decide how they are receiving the order. These retailers are often called “bricks and clicks” (Murphy, 2003). As discussed earlier, the supply chain networks have been developing to support more efficient fulfilment and distribution. In an investigation into OC fulfilment processes, Wollenburg et al. (2018a) found that grocery retailers need to consider the variables of order volume and customer preferences with each channel to decide the most suitable operation model. Thus, in the following chapters, the thesis will analyze different fulfilment and distribution models in OC grocery retailing more thoroughly.

2.2.1 Omnichannel supply chain network

The distribution networks have developed when retailers have increased the sales channels and distribution methods to provide improved services. The simple distribution network with both brick-and-mortar and online sales is called multi-channel retailing (Galipoglu, 2018). In a multi-channel network, the sales channels work parallel to each other and have separate fulfilment and distribution methods meaning that the customer can either use the online store and the defined delivery method or go to the brick-and-mortar store (Galipoglu, 2018). In omnichannel retailing, however, the operations and processes are integrated, and the online orders and physical stores can be replenished from the same DCs and with the same transportation unit (Beck & Rygl, 2015). Increasing the touchpoints for the customers can improve the customer experience and the SC performance by optimizing the distribution methods (Galipoglu, 2018). Beck and Rygl (2015) defined that in omnichannel retailing the assortment range and the services are consistent in all sales channels and the pricing and inventory management is integrated into all sales channels. Furthermore, they stated that the customers also need to be able to return the products in all channels regardless of where the item was bought. However, the returning options do not play a significant role in online grocery retailing.

Earlier, the literature has been focusing on single-channel fulfilment and distribution and only in recent years have analyzed the OC replenishment specifically (Hübner et al., 2016a; Galipoglu, 2018; Beck & Rygl, 2015). Agatz et al. (2008) found that online grocery retailing does not only provide the same products as brick-and-mortars but also includes services like home delivery that traditional retailing does not provide. Integrated supply chain operations increase the options of how a specific product can be delivered from the supplier to the customers. One option for an omnichannel network is introduced in Figure 3 below where CDC and RDCs are used to deliver the items directly to the customers, via separate pick-up points, or through stores, dark stores or MFCs.

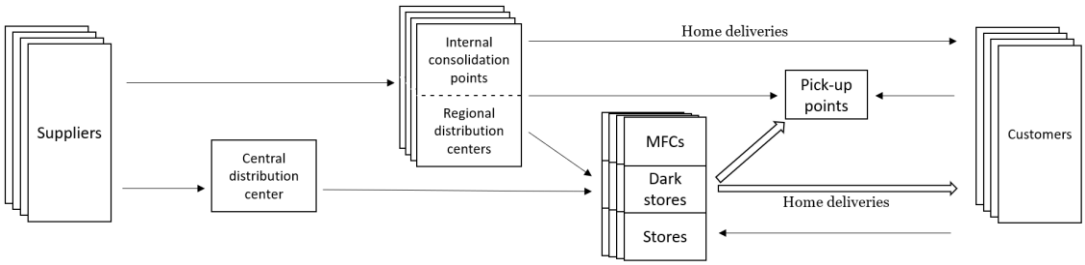

Figure 3: Omnichannel distribution network (Modified from Kuhn and Sternbeck, 2013 and Hübner et al., 2019)

The omnichannel network can include multiple picking methods by which the customers can decide how they want to receive the order. In the network, grocers need to configure how the picking is done for the specific type of orders and the fulfilment of the orders can basically be fulfilled at the RDCs, MFCs or dark stores or stores. As mentioned, the store fulfilment is the most traditional and easy to set up from a B&M's point of view but can be costly and create congestion in the store aisles. Second, RDCs fulfilment can be used to improve the picking efficiency in larger warehouses but decreases the delivery speed due to the longer transportations. Finally, MFCs and dark stores bring the fulfilment closer to the customer with faster picking but require significant additional investments from the grocers. The fulfilment methods will be analyzed more thoroughly in the following chapters.

In the early phase of online grocery retailing either pure online or multichannel options were popular and for example in the US pure online players, like Webvan and Peapod, dominated the market in 2001 (Finch, 2001). Traditional grocers had either the option to pick orders at the store or the warehouse. Later, for example, Tesco started to use a hybrid model with both in-store and DC picking to fulfil the online orders which strengthened the position in the market (Rowley, 2003). In contrast, technology giant Amazon, which sold grocery purely online for a long time, expanded to provide B&M option first by offering an offline channel for customers by acquiring Whole Foods and later creating a new concept of automated convenience store Amazon Go (Tjon Pian Gi & Spielvogel, 2021; Cheng, 2019). However, Amazon Go wanted to offer something new compared to traditional retailing, cashier-free shopping with advanced technology for people that need the products faster than online delivery (Wankhede et al, 2018). This type of behaviour

to changing from pure online to omnichannel for more opportunities was also recognized by Agatz et al. (2008).

These solutions show that large grocery chains aim for providing a full grocery service for the consumers and compete for the share of the total grocery industry, not only for only online or brick-and-mortar. As the buying habits affect the buying decision greatly, grocers need to get the customer used to their services and brand that will provide the unified grocery service for all needs. Thus, in the next chapters, we will focus more on the sales, fulfilment and distribution methods and other processes that are needed for a functioning and efficient omnichannel SC network.

2.3 Omnichannel sales

First, when omnichannel SC is set up, the purchase behaviour of customers should be analyzed in each channel because the online store sales can differ quite a lot from brick-and-mortar and the delivery method preferences affect the customer choices. The sales will affect what fulfilment and distribution models should be used for the most efficient performing supply chain. Tanskanen et al. (2002) emphasized that the geographical area affects online groceries significantly as customer density can differ a lot between two areas and flip the characteristics of the business totally. Naturally, more dense areas are more profitable for home deliveries because of shorter travel distances compared to rural areas Tanskanen et al. (2002).

The sales can come from either of the channels and the grocer then needs to fulfil the order with the delivery method the customer has chosen. In grocery retailing, the country can affect the preferred delivery methods of online orders by consumer habits. For example, in the UK and the Netherlands, attended home delivery is the most frequently used when groceries are ordered online but in France, the pick-up method dominates the share of the online orders (Hübner et al., 2016a; Saskia et al., 2016). In addition, unattended home deliveries are preferred in Switzerland and only one player, Migros Online (former LeShop), plays a significant role in enabling the service (Hübner et al., 2016a). As these last-mile delivery methods differ significantly, the supply chain operations of the grocer need to be adjusted to support the planned distribution options available for the customers. If the grocer is not providing preferred options to the customers, they might switch to the competitor for more convenient services and the grocer loses sales.

Furthermore, the grocers need to consider how online sales affect the operational efficiency in the distribution network due to the increased need for workforce and a changing impact on inventories in different parts of the supply chain. If the picking happens at the stores, the same inventory should satisfy both channels which can be hard to fulfil without proper planning. According to Hübner et al. (2019), online and B&M sales are likely to follow different sales patterns and thus make store fulfilment more complex and increase the risk of OOS.

As online orders have longer lead times than in traditional shopping and include some service fees the basket sizes are larger in online orders. Based on an article by Finch (2001), the online basket size at Tesco.com were £85 which was four times larger than the average in stores. Also, the online orders included proportionally more bulky items with low margins than store baskets according to the store executives. Similar results were also observed by Chintagunta et al. (2012), who studied the channel-specific transaction costs. They noticed that the average basket size in an online store was 155€, which was 3.5 times larger than the average basket size of offline purchases by the same customers. Furthermore, there existed a threshold of 100€ for cheaper home deliveries in the grocery chain they examined which could be seen clearly in the basket size distribution where the peak was in the range between 100€ and 110€. Whereas in brick-and-mortar sales the most usual basket size ranges were purchases under 10€ and between 10 and 20 euros and the larger the basket sizes were, the more the share decreased. Another reason for larger basket sizes was the long lead time compared to traditional shopping. As online shopping needs more planning compared to in-store purchases, it was more convenient to buy larger baskets at once leading to less frequent purchases of groceries. This could be seen as 8% of the purchases ranged between 90 and 100 euros which were left just below the threshold for the cheaper delivery (Chintagunta et al., 2012).

Another notice by Chintagunta et al. (2012) from the shopping behaviour was that with multiple sales channels that the share of fresh products was significantly larger (29.2% of the expenditure) in the store purchases than in the online orders (11.7% of the expenditure). Also, heavy or bulky items were found to be ordered proportionally more online than bought from the stores (Chintagunta, 2012). Thus, we can conclude that the shopping behaviour and the sales patterns can differ significantly

when online and offline sales are compared making online sales forecasting more important with in-store replenishment to ensure availability for both channels.

As online basket sizes are larger, more OOSs per basket might happen. OOSs can happen more often especially in stores where both B&M customers and online customers consume the same inventories. The online sales from the store inventory usually happen on the day before picking which increases the chances for the item to be sold before the order gets picked. If availability issues occur, the grocer needs to decide how the OOS is compensated to the customer and if a replacement needs to be set to the order to maintain customer satisfaction. These situations of OOSs are discussed more in the following chapter of order fulfilment.

In online retailing, returns play a significant role in a successful online store. Also, in grocery retailing, the risk for returns is greater as the customers cannot feel or see the actual item they have ordered. Furthermore, as the freshness of the online orders has been a significant criterion for ordering online, it could be expected that people can be unsatisfied with the items they have received and thus wanted to return. However, as the food items cannot be often resold after the return and the return process would be extremely costly, a money-back guarantee or other compensation of the product is more used and only under 1% of the items are returned (Hübner et al., 2016a).

2.4 Omnichannel fulfilment methods

According to Tanskanen et al. (2002), the online grocery retailers at the beginning of the 21st century failed due to profitability issues that related to large initial investments and costly operations without a sufficient customer base. The investments and operations were heavily related to the inefficient operations in fulfilling the online orders. Thus, most modern grocery retailers have started online retailing with the in-store order picking that needs the least initial investments but still enables the scaling of the online channel geographically easily. (Mkansi et al., 2018; Hübner et al. 2016a). In addition to the in-store picking, Hübner et al. (2016a) list two other fulfilment methods for online orders: separate fulfilment centers and central warehouse. Hübner et al. (2019) state that order picking can account for 25% of the costs of the supply chain and thus, it needs to be analyzed thoroughly. Picking can be defined as the action where multiple items are compiled to fulfil the store or

customer orders (Hübner et al., 2019). In this thesis, the analysis of fulfilment methods will be divided based on where the online orders will be picked in the omnichannel network.

In fulfilment of both channels the picking distance the pickers travel should be minimized to decrease the workload of the process. Also, the fulfilment of the orders should consider the availability of the items to improve customer satisfaction. However, the inventories should not be increased drastically to keep the inventory costs low and avoid spoilage of the fresh products. Third, the lead time should not increase drastically due to the long distances from the delivering warehouse to have lower costs in picking. Furthermore, the orders usually include products with different temperature needs which complicates the fulfilment process (Hübner et al., 2019).

Fulfilling the orders for a store from the warehouse is significantly simpler as the orders are usually placed as multiples of the case sizes and the packs can be unpacked after the delivery to the store or even placed on the shelves without unpacking (Kuhn & Sternbeck, 2013). Thus, the picking job for store orders contains only 15 different items on average (Hübner et al., 2019). However, when the online orders are fulfilled, the order packaging units will be used, and the cases need to be broken up into secondary packages which will be further broken up into customer units (Hübner et al., 2019). As online basket size can be up to 70 units on average, online order picking becomes a lot more complex even though it would be done in the warehouse (Agatz et al., 2008; Fernie & Sparks, 2009, p. 218). Furthermore, the temperature zones need to be maintained all the way to the customer which increases the complexity of the logistics of online orders. Due to the complexity of fulfilling the online orders in the omnichannel network, next the thesis is going to analyze each fulfilment method of online orders more thoroughly.

2.4.1 In-store picking

In-store picking has been stated to be the most usual concept of how traditional retailers set up the online channel (Hübner et al., 2016a; Mkansi et al., 2018; Vazquez-Noguerol et al., 2021). The online channel based on the existing store network enables easy expansion of services provided. Furthermore, with in-store picking, the cases of items are not needed to be broken up before the stores and the

fulfilment of the inventory at the store can be managed with similar methods that were used with only the offline channel (Wollenburg et al., 2018b). Also, the distribution network does not need any new warehouses for online orders with this model and the whole assortment range will be available for the customers from the beginning (Wollenburg et al., 2018b; Hübner et al., 2016a). Often with low online volumes, the assortment range for online stores is reduced if the picking is done at a warehouse which gives a competitive advantage for fulfilling the orders at the store (Galante et al., 2013). However, Hübner et al. (2016b) state that this is usually the issue for online stores at the beginning and 60% of the examined retailers offered a wider online assortment compared to stores.

Picking for stores can be done in large quantities at regional DCs or the CDC, depending on the needs of the product. With in-store picking, the grocer can offer either pick-up at the store, pick-up from a separate pick-up point or home delivery from the store for online orders. Furthermore, the same transportation flows can be used for the online and store orders in the supply chain network (Hübner et al., 2019). Naturally, if the customer is willing to pick up the order at the store, it will be most profitable for the grocer as the grocer would not need to deliver the order to the customer. In the case of home delivery, the stores are already close to the customer and can have short lead times but require a lot of transportation capacity if every store is wanted to be used for home deliveries (Hübner et al. 2019). Thus, with a very dense store network, it can be justified that only some of the stores can be used for home deliveries to have improved utilization of the transportation capacity.

Even though in-store picking has the advantage of being easy to set up, it also has multiple challenges like inventory management, resource management and costly picking operation (Vazquez-Noguerol et a., 2021; Hübner et al., 2016a; Mkansi et al., 2018). As picking has been noticed to have a significant impact on SC costs in grocery retailing, it is natural that the inefficiency of the store-based order fulfilment is examined. For example, Kämäräinen and Punakivi (2002) suggested that picking at the store is more expensive than picking at the DC due to the possible automation and adaption at DCs. In addition, the layout and large surface of stores are not optimized for picking because the main focus is to service the B&M customers and create revenues by guiding the customer path in the store (Kämäräinen et al. 2001b). Mkansi et al. (2018) also emphasize that in addition to being slower compared to

automated picking, the errors in the manual picking will create issues in customer satisfaction when the customers do not get the exact items that they have ordered.

Valle et al. (2017) have shown that picking route optimization and grouping the orders can improve the picking performance at the warehouse significantly. Furthermore, Naveo Commerce (2021) stated that with the software, the picking times have been able to be reduced by 50% with their customers. With the software, there is not as much need for specialized pickers as Mkansi et al. (2018) suggests as the picking process is more standardized and there exist fewer decisions that need to be made by the picker. Naveo Commerce (2021) also reported that the solution will eliminate the picking errors leading to better performance in store-based picking.

In addition, for slow picking compared to warehouses, the pickers at the store can create congestions on the aisles which reduce the customer satisfaction of the shoppers that come to the store. Thus, Mkansi et al. (2018) discussed the opportunity of picking the orders before B&M shoppers come to the store and Vazquez-Noguerol et al. (2021) confirmed this to be the most efficient method due to less traffic in the store. Nonetheless, Mkansi et al. (2018) also discussed the requirements of fresh products easily prevents the early picking of the products because there is usually not enough capacity to store the picked items that need to be refrigerated or frozen. Furthermore, it needs to be considered that only picking in the mornings does not enable any same-day deliveries.

The in-store pickers do not only take the floor space from the B&M shoppers but also compete for the same inventory. According to the literature (e.g., Mkansi et al., 2018; Hübner et al., 2016a; Murphy, 2003) in the store-based picking model it is more common that between the time the item gets ordered and picked, the item gets OOS compared to the warehouse-based fulfilment model. Thus, it has been suggested that the stores have needed to increase the inventories for improved availability and customer satisfaction (Mkansi et al., 2018). However, due to perishability and limited shelf space, any excess inventory will increase the costs of inventory. Furthermore, in online grocery retailing the freshness of the products plays an important role in customer experience and thus any products that do not have sufficient shelf life left should not be picked to the customer's order (Mkansi et al. 2018). OOSs are also critical due to the substitution need they create. Usually, the

grocers need to replace the product with a more expensive one to maintain customer satisfaction and thus decrease the margin (Mkansi et al., 2018). In addition, the pickers need to estimate which substitute will match the missing item best the quality and for example, allergy criteria need to be met too. To have an efficient and accurate substitution process, Mkansi et al. (2018) suggest that experienced personnel should be used in selecting substitute items.

Fortunately, IT solutions have been created to help in both issues of OOS. However, it has also been stated that modern software should be used in the substitution process to standardize the process and get appropriate suggestions fast (Delaney-Klinger et al., 2003; de Polignac et al., 2015; Naveo Commerce, 2021). To solve the root cause for OOSs, ARS should be used for increasing the availability and maintain reasonable inventories (Kiil et al., 2017; van Donselaar et al., 2005; Horzella, 2005, p. 94). Thus, with store-based online order fulfilment, the importance of advanced ARS increases as OOSs become more critical to the business. However, as online sales have been noticed to follow different sales patterns, both the B&M and online sales should have separate forecasts if the sales levels are sufficient to improve the availability even more (Hübner et al., 2019). Still, as both channels are replenished with the same methods from the DC, a more complex more joint forecast needs to be used.

Finally, the issue of shared resources in the store complicates resource management. As stated above, the items sold online and B&M both compete from the same limited shelf space in the store. Also, as the packing and storing the online orders take space from the back-end storage, grocers need to make sure neither of those limits the performance of another too much (Pires et al., 2017). However, it has been also discovered that using backroom space for storing products to be sold in stores is not efficient and leads to increased operational costs in store and OOSs (Corsten & Gruen, 2003; Kuhn & Sternbeck, 2013) and it increases the inventory value. Thus, using the backroom for online order fulfilment and storing is a logical use of the space.

As the backroom space is expensive due to the locations of stores in densely populated areas, Aastrup and Kotzab (2010) suggest that the existing backroom could be used in fulfilling the online orders to create more efficient use of the space and not having availability issues on the shelves of the store. Also, Gorczynski and

Kooijman (2015) state that the backroom could be utilized more effectively for storing frequently online purchased bulky items and picking these items in the backroom. Vazquez-Noguerol et al. (2021) stated that heavy and bulky items should be picked after the other items in the basket to increase the picking efficiency at the store which justifies utilizing the backroom for picking bulky items. This model could decrease the picking costs because the picking in the store warehouse is more efficient compared to picking from the shelves. According to Pires et al. (2017), the academic literature on backroom usage is quite limited compared to the extensive literature of SC management and thus the options should be researched more.

Another resource management based issue in store based picking is the workload that the picking of online orders created as the tasks are traditionally performed by the same employee pool (Mkansi et al. 2018). When the two channels compete from the same workforce, it can cannibalize the performance of the other. For example, if the need for picking online orders increase more than was expected, the store will have an insufficient number of resources for the traditional store operations and decrease customer satisfaction. Thus, effective forecasting systems are even more important because in these situations it helps to forecast the need for the workforce for each process. Forecasting the workload and thus optimizing the resource levels for each task can decrease the costs of the operations and helps in solving the issue of shared workforce resources (Ernst et al., 2004; Güney, 2019).

2.4.2 Picking at a separate fulfilment center

Picking at a separate fulfilment center can solve the issue of workload heavy process of in-store picking. Thus, literature has discussed having separate fulfilment centers to use for online order picking. Hübner et al. (2019) suggest that the online orders could be picked in a separate DC dedicated to online orders due to more efficient picking performance compared to the store-based model. In this model, the online DC (ODC) can be designed for online order picking and thus decrease the picking costs (Hübner et al., 2016a). Minimizing the route of the pickers by designing the warehouse decreases the time of the operation but also in the warehouse, no customers are slowing down the process (Kämäräinen et al., 2001b). Conversely, using a separate warehouse for picking online orders does not create the issue of creating congestions on the aisles and thus does not bother the customers of the B&M channel (Hübner et al., 2016a).

Also, using a separate ODC model for online orders helps in the availability issues that can happen with in-store picking. With separate ODC nothing else than spoilage should reduce the inventory in addition to the online sales and thus the inventory information will be up to date leading to fewer substitutes needed in the online orders (Hübner et al., 2016a). Compared to picking in the central warehouse, using separate fulfilment centers for online orders reduces the transportation time and costs by being closer to the customers and thus enables shorter lead times (Hübner et al., 2016a). Still, the transportation distance increases compared to the delivery from stores, but the vehicle utilization can be improved with a more centralized home delivery process. ODC differs from a regional DC that distributes to stores so that the products are already "broken up" to the consumer units in the warehouse to be ready for picking (Wollenburg et al., 2018b). Kämäräinen et al. (2001b) suggest that warehouses could be used for more efficient picking and automation will be the solution to increase the picking speed even more. However, they state that because of the large investments needed, the automated warehouse option will not be flexible and often the utilization of the warehouse can remain low. Thus, expanded ODCs for online picking sound like an attractive solution.

Using separate ODC helps the grocer to solve many issues that the store-based picking model creates but still requires significant investments for new warehouses and changes in the distribution network. Furthermore, if the omnichannel grocer wants to also offer an option for pick-up at the store, it complicates the SC with the need for multiple distribution flows for the online channel and increases the inventory levels (Hübner et al., 2019). Thus, utilizing an ODC model should be utilized more in the markets where home delivery is the preferred option by the customers.

Dark stores that simulate the B&M store but are not open for customers can be used to bring separate online warehouses closer to the customers to decrease the lead time (Hays et al., 2005). Another reason to use dark stores is that due to the shelf space limitation of the B&M stores and pick-up from store option, the assortment of the online store is usually limited to the same products that are offered offline (Hübner et al., 2019). However, with dark stores, the inventory levels of different products can differ compared to the B&M stores to serve the online demand better. Similarly to ODCs, also dark stores can be designed to support picking efficiency. According to López et al. (2014), dark stores were first designed to have the same

layout as the stores which is why it is called a store instead of a warehouse, but it was quickly noticed that the picking efficiency is not optimal with such a layout.

In addition to separate warehouses for online orders, micro-fulfilment centers (MFC) are becoming a more popular option in fulfilling online orders. MFCs are highly automated and do the picking of online orders with advanced robots. With a compact design, MFCs could be considered as a hybrid solution of store-based fulfilment and separate online warehouse solution as MFCs can be small and attached to the store or separate centers close to customers (Ladd, 2020). An example concept of MFC can be seen in Figure 4 below. The academic literature of MFC is scarce but more common on commercialized articles. That is because, with former technologies, it has been considered that smaller automated warehouses do not have the capacity to enable profitable automated picking (Hübner et al., 2016a). However, according to Haddioui and Lange (2021), rising costs of labour, the growing share of online grocery and falling costs due to smaller interests and improved technology have made automation more attractive for grocers.

Figure 4: MFC concept attached to a grocery store (Robotics 247, 2021)

According to the report, grocers have achieved picking rates with approximately 800 items per hour with MFC solutions and with dense design, the number of different SKUs in the warehouse has been able to be increased compared to the traditional online DC. However, according to a cost comparison of fulfilment methods, it was assumed that all the items could be picked with the automated solution (MWPVL,

2021). Still, based on the study, approximately 50% of the items are needed to be picked manually in a realistic scenario.

MFCs have increased picking speed compared to stores but are still small enough to be located closer to customers which leads to decreased delivery time compared to delivering from the warehouse. Thus, the MFC option should be discussed more in the academic literature as a viable option for online order picking in the grocery industry. Furthermore, the option for having an MFC in the backroom of the B&M store would create synergies in the logistics network and the MFC could be easily scaled to the spaces of the store if the share of the sales changes significantly and the B&M channel does not require as much space.

In addition to MFCs, also larger separate ODCs can be automated. For example, Ocado Group, a technology company focused on the automation of warehouses, provides a solution with large, automated warehouses for picking online orders and call those customer fulfilment centers. Ocado states that an order of 50 items can have an 80% shorter picking time with the automated solution compared to manual picking (Ocado, 2021).

Even though separate fulfilment centers can solve the issues of workload heavy picking operation and OOSs in the store inventory, the high fixed costs and large investments needed for separate fulfilment centers have reduced the attractiveness of the solutions (Hübner et al., 2016a). Having an ODC without automation enables to scale up the online order fulfilment capacity but if the demand does not match the capacity, the advantage of the investment decreases. Thus, focusing on the scalability of the online channel operations has had a great focus in the academic literature and in-store picking has been the most discussed topic.

The customer can pick up the order from separate online fulfilment centers that are close to the customer. However, that is not as convenient as C&C from the store because the customer might want to fill in some items from the store at the same time. Besides, with separate online order fulfilment centers, the grocer needs to increase the inventory levels for double safety stocks, in the store and warehouse (Hübner et al, 2016a). Despite these challenges, OFCs and MFCs could solve many problems in online grocery retailing making it more attractive for OC retailers when the share of online groceries increases. While it also helps them to solve cost issues

of workload-heavy operations, it also enables shorter lead times and improved availability leading to more satisfied customers giving a competitive advantage.

2.4.3 Picking at the central warehouse

Finally, Hübner et al. (2016a) suggest an option of picking the online orders in the central distribution center (CDC) so that both store and online orders are picked in the same location. Picking in the integrated CDC allows the grocer to make more short-term allocation decisions and decrease the picking costs compared to the store-based picking (Hübner et al., 2016a). Furthermore, the integrated inventory in CDC enables decreased inventory costs compared to the option of having separate DCs leading also to improved availability (Boyer et al., 2004, p. 130). Integrated inventory makes all the SKUs available for everyone in the delivery range of the CDC without regional differences, increases the product assortment and can offer fresher products to the customer due to the delivery straight from the warehouse and thus can improve customer experience (Boyer et al., 2004, p. 130; Hays et al., 2005). In addition, it makes the distribution network easier to manage as there are fewer links. As the picking is performed in a warehouse in this model, the pickers do not create congestions on the store aisles and do not compete from the same inventory like in the separate online fulfilment center model leading to improved customer satisfaction compared to the store-based model.

Besides, similarly to separate fulfilment centers, CDCs can be designed to have efficient online order picking operations too. If the picking is done in CDC, it can be automated with robots but require significant investments and thus a great demand (Hübner et al., 2016a). Delaney-Klinger et al. (2003) stated that Ocado believed in the CDC-based picking model due to the efficiency of the picking and the possibility of automation. According to Hays et al. (2005), a centralized assortment model also enables cost savings from the deliveries from the suppliers as all the items are delivered to one location.

Even though CDC-based picking can be efficient, it has multiple drawbacks which decrease the attractiveness of the solution. The automated central warehouses for online orders need significant investments and one distribution center can cost over $30 million (Hays et al., 2005). The warehouse with a larger capacity for handling online orders needs also high and well-forecasted order volume to utilize the capacity of the facility all the time and not have varying utilization (Kämäräinen et

al., 2001b). Hays et al. (2005) report that one of the main reasons for Webvan to fail was the high initial investments to 26 CDCs for $1 billion leading to high fixed costs with insufficient demand to get break even. However, if the same DC is used for picking the store orders, the investment in the facility decreases on behalf of the online channel and the picking can be either automated or manually picked depending on the demand (Hübner et al., 2016a). Still, Hübner et al. (2016a) notify that the online orders need to be picked in consumer units instead of pallets leading to changes in the CDC where both B&M and online orders are picked. This complicates the picking as multiple methods need to be used inside one facility.

Finally, the CDCs are large, they need to be in distant locations to have reasonable costs. Also, one facility needs to cover a very wide range of online orders leading to longer transportation times (Hays et al., 2005). Thus, both the transportation costs and the lead time of online orders can increase. Longer delivery distances can enable more efficient delivery operations if the orders are set early enough, and the customers are tolerating date-specific deliveries in a certain area. This model has been used by Picnic and it enabled an increased drop rate of orders but compromises in the lead time and flexibility of the system (Kuijpers et al., 2018). However, as modern technology has enabled smaller automated warehouses closer to customers with great assortment and picking efficiency, the CDC-based picking does not have great advantages over separate smaller online fulfilment centers. Furthermore, picking in CDC does not remove the need of picking in the store if the C&C option is required by the customers.

2.4.4 Summary

The decision of which picking location should be used depends on the environment where the grocer operates and their online channel strategy. If the retailer is located in a country with high demand for C&C, a store-based picking model should usually be preferred to enable efficient omnichannel logistics. When the demand increases in such markets, MFCs could be attached to the store to bring improved picking efficiency to cover the demand. In-store picking enables the grocer to expand the services fast from B&M to OC retailing and thus can be suggested for most players in the market. If a store-based picking model is used, the grocer needs to make sure that the inventory management is getting sufficient focus to maintain the availability and avoid OOSs. The short distances to customers enable fast deliveries but the

utilization of the transportation vehicles might not be as good as with a more centralized model. As the order picking at stores is the slowest compared to any other picking model, IT solutions for optimized routes in the store and substitution selection should be utilized for more standardized operations.

Second, the picking model with separate fulfilment centers for online orders seems to be the most reasonable option for markets with increasing online demand and home deliveries as the most preferred option. Thus, the picking operation has improved performance with automation and warehouse design and OOSs do not create an as large issue as in the store-based picking. Also, smaller ODCs can be located closer to the customers leading to shorter lead times compared to the central warehouse based model. However, the ODC-based model requires significant initial investments, and the capacity needs to match the demand well to enable the profitability that faster picking can create.

Finally, the picking at the central warehouse enables the integrated inventory for all the channels and faster picking speed compared to the store-based picking. Thus, the model could be used in markets that prefer home delivery options. Similarly to ODCs, CDC can be designed to support the picking efficiency and it reduces the OOSs and congestions on the shop floor. In addition, it can increase the assortment for all customers in the range of the central warehouse compared to other options. However, the high investment needed for CDC and longer distance to customers make the option less attractive for grocers when the order volume is not high enough and can vary a lot. The picking models are also summarized in Table 1 below.

Based on the study of multiple different ODCs types by Eriksson et al. (2019), the decision parameters for the separate online warehouse are interdependent and one factor can affect the other. Thus, for example, the picking strategy to be used is dependent on the customer requirements, characteristics of the items, and the categorization of the ODC (Eriksson et al., 2019). These results implicate that the optimal picking method cannot be decided in advance but adjusted to fit the market and match the retailer's strategy.

Table 1: Summary of different omnichannel picking models

Model	In-store picking	Online fulfilment center	Central warehouse
Description	Manual picking from the store inventory	Separate smaller DCs for online orders	Integrated CDC for all sales channels
Automation	Manual, option for automated attached MFC	Automated, semi-automated or manual	Automated, semi-automated or manual
Advantages	Fast way to expand online; does not need significant investments; short distance to customers; possibility for MFC later	Faster picking through warehouse design and automation; fewer OOSs; not interacting with customers at the store; short distance to customers	Faster picking through warehouse design and automation; fewer OOSs; not interacting with customers at the store
Challenges	Slow picking speed; availability issues due to shared inventory; creating congestions on the aisles	High investments and fixed costs for a separate center; increases inventory levels due to new locations	High investments and fixed costs for a separate center; long distance to customers; online demand needs to be high and stable

MWPVL (2020) analyzed the different picking methods by the labour intensity that picking and delivering the order to home needs. They reported that picking in the store was the most workload-intensive method and required over 9 times more labour than sales through an offline channel. The least labour-intensive method was the automated CDC-based method which required only roughly 51% of the workload compared to the in-store picking. The automated MFC-based model was close to the automated warehouse in the efficiency and manual picking external locations were in between the worst and best-performing methods. However, when the delivery was deducted from the labour costs, the MFC-based model was clearly performing the best as the pickup model is not available from the warehouse. Also, it was noticed that with automated picking solutions the delivery creates a larger part of the costs and pick-up orders thus can improve the profitability of the online channel. However, the study by MWPVL (2020) did not consider any other costs than the workload of each method and thus cannot be used directly to decide the optimal picking location.

Furthermore, Hays et al. (2005) discuss an option of utilizing existing knowledge on efficient online fulfilment by partnering with fulfilment ecosystems. For example, today Monoprix and DIA are partnering with Amazon, Morrison with Ocado, and Reitan with Kolonial.no to profit from the experience and capabilities of the partners in the online industry (Tjon Pian Gi & Spielvogel, 2021). Traditional grocers could use partnerships with pure online players to help them build infrastructure and capabilities faster than in a self-developed online model (Hays et al., 2005). The partnerships in picking operations could relate for example to order management, automated order picking or route optimization in store-based picking.

2.5 Omnichannel distribution methods

In this chapter, the thesis is going to analyze different distribution methods of how online orders can be delivered to customers in the omnichannel environment. The distribution methods vary from delivering the product directly to the customer or letting the customer pick up the order from the store or solitary collecting station (Hübner et al. 2016a). The last-mile delivery of the online orders has been noticed to be the most challenging part of the SC due to the inefficiency of the deliveries and the strict time restrictions that the customers have (Boyer et al., 2004, p. 186; Hays et al., 2005). Especially for groceries, the delivery rate has been low compared to other industries due to the large orders with temperature requirements that are needed to maintain the cold chain until to the customer and the short delivery windows (Boyer et al., 2004, p. 188; Punakivi & Saranen, 2001).

Even though the C&C model is the cheapest for the grocer to deliver groceries, the most popular delivery model depends on the geographical markets and the omnichannel grocers need to adjust their services accordingly (Hübner et al., 2019). For example, in the UK, home deliveries are the most preferred shopping method in online groceries whereas C&C is the most popular in France (Saskia et al., 2016).

2.5.1 Home deliveries

The home deliveries can be divided into attended home deliveries and unattended home deliveries where the orders are left to a locked reception box (Kämäräinen & Punakivi, 2002). In addition to picking, with the home delivery method, the grocer needs also to manage the delivery logistics increasing the costs of the online order.

In attended home deliveries, the customer decides an available delivery window to receive the delivery that can vary from one to several hours and the customer needs to be at home to receive the package (Kämäräinen & Punakivi, 2002). Conversely, in unattended home delivery, the customer does not need to be at home as the reception box, which can be refrigerated, is used (Kämäräinen & Punakivi, 2002). Thus, the delivery window can be a lot longer than in the attended home delivery without decreasing customer satisfaction significantly. Chintagunta et al. (2012) found that even though the home delivery was considered convenient by the customers, the customers were very price-sensitive about delivery charges and thus reluctant to pay for the service.

In most countries, the attended home delivery is the most used option of last-mile distribution methods (Galante et al., 2013; Hübner et al., 2019). Because the home delivery model increases the convenience of online shopping, it is preferred by the customers often. However, the need for being at home at the time of the delivery with long time windows has been noticed to be inconvenient for the customer (Galante et al., 2013). Conversely, the shorter delivery windows with high demand on the afternoons are costly for the grocer as more transportation capacity is needed and the routes are not optimized (Kämäräinen & Punakivi, 2002). Kämäräinen and Punakivi (2002) also mention that if the customer is not home at the time of the delivery, the delivery fails, and the retailer needs to take the order back to the starting point and store it which increases the costs of the delivery even more.

For providing the delivery service, the grocer needs also to have the vehicles needed for the delivery operation (Hays et al., 2005). Another option is to outsource the delivery to third-party service providers. Managing the delivery windows create a huge challenge for the grocer due to the uncertainties and optimal routing. To tackle the issue of uncertainties and route optimization, routing software has been used (Hays et al., 2005). The longer the delivery windows are and with sufficient planning time, the more optimized the route will be, and the grocer will be more cost-efficient. Still, because customers prefer shorter delivery windows to longer ones, grocers have needed to offer shorter windows to remain competitive.

The unattended home delivery option would solve the issue of the short delivery windows for both, the delivery and reception side. Punakivi and Saranen (2001) found that attended home deliveries can be over 2.5 times more costly compared to

unattended delivery with reception boxes. The cost savings resulted from longer delivery windows with optimized routing and fewer vehicles needed for the deliveries due to dampening the demand from the most popular hours. However, they also noticed that if only 10% of the deliveries are attended home deliveries, the need for transportation vehicles doubles compared to the completely unattended deliveries. Still, Punakivi and Saranen (2001) showed that every unattended delivery decreases the workload of online orders and thus can improve the profitability of the online channel.

Despite the advantages, unattended home delivery is not as popular as attended home delivery due to the costly reception boxes with cold chain requirements and the possibility of theft (Hübner et al., 2016a). Agatz et al. (2008) report that a well-known example of an online grocer, Streamline, in the US could not manage the investment to refrigerated reception boxes. Thus, it went bankrupt due to the unsustainable cost structure. However, Migros Online in Switzerland has managed to deliver the orders using cooled delivery boxes and collecting the boxes afterwards (Hübner et al., 2016a). Even though the cooled delivery boxes do not need as large initial investment as solid reception boxes, the collection requires extra effort from the grocer and is more vulnerable to theft making it not so attractive in many countries.

2.5.2 Pick-up points

To solve the issues for costly logistical operations in the home delivery, an option of picking up the order from a pick-up point that the customer has selected. The pick-up model can be divided to C&C from a store, pick-up points attached to a store to allow drive-through and separate pick-up centers (Hübner et al. 2019). In the C&C option, the customer orders online and picks up the order from the B&M store. This model makes the customer bear the cost of the last-mile delivery and the grocer does not need significant investments in new facilities or delivery vehicles (Hübner et al., 2019). As the customer still needs to go to the store, the delivery model is not as convenient for the customer as the home delivery model is when only the time of picking the items is saved by the customer. However, C&C makes it easy for the customer to fulfil the order from the store if all the needed items were not ordered through the online channel. Still, as grocers are able to provide the service cheaper compared to home delivery, it can be more attractive to the more price-sensitive

customers. Also, as the customers can avoid the congestions in the store and checkout, the popularity of the service is expected to grow (Harris et al., 2017). According to Hübner et al. (2016a), C&C from the store can save up to 70% of the logistical costs compared to the home delivery. Thus, C&C from store service is considered an attractive option for OC grocers with a low level of online sales and providing that to the customers can improve the profitability of the online channel. However, as the C&C still contains the challenges of inefficient store-based picking and availability issues, the option for MFC attached to the store should be considered after the share of online sales increases. According to Davies et al. (2019), C&C will not reach the full potential of OC retailing in the long term due to efficiency loss in the network.

Online orders can be collected from a pick-up station attached to a store or an online fulfilment center. The setup with an attached pick-up station enables the drive-through option for the customers and the advantages of this type of solution are very similar to the C&C in the store. However, the reception boxes do not need to be in the store, and it is less costly to set up an attached station compared to a separate picking station when the orders can be delivered from the store (Hübner et al., 2016a). With the option of a separate pick-up station, the pick-up is handled from the online fulfilment center that has been discussed as the separate picking location earlier. Thus, the picking speed and availability can be improved in the location. However, these locations still need to be close to customers to be as convenient as C&C from a store. In addition, the separate pick-up centers with order picking need significant investments from the grocers compared to the store-based C&C and thus a higher share of online sales is needed to enable operational efficiency (Hübner et al., 2016a).

Finally, a hybrid solution for separate pick-up locations can be offered by the grocers. With this solution, there exists a network of shared reception boxes. As the model of unattended home delivery had the issue of low utilization and expensive investments to the reception box network, Punakivi and Tanskanen (2002) studied the option of shared reception box service. In this model, the reception boxes could be set to shared locations where multiple people have convenient access to them and one location can have multiple boxes. In the study, it was found that the shared reception box concept reached 55-60% costs savings in the delivery costs compared to attended home delivery with a two-hour delivery window (Punakivi & Tanskanen,

2002). In addition, the driving time decreases as there will be fewer stops if several orders are delivered to the same location and the shared reception boxes can be on more central routes compared to single customers.

Because the shared reception boxes need to have some time window to pick up the order by the customer and the customer needs to get to the reception box, it is only considered to deliver the order halfway. Still, the shared reception boxes are closer to the customer than the store and the customer does not need to be at home at the time of the delivery making it convenient for the customer. This works especially in the densely populated areas where the utilization rate of the reception boxes is higher and the boxes can be closer to customers enabling the advantages of unattended home delivery but with smaller investments to the infrastructure (Punakivi and Tanskanen, 2002).

2.5.3 Summary

The distribution model for delivering the order for the customer is costly and cold chain requirements make it more complicated. The orders can be delivered to the home of the customer or to a pick-up point where the customer bears the cost of transportation. The most popular home delivery hours create the largest challenges for the grocers due to the increased need for delivery vehicles and less optimized routes. The issue has been tried to solve with reception boxes enabling unattended delivery but again, the investments needed for the solution are large and the payback time can be over 6 years (Punakivi & Tanskanen, 2002). Shared reception boxes can reduce the payback time by over 50% due to improved utilization of the boxes (Punakivi & Tanskanen, 2002). The C&C services are preferred in some countries more than others due to the convenience of not having to wait at home and lower cost for online shopping. It is also easy for the OC grocer to set up due to the existing store network and does not require significant investments. In Table 2 and Table 3Table 3 below, the advantages and challenges of the last mile delivery are summarized.

Table 2: Summary of home delivery options

Model	Attended home delivery	Unattended home delivery
Description	Delivering the order to the home of the customer with the need of being at home at the time of the delivery	Delivering the order to the home of the customer without the need of being at home at the time of the delivery
Customer preference	The customers prefer home delivery over pick-up; shorter delivery windows are preferred, and same hours are preferred by many	The customers prefer home delivery over pick-up; fewer requirements to meet the delivery window compared to attended delivery
Advantages for grocer	Possibility to improve customer experience and remain competitive	Possibility to improve customer experience and remain competitive; orders can be delivered throughout the day; routes are more optimized; improved vehicle utilization; decreased transportation costs; improved success rate of deliveries
Challenges for grocer	Costly for the grocer; price-sensitive customers; complex routing; common and short delivery windows; the customer might not be at home at the time of delivery	High investments to the reception box infrastructure; temperature requirements; theft

Table 3: Summary of the pick-up options

Model	In-store or attached pick-up point	Separate pick-up point	Shared reception box
Description	Customer picks up the package from the store	Customer picks up the package from a separate pick-up station	Customer picks up the package from a shared reception box station
Customer preference	Avoids congestions at the store; possibility to fulfil the order with the same trip; does not need to pay for the delivery	Avoids congestions at the store; does not need to pay for the delivery	Closer to the customers than regular pick-up; customer does not need to be at home at the time of delivery
Advantages for grocer	The least costly delivery model; no significant investments needed	The least costly delivery model; easy to scale up; improved picking efficiency in a separate location	Orders can be delivered throughout the day; optimized routes; improved vehicle utilization; decreased transportation costs; decreased investment costs compared to unattended deliveries; improved success rate of deliveries
Challenges for grocer	Picking at the grocery store is slow; hard to scale up due to limited space	Investments to the pick-up station needed; no synergies with the store	High investments to the reception box infrastructure; temperature requirements; theft

2.6 Forecasting and replenishment systems

In grocery retailing, automated replenishment planning has become essential due to the great number of different items and low inventory levels which lead to the workload heavy process (van Donselaar et al., 2005; Horzella, 2005, p. 94). Large grocery retailers can have easily over 10 000 SKUs in the assortment of the stores and one retailer can have hundreds of stores. Taking care of millions of SKU-location combinations requires huge amount work hours if the replenishment decisions are made manually. Even though IT systems have not been able to outperform the store managers with many years' experience in order management of some items, the benefit comes from the great average performance of the automated order calculation and saving time when millions of decisions would be needed to be done

daily letting the order planners only to focus on exceptions and assist on the replenishment of products with volatile sales that are hard to forecast (Angerer et al., 2006, p. 165, 148).

Efficient forecasting and optimized ordering allow the grocer to match the inventory with the demand at the sales location with improved accuracy. Thus, the availability can be improved without losing any sales or increasing spoilage (Kiil et al., 2017; van Donselaar et al., 2005; Horzella, 2005, p. 94). Automatic replenishment systems (ARS), that forecast the demand and calculate order quantities automatically, have been improving to be more effective in the recent decades, and with small margins and trends in sustainability, the importance of functional system increases especially in the grocery industry with perishable products (Kiil et al. 2017; Deshmukh et al., 2008). In addition to automated ordering, ARS enables transparency in the inventory management through the supply chain enabling the retailer to do more in-depth analysis about the inventories at each location without manual labour (Angerer et al., 2006, p. 715).

OOSs has been recognized as one of the main issues in the store-based picking model for OC retailers due to both channels consuming the same inventory (Angerer et al., 2006; Mkansi et al., 2018). Thus, with greater chances to OOS, having optimized safety stock levels and an ordering process that consider the perishability of the product helps OC grocers to reduce the number of OOSs and thus reduce the substitution process that follows the OOS in online orders. According to Angerer et al. (2006, p. 184) with ARS, the inventory levels have been enabled to decrease by 16% in the dairy products compared to a control group while the inventory was more stable in products that were ordered with ARS. Similar results have been noticed by Kiil et al. (2017) where the freshness of the products was noticed to gain 5.2% improvement and decreased the food waste by 1.3%.

As online sales have been noticed to have different sales patterns and preferences compared to B&M sales, utilizing ARS to forecast and replenish the online orders could solve the availability issues in stores (Hübner et al., 2019; Chintagunta, 2012). Thus, grocers with multiple channels should focus that the ARS is up to date with the sales channels and the items are replenished accordingly. If OOS occur, it should be considered in the ARS to avoid the incident in the future as well as possible.

Also, ARS should take the picking time of the order into account even though the actual sale would happen later. It has been studied that the most efficient picking time of online orders at the store is in the morning when there are none or only a few customers at the store to avoid the congestions on the aisles (e.g., Vazquez-Noguerol et al., 2021). According to Mkansi et al. (2018), the timing of the replenishment has significant effects on picking efficiency and the quality of the online orders if the delivery has not been shelved before the picking. First, if the fresh items have not been fulfilled to the shelves before the picking the online orders are fulfilled with items without full shelf life left which might decrease customer satisfaction. Second, if the stockout has happened on the product, the picker collects other items in the orders and then returns to the item with OOS. If the item is still not fulfilled to the shelf, then the substitution process needs to be performed. Thus, late deliveries of the store orders decrease the picking efficiency and might lead to OOSs decreasing customer satisfaction (Mkansi et al., 2018). Therefore, ARS should consider the picking time of the orders when the automated orders are calculated to have sufficient balance at the store early enough in the morning. Angerer et al. (2006, p. 177) summarize the following benefits and costs or challenges of using ARS in Table 4 below.

In addition to these challenges, van Donselaar et al. (2010) found that the ARS system that is implemented for a retailer might not be utilized to its limits due to the system inadequacy and misaligned incentives of the users. It was noticed that the users modified the automatic orders due to available shelf space, seasonality, the uncertainty of the demand, case size's ratio to the sales quantities and product variety (van Donselaar et al., 2010). Because the online sales can follow a separate demand pattern to the B&M sales, automated orders related to the products sold online from stores can be expected to have many manual adjustments if the data from online sales are inadequate and the ordering parameters are not set for the online demand. Furthermore, when people are buying more heavy and bulky items from the online store, the safety stock for these products should be larger to enable orders with large quantities of the same product and not as steady demand.

Table 4: Benefits and challenges of using ARS (Angerer et al., 2006, p. 177)

Benefits	**Costs or challenges**
• Fewer OOSs • Increased product turnover • Improved quality of fresh products • Less frequent deliveries to stores • The decreased workload for the ordering process • Improved demand scheduling at DC • Improved customer service • Improved inventory visibility	• Investment and service costs of IT • Need for educating the personnel • Frequent and small deliveries for some products • The increased workload in product handling in store • Additional need for people managing the system at headquarters

Even though Angerer et al. (2006, p. 177) list the improved inventory visibility to the benefits of using ARS, according to Bimschleger and Patel (2020) the visibility to the inventory has been a challenge for omnichannel retailers and IT systems have been inadequate for providing the needed information. They note that locating products and the availability has not always matched with what is in stock leading to decreased customer satisfaction and false information on what is available to order.

In addition to forecasting the demand and optimizing order quantities, the workforce can be optimized and planned similarly. Mkansi et al. (2018) reported that managing roles and responsibilities have created significant problems in the online grocery industry. They mention the scarcity of specialist skills, balancing labour hours with costs and limited operational capacity to be some of those issues. It was stated that a weak understanding of demand and trends in the workload, inaccurate wage forecasting and poor leave management planning have led to shortages or excess in the workforce capacity leading to weak operational performance.

However, Haddioui and Lange (2021) report that analytics can be used in planning against fluctuations in traffic and workload. They state that these methods aim for lower costs in the operations in the store or warehouse and the delivery. Forecasting the workload requirements gives improved visibility to shift planning and helps the

retailer to match the workload to the demand. They report that implemented solutions have reduced the costs up to 15% in the stores and warehouses. In addition, Mirrazavi and Beringer (2007) showed that the forecast of the needed workforce could be utilized and then generate optimized shifts and assign the tasks to the employees with the right skillsets in a retail store. With this optimization, it was possible to improve workforce efficiency and thus reduce operational costs. Furthermore, it reduces the need for administrative work and thus frees the managers' time for other operational decisions at the store improving the workforce efficiency even more (Mirrazavi & Beringer, 2007). Thus, analytics could be used in shift planning and optimizing the workforce capacity for each moment to improve the efficiency of OC operations.

2.7 Summary of the literature review

Online groceries have increased in recent years and is forecasted to continue the growth. Furthermore, the current pandemic has boosted sales by tripling the share of online groceries compared to the year before the pandemic in some markets (Aull et al., 2021). Thus, focusing on online groceries has increased its significance and traditional grocers have reacted to the change by providing more extensive services. However, online groceries have brought new challenges for grocers. Even though online groceries have been conceived as convenient by the customers, the customers are price-sensitive and not willing to pay for the total picking and delivery costs. Based on the literature, workload-heavy operations of picking and delivering the orders can account for half of the supply chain costs (de Polignac et al., 2015; Hübner et al., 2019). Furthermore, the new channel has increased the importance of availability and OOSs create more significant issues for the grocers as stockouts decrease customer satisfaction more and the substitution process is costly.

As online sales have their own characteristics and the buying habits of online customers differ from the traditional shoppers, online sales should have a separate forecast for replenishment. In addition, different fulfilment and delivery methods have their own advantages and challenges which require attention from the grocers. The most common model of in-store fulfilment is easy and inexpensive to set up and locates close to the customers but the manual picking in the store is costly and it creates availability issues. Separate warehouses for online orders enable more efficient picking and automated picking solutions can be used but require high initial

investments and have high fixed costs. With CDC-based picking, similar advantages and challenges exist, but larger warehouses enable greater assortment and fewer inventory costs with a simple supply chain network. However, CDCs are usually located in less populated areas further from the customers increasing transportation time.

With different delivery methods, home delivery is the most common delivery method the customers prefer due to the convenience of not needing to go to the store at all. However, it is also the most expensive method for the grocer and the delivery fees do not usually cover the costs of the delivery. In addition, the customers need to be at home at the time of the delivery which makes the deliveries to concentrate on the evenings and weekends. Unattended deliveries have been studied to decrease the delivery costs and increase the convenience for the customers but the infrastructure for separate reception boxes has a low utilization rate and thus are expensive for the grocers. In some markets, C&C service has been found to be approved by the customers as it is the cheapest delivery method for both the customer and the grocer. However, as it is not as convenient as home delivery. Finally, separate pick-up points could be used for delivering the orders closer to the customers but enabling unattended deliveries making it more cost-efficient for the grocers. However, as it requires investments and is not conceived as convenient by the customers, it has not been adopted broadly yet.

OC sales have changed the operations in the supply chain and forecasting and replenishment systems should be adjusted for the changes. ARS has been found to decrease spoilage and inventory levels with improved availability. OOSs have been found to be one of the main challenges in store-based order fulfilment and thus, effective ARS should be adjusted for the new online channel with different demand patterns. In addition, sales forecast could be used for forecasting the workload and optimizing the workforce for more efficient operations in picking and delivering the orders. In Figure 5 below, a summary of the most significant and the causes of challenges in OC groceries are represented.

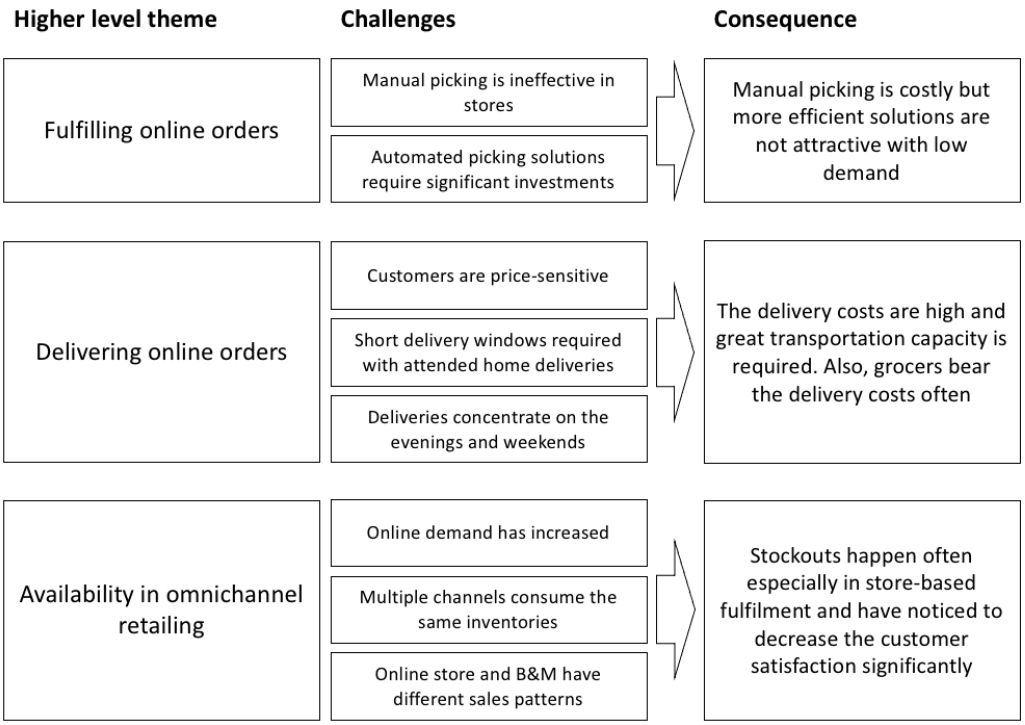

Figure 5: Summary of the most significant challenges of omnichannel grocery retailing based on the literature

3 Research methodology

The research questions of the study focused on how the fulfilment of omnichannel sales is performed and what are the main challenges in omnichannel retailing. To study this phenomenon, first, an extensive literature review was conducted. Second, an empirical multiple-case study was performed, and qualitative interviews were used as the data. In this chapter, the design of the empirical study is presented justified, and the methods and the process are described more thoroughly. In addition, the collected data is analyzed, and the validity of the research is discussed.

3.1 Research design

In inductive studies theory development follows the data and concentrates on acquiring an understanding of the meanings that are attached to the phenomenon (Saunders et al., 2007, p. 118, 120). The more flexible structure of inductive studies enables changes during the research and a smaller amount of data and qualitative research are traditionally used (Saunders et al., 2007, p. 119, 120). In addition, Eisenhardt (1989) states the multiple-case studies have often the characteristics of inductive research.

In the thesis, the existing literature is compared with the qualitative case data of current practices in the online grocery industry and ways to improve the online order fulfilment performance are generated. Thus, the thesis follows the characteristics of an inductive study. Yin (2017) suggests that "how" and "why" questions can be examined with case study research. According to Yin (2017), a case study *"is an empirical method that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context"* and *"copes with the technically distinctive situation in which there will be many more variables of interest than data points"*. Thus, a qualitative multiple-case study approach has been chosen to evaluate the OC environment and the existing challenges around the topic. Furthermore, a case study helps in getting an in-depth understanding of the topic.

Multiple-case studies were discussed by Eisenhardt (1989). Understanding the phenomenon of challenges in online grocery fulfilment, a multiple-case study can be used to gather information on how different companies perceive the challenges in different situations (Eisenhardt, 1989). This type of view gives an objective view of

the issue and helps in seeking patterns. Even though the challenges of online groceries have been studied quite a lot earlier, the industry is developing rapidly as the demand rockets. In phenomena where fresh perspectives are needed around the researched topic, multiple-case studies are appropriate for theory building. Thus, Eisenhardt's method can be justified to be used in the study (Eisenhardt, 1989).

Eisenhardt's method focuses on an objective description of the phenomenon and is interested in the events themselves. These perspectives help to create a generalizable theory and propositions around the research topic. Having multiple cases enables examining different perspectives and comparing processes and performance (Eisenhardt, 1989). In Eisenhardt's method, cross-case analysis is used to find the patterns of similarities and differences between the cases for the theory-building (Eisenhardt, 1989). Thus, different types of grocers around Europe that sell also online were investigated to analyze different setups and the challenges they have met during the recent years.

In this process also sufficient literature review is essential for theory building. Comparing the earlier literature to the cases improves the validity of the results by bringing out similar results to the theory from the literature (Eisenhardt, 1989). Besides, analyzing the conflicting literature improves the creativity in the theory building and forces the researcher to think about the phenomenon from a different perspective (Eisenhardt, 1989).

3.2 Data collection

In this thesis, in addition to the literature review, semi-structured interviews were conducted with grocery retailing managers that are familiar with the fulfilment methods used in the company. The companies in the study were all the customers of an ARS software provider. Thus, the forecasting and replenishment processes should be as close to each other as possible and the differences come from how the fulfilment is done in practice and how they utilize the IT solution in the replenishment.

Semi-structured interviews are greatly used in qualitative studies. In semi-structured interviews, a list of themes and questions is used instead of a standardized set of questions and the researcher can change the questions from an

interview to another (Saunders et al., 2007, p. 312). In addition, to improve the flow of the interview, the order of the questions can be changed between interviews. Saunders et al. (2007, p. 312) also state that questions can be added to the interviews to explore the research questions in specific companies and cases. The semi-structured interviews have naturally open-ended questions about the phenomenon that is research to enable the conversation and not guiding the interviewees to the direction of the answer to reduce bias (Saunders et al., 2007, p. 316, 318). Also, Yin (2017) states that the semi-structured interviews are suitable for case studies and remind more of guided conversations than strictly planned questionnaires.

Due to the conversational type of data collection, the interviews were recorded so that the interviewer did not need to focus on taking notes during the interview. It also helps to return to specific quotes and statements afterwards. Even though traditionally interviews are held face-to-face, due to the COVID-19 pandemic, all the interviews were held remotely through an online meeting platform (Saunders et al., 2007, 341). However, due to the past year, people have used to remote working and the interviewees acted very naturally in the online meeting platform with video connection. Besides, utilizing an online meeting platform enabled interviewing people around Europe easily and helped the researcher to get a sufficient number of interviews.

In addition to the interviews, data from public sources about the online channel strategy of the case companies were analyzed. The public data included the online stores of each case company for analyzing the provided services of delivery methods and meal kit offering and articles of the recent development of the online channel.

3.2.1 Sample selection and interviews

According to Eisenhardt (1989), selecting the population and the sample for the case study plays a crucial role in the theory building and the validity of the results. The population in this study were the multi-channel grocery retailers of a European ARS provider. Instead of omnichannel retailers, multi-channel retailers were selected due to the scarcity of pure omnichannel retailers. Still, as the customers of the ARS provider are located around the world and have different models for online grocery retailing, the population can be thought to represent the online grocery industry well. In total five grocery retailers that sell both through stores and online channels

were selected for the study. In addition, one pure online retailer was selected as well to give a different view of the challenges in online groceries.

This sample was selected from the population and based on the availability and the online channel profile of the case companies. The interviewees were mostly contacted by the managers at the ARS solution provider, to improve the success rate of contacting the customers' managers. This was noticed to be effective and only a couple of the contacted customers stated to be not available for the study. According to Eisenhardt (1989), usually from 4 to 10 cases is sufficient for multiple-case studies and after that, the volume of the information becomes complex and difficult to cope with. In addition, in multiple-case studies, the saturation of the primary data is the key for the number of cases (Eisenhardt, 1989). It was stated that after the theoretical saturation is reached, adding more cases to the study will not bring incremental improvement to the theory.

Therefore, six case companies were decided to be sufficient and companies with different performance and operating models were selected to reach saturation and get an objective understanding of the challenges in online groceries. The selected case companies are significant grocery retailers in their country and also have an increasing online channel. The interviewees were supply chain managers in the case companies and were familiar with the fulfilment methods of the online channel. Thus, the interviewees can be considered to have a suitable understanding of the challenges of online grocery retailing and omnichannel management.

All the case companies were European due to the type of the retailers and the customer base of the European ARS provider. In addition, all the interviews were conducted anonymously to protect the interviewee and the company-specific business-critical processes. This way, the interviewees could speak more freely about the phenomenon and share their own opinions. This was also suggested by Saunders et al. (2007, p. 187). Below in Table 5, you can see the summary of the interviewees and the case companies.

All the interviews lasted about one hour, and in the beginning, the interviewer introduced himself and the study and emphasized anonymity. In addition, permission for recording the interview was asked. In a couple of first interviews, also another interviewer was in the interviews asking further questions about the topics

in the study. This has been discussed to be an efficient way of reducing the interviewer bias that can happen when interviewing alone and helps in investigating the phenomenon from multiple perspectives (Eisenhardt, 1989). These different perspectives could also be utilized in the later interviews where the researcher was interviewing alone. The template of the interview can be seen in Appendix 1.

Table 5: Summary of the interviewees and case companies

Case company	Interviewee	Picking model of online orders	Online focus level	Date
A	Supply chain manager	Automated warehouse and in-store picking	High	24.5.2021
B	Supply chain manager	In-store picking only	Medium	7.6.2021
C	Supply chain manager	Manual picking at the warehouse and in-store	Medium	10.6.2021
D	Process manager	Dark store	Low	29.6.2021
E	Supply chain manager	In-store picking and dark store	Medium	7.7.2021
F	Logistics manager	Manual picking at the warehouse	Pure online	7.7.2021

3.3 Analysis

The data analysis started with getting to know the case company and then analyzing the online strategy and fulfilment model. The researcher used public sources to get to know the company's online model to adjust the semi-structured interviews accordingly. As the interviews were recorded, it was easy for the interviewer to return to the interview. The interviews were then transcribed so that the answers were gone through again and the researcher gets familiar with each case. According to Eisenhardt (1989), this method makes the case more familiar and enables noticing unique patterns before any generalized patterns are created. Transcribing the interviews helped to highlight the most important parts of the interviews and understand a more specific model of the supply chain in OC retailing in the case company.

First, the case-specific profiles and the challenges were recognized with a within-case analysis. Then, cross-case comparisons were made to find patterns in the performance and challenges of the cases. Based on Eisenhardt (1989), the cross-case comparison is a great way to find the similarities and differences in each case and it forces the researcher to investigate the cases with more depth and not trusting the initial impressions. In Eisenhardt's method, it is also important to iterate the theory-building process throughout the research and thus the emerging theory was compared with the case data to validate the results (Eisenhardt, 1989).

Based on Eisenhardt's (1989) suggestion, categories were selected to find similarities and differences in the cross-case comparison: dominant fulfilment model of online orders, share of the online channel in the market and focus on the online channel. These categories can be used in finding the main challenges and pain points that could be improved by creating a more objective view of the phenomenon with categorized results.

3.4 Reliability and validity

The quality and credibility of research can be defined by the reliability and validity of the results (Yin, 2017). The reliability of a study refers to the degree of being able to provide consistent results about the phenomenon with the used methods for data collection and analysis (Saunders et al., 2007, p. 149). This means that if the same research were to be performed again, were the results be similar with different researchers. In qualitative research, the participant bias and the observer bias can create challenges with the reliability of the research as the semi-structured interviews enable forming biases.

For creating transparency in the research, the themes discussed in the semi-structured interviews can be seen in Appendix 1. In the semi-structured interview, the discussion was tried to be maintained open to reduce bias from excess leading. Furthermore, the case companies and the interviewees were selected carefully to represent different kinds of online grocers and anonymity was emphasized to provide a safe environment for the interviewees to share their opinions. In addition, the interviews were recorded and transcribed to reduce the possibility of misunderstandings and forgetting important details. Despite the actions for ensuring reliability, similar results will be hard to conduct in the future as the

attitudes towards online groceries change fast and the ongoing pandemic with exploding demand for online groceries creates a special environment.

The validity of a study considers the correctness of the results and if the research explains the phenomenon (Saunders et al., 2007, p. 150). To provide validity to the research, the interviewed case companies were selected all over Europe with different kinds of online grocery markets to create an objective view of the phenomenon. The case companies' different levels of focus to the online channel create generalizability to the research but due to focusing only on Europe, the results might not reflect the situation, for example, in Asia or North America perfectly. Furthermore, there were no significant conflicts with the existing literature which enhances the validity of the results. However, further research about the results should be conducted to prove the validity of the suggestions.

4 Results

In this chapter, the results of the empirical data are presented, and the data is analyzed based on the methods explained in the previous chapter. The literature review of OC grocery retailing showed that literature about the challenges in online groceries have been studied and suggestions have been created. However, the empirical data shows the current challenges with different OC methods and provides insights into how grocers operate in practice. In addition, the results show what are the challenges and possible solutions and how the case companies see the future of online groceries.

Due to the uniqueness of each grocer and the market they operate in, the challenges were not the same for all grocers and different aspects were emphasized. However, interviewing different types of retailers gave an objective view of the challenges and thus helped in forming the theory of online grocery fulfilment processes. The store-based fulfilment had the most significant challenges of slow picking speed and availability issues. However, the scalability of store-based picking has become vital for OC grocers while the demand has increased fast. However, automated fulfilment solutions have become more attractive and online grocers are planning on investing in advanced solutions.

In this chapter, first, the thesis will introduce the case companies. Second, the used fulfilment models and the challenges are discussed, and the delivery methods are analyzed. Finally, the current technologies used are examined and possible solutions for the current challenges of OC grocers are presented.

4.1 Within-case analysis of the cases

4.1.1 Company A

Case company A is a huge European grocery retailer located in a market with high demand for online groceries. The interviewee was a supply chain manager. The company's focus on the online channel has been significant in the past years and investments in the online service have been made recently. The case company operates hundreds of stores all around the country and is one of the largest supermarket chains in the country. The company's focus on the online channel has

changed in the past decade radically as they started the online service from zero with a partner handling all the online orders in a separate automated distribution center a few years ago. This way they were only able to service the most populated cities and expanded their service with new ODCs.

However, due to the pandemic, they decided to expand their services by doing in-store picking and thus being able to reach much more households fast. In addition, in the cities where the ODCs were, the capacity was not large enough to cover the demand, so stores operated in the same markets. According to the interviewee, with store-based picking, they were able to serve twice as many customers with only in-store picking compared to the ODC-based service. Because all the online sales and delivery were managed by the partner earlier, they decided to invest in their own fleet to deliver the online orders from the stores. In addition, they needed to create processes fast to do in-store picking. They started the store-based order fulfilment with 15 stores but by the end of the year 2020, they managed to expand the service to roughly 400 stores. Still, the future plan was to improve the reach of the automated warehouses with better picking speed.

The replenishment process for online sales was not optimized yet. For the partner, company A acted as a supplier rather than managing the online channel with the partner. However, the customers could see both options of delivering from the store or ODC interchangeably and thus decide the assortment and the inventory where the order gets picked from. This option is only in the areas that are in the delivery range of both options.

For company A, OOSs created significant issues at the stores where online orders were fulfilled. In addition, based on the interview, the KPIs of the delivery accuracy and stock integrity were a lot worse than the partner's KPIs. The reason for lower delivery accuracy was due to the low picking speed in stores. However, the company has planned to enable forecasting the online sales in the stores separately for improved replenishment accuracy.

4.1.2 Company B

Case company B is a large European grocery retailer with over a thousand stores operating in smaller online markets than company A and having a low share of online sales. The business model of company B is based on having single

storekeepers in a large grocery chain and each store can have its own operations and assortment. The interviewee was a supply chain manager in the company. By having the storekeeper-based model, the chain can offer focused store specific service and experience to the customers leading to improved customer satisfaction. Despite, the online service is provided in the chain and the store-specific experience is only seen as changes in the assortment. Furthermore, all the online orders are fulfilled at the store due to the low demand and easily scalable store-based picking model.

The latest investments have related to the front end of the online channel platform and the customer experience in online orders. As the online sales have been on a low level before COVID-19, no significant investments have been made to the fulfilment process of the online orders. However, as the pandemic has increased online sales significantly, investments to more efficient fulfilment are needed. Still, the interviewee was not willing to mention the exact plans of the company. In addition, the online orders have not been separately forecasted due to the low demand but as the demand has increased significantly, it will be a probable change in the future to improve the SC performance.

In company B, there are over 400 stores that can be used in online sales. However, many of those are smaller convenience stores where the online orders are occasional and only provided as a special service. Still, the demand for online orders in the large hypermarkets located in more populated areas has increased a lot and the level of online orders is large enough to create challenges for the grocer leading to planning changes in the online fulfilment model. The company is planning to set up an automated warehouse to fulfil online orders. However, the interviewee stated that the automated systems are slow to set up and even though they have reacted to the increase in the demand, it takes time until the new model is ready to be used.

For company B, the greatest challenges have been the low picking speed and OOS management. Even though they have been using picking software in the stores, the personal differences of the pickers still affect the picking performance a lot and the software has not been able to provide sufficient improvements. Also, the company stated that the change in the flow of goods has created congestions in the backroom and loading area decreasing the performance of the operations.

4.1.3 Company C

Company C is a European smaller grocery chain with around 30 stores and offers high-end products for the customer. The chain is located in a country with a high level of online demand but the focus on the online chain has been moderate due to the premium product assortment and the service they have the core competence in. Due to the premium brand, the customers are extra keen on feeling and seeing the fresh products they buy. In addition, the company sells product packages and meal kits through the online channel which has been noticed to be profitable. The interviewee was a supply chain manager in the company.

Before COVID-19, the online channel of the company was mostly used for enabling the ordering of high-end products that are not possibly available in the stores regularly, for example, specialized birthday cakes or high-quality steaks. Furthermore, they did not have home deliveries at all before the pandemic but now they have expanded to deliver to the proximity of the stores. However, this has not been in the focus and the home deliveries need to be agreed with the store that delivers the orders separately so that the people that could not go to the store would be able to remain as customers and improve customer loyalty.

The model that has been in use in company C is highly dependent on the performance of the suppliers as close partnerships are created to enable shorter lead times on the ordered items. Because of the premium brand, company C has not focused on the efficiency of the online channel but the quality of the service and the freshness of the products. In this kind of model, the OOSs are extremely difficult as there might not be any suitable substitutive products and each substitution is asked separately from the customer.

The picking of the online orders happens usually in the stores, but special items need to be delivered from the warehouse to the stores with separate orders. The store-based model is used due to the simplicity of the supply chain model. It was stated that the store can be more agile in adapting to the situation and making sure that the order gets delivered on time. Also, picking in the warehouse would require a lot of space if all the picking was performed there. The company has no specific plans to improve the picking efficiency at the moment as they focus more on the high-end service rather than efficiency in operations. However, they are trying to improve the

supply chain performance on the delivery times from the supplier to the stores as it would decrease the lead time for the customer.

4.1.4 Company D

Company D is one of the leading grocers in a European country with low demand for online groceries. The grocery chain has hundreds of different sized stores around the country and has been offering also online service for a few years. The focus on the online channel has not been significant because of the price-sensitive customers in the market and challenges in profitability. The interviewee was a process manager in the company.

The online channel of the case company focused on one dark store which handled almost all online orders and is replenished from the CDC. In addition to this, few other stores were also delivering online orders but on a significantly smaller scale. The dark store is attached to a supermarket and the location was decided to be naturally in the capital of the country to be in the most densely populated area. The dark store has a limited assortment compared to the stores and has mostly products with high sales volume and not ultra-fresh products. Earlier, the orders collected from the dark store were fulfilled with the items from the store to maintain the store assortment but due to the availability issues in the store, the online orders were changed to be picked from the dark store only.

Even though the fulfilment process of the stores is very centralized in the organization, the dark store has its own managers responsible for the replenishment. With the increased attention to the online channel, company D focuses to improve the availability in the online store and manage the fluctuation in the demand. The picking in the dark store is performed manually with helping software that guides the pickers.

The most common delivery method is the attended home delivery. However, they have launched multiple separate pick-up points around the city that are used like shared reception boxes in conventional locations. This way they have been able to decrease the delivery costs of online orders. According to the interviewee, the company's online order picking capacity has not been enough for meeting the demand for online orders and high demand has decreased the performance more. However, the benefit of having only dark store-based fulfilment has improved the

stock integrity and the interviewee did not consider OOS as a significant challenge. In addition, having increased inventories and a separate demand planner for the dark store has improved the availability. Despite the challenges with the picking capacity in the dark store, the company has not been planning on increasing the capacity with store-based fulfilment or investing in automated solutions. The decision has been made because the online channel has not been profitable, and they have not been able to compete with the prices or service level decreasing the competitiveness in the market.

4.1.5 Company E

Company E operates in a market with medium online grocery demand in Europe and has hundreds of stores around the country. However, only around 40 of those are used in online sales which have wide assortments. All the stores are fulfilled centrally from the CDC, but they have their own forecasting and replenishment managers at the stores. The focus on the online channel has been moderate as the fulfilment model has changed recently but the future of the online channel was not clear. The interviewee was a supply chain manager at the company.

The company has operated a dark store to fulfil all the online orders but due to the pandemic, they changed the operating model to pick most of the online orders at the stores to have increased capacity. The increased capacity in stores enabled to keep up with the demand but created new problems for the stores due to the large change. At the moment the dark store is used to pick readily planned meal kits that customers can order with a recipe. However, as the ready meal packs need to be ordered in advance, the dark store safety stocks can be kept at zero and the CDC supplies only the needed quantities of items. The store-based model allowed the company to match the demand and offer a greater assortment for the customers. Pandemic has changed the attitudes towards online grocery retailing in the market and very price-sensitive customers have started buying groceries online.

Due to the price-sensitivity of the customers, C&C is the dominant delivery method in the omnichannel model and helps the company to have a more efficient online channel. Still, picking at the stores is inefficient and the store-based fulfilment model has sometimes issues with availability as the demand fluctuates during the pandemic. However, the company did not have plans to centralize the online order

fulfilment in the near future as the demand is quite unpredictable and as the C&C is the dominant delivery method, the store network gives them a good reach to a wide customer base. The company did not have a plan on changing back to the dark store-based fulfilment model due to the capacity restrictions it creates. While the demand is moderate, picking will be done in the stores but the demand planner at the store need to focus on the availability to reduce the number of OOSs.

4.1.6 Company F

Company F is the only pure online player interviewed in the study. Company F operates in a European country with medium online demand and distributes the online orders to the whole country from three different warehouses. The company is the leading online grocer in the country but has competition with omnichannel grocers and other smaller online players. The warehouse-based model enables efficient picking and great product assortment to offer for the customers. Also, they can compete with price as the grocery business is extremely price-sensitive. The interviewee was a logistics manager in the company.

Due to the pandemic, the company had to increase its capacity and set up a third warehouse. The increase in demand led them to struggle with the capacity which made the company lose sales in addition to decrease the efficiency in the overloaded warehouses. The company had a longer-term plan to set up a larger automated warehouse instead of setting up more warehouses they needed to scale up the capacity fast to increase the customer base. Even though they have just set up a new warehouse, they have the plan to set up the new larger automated warehouse in a couple of years and putting down two of the current warehouses. Thus, they would be able to increase the assortment in the online store and improve the picking efficiency significantly. However, they need to keep one of the current warehouses to enable reasonably fast deliveries to the whole country.

The interviewee stated that the company has selected the strategy of fewer larger warehouses to have competitive prices instead of fast delivery times due to the demand in the market. Based on the interviewee, building automated warehouses is so expensive that it would not be profitable to build many of those with the current demand forecast. For the online grocer, the largest challenges in providing the service are picking efficiency in the manual warehouses and the inefficient

deliveries. At the moment they are having only attended home deliveries, but they have tested the pick-up point system. The model with pick-up points worked well but due to technical issues with the reception box provider, they quit the pilot.

The largest advantage over the store-based model in manual picking is the warehouse design which decreases the walking distance of the pickers compared to stores. The unique organization of the products enables denser and higher shelves with the layout that has the best selling items in one place and heavier items in one place for example. In addition, the picking can be done in the warehouse the whole day which increases the picking capacity. Even though stockouts have been a major challenge in online grocery retailing, the pure online player has not considered it to create significant issues. OOSs still happen at company F and the replacement process is very manual but due to the pure online model, stockouts do not happen so often compared to a store-based fulfilment.

4.1.7 Summary of the cases and cross-case analysis

The summary of the cases and a cross-case analysis can be seen in Table 6 below. The cross-case analysis is further conducted in the results section later and the categories of the cross-case analysis are used to analyze the results.

Table 6: Summary of the cross-case analysis

Case	Online market demand	Online fulfilment model	Changes in the supply chain	Advantages of the chosen model	Most significant challenges
A	High	Automated online warehouses by the partner and in-store picking by the company	Expanded to the store-based picking due to the fast increase in demand	Efficient and easy online operations with the partner. In-store picking created the needed scalability and geographical reach	Fast expansion with the warehouses is challenging. Availability and picking efficiency issues in the stores
B	Low	In-store picking	Has been planning to enable automated warehouse for picking	Store-based picking easy to set up and low fixed cost with low online demand	Picking efficiency decreases profitability. Availability issues
C	High	Piking in the store and warehouse	Started to offer home deliveries due to the restrictions	High-end service with high-end items. Service before efficiency	Increased demand increased OOSs
D	Low	Picking in the dark	-	Improved availability when picking only in the dark store. Faster picking than in stores	Picking capacity and assortment are too low
E	Medium	Picking in the stores and dark store	Changed to store-based picking and picks only meal kits in the dark store due to capacity issues	In-store picking enabled scalability when demand increased	OOS issues in the stores. Picking speed in the stores low but dark store did not have the needed capacity
F	Medium	Manual picking in the warehouse	Set up the third warehouse recently and planning to build a larger automated warehouse soon	Large warehouses for picking enable increased assortment and the warehouse design more efficient picking	Capacity issues when the demand increased. Slow to expand the service

4.2 Scalability of the store-based order fulfilment

The profitability of online grocery retailing was questioned in the interviews multiple times and due to the high costs of online retailing, companies have struggled with the online channel and invested in the channel with different importance. A couple of the interviewed companies where the online focus was low, discussed the better profitability of B&M sales compared to the online channel and thus having a lower interest to invest heavily in the online channel operations.

Naturally, the low efficiency of store-based picking came up in all the interviews. However, most of the companies still picked most of the online orders in stores. As discussed in the literature review, the store-based picking model of online orders enables a scalable online channel without large investments in external facilities. This came up in the interviews multiple times. In addition, especially in the model of company A, the extreme advantages of in-store picking came up. Company A first had only separate fulfilment centers for online orders but had to expand their services also to a store-based model due to the lack of capacity and the geographical reach of the ODCs of the partner. When the demand exploded due to the pandemic, they had to be able to serve the demand to remain competitive in the future and gain customers. This could be seen in company E too, where they changed to in-store picking from the dark store-based model due to the increase of the sales and inadequate capacity in the dark store.

Conversely, for example, in the model of company B, store-based online order fulfilment enabled offering the online channel with low online demand. With low online demand, the ODC-based fulfilment has been found to be unprofitable and this came up in the interview of company D which used dark store to pick online orders but struggled with profitability. In addition, Kämäräinen et al. (2001b) stated that in online grocery retailing, focusing on levelling the demand will be more important than investments in advanced warehouses with high fixed costs.

Furthermore, company B mentions that as the stores and the backrooms of the stores have been designed for one-way flow, picking and delivering online orders creates huge congestions in the backroom and the loading dock when large trucks deliver the goods and smaller vans leave with the orders. Even though backroom storage utilization was suggested by Aastrup and Kotzab (2010), multiple case

companies did not have the needed space for further utilization and the backroom was already full. Also, it was stated that the physical restrictions in picking carts also slow down the picking process as the aisles are narrow and therefore neither more orders can be picked by the same picker nor more picking carts will fit the store at the same time. Thus, the store-based model will have more limits in scaling up the online channel than picking speed only and the flow of goods needs to be designed again if stores are used in the online channel in the future.

At the moment the level of online groceries has increased so much that focusing on more automated solutions has become an attractive option for omnichannel grocers. In addition, the pure online player, company F, has succeeded with the warehouse-based model and increase the capacity in a short time. As the demand has now levelled after the huge increase due to COVID-19, it will be easier to plan the size of the automated warehouses needed. However, the huge increase in online groceries led to the overloaded warehouses and decreased the efficiency of the whole supply chain. Thus, company F needed to set up a new warehouse to manage the increased demand.

Despite the market share of online groceries in the market before COVID-19, online grocery sales increased significantly and created issues for the grocers in managing the sales. However, the company's focus on the online channel could be noticed to have helped the company to cope with the issues and react faster to the challenges that the increased sales created. Thus, the lack of focus and investments in the online channel will reduce the grocers' competitive advantage and slow down the reactions in the changing market.

Before COVID-19, the case companies had extra capacity to pick and deliver the online orders due to the centralized demand to the most popular hours after work. However, now as people are at home a lot more, people are willing to order groceries at home with deliveries during the day which has evened the demand but decreased the capacity buffer leading to capacity challenges also in stores. Thus, increasing the picking capacity should be done in the future to meet the demand with efficient operations. Furthermore, companies with store-based fulfilment models had similar challenges in fulfilling the online orders: the picking efficiency in stores is low and the poor availability of the products.

4.2.1 Picking speed in stores

As it was expected, according to the interviews, the picking speed in stores has been slow and creates a lot of costs in the online fulfilment process. Despite the focus and effort to the online channel, all of the case companies considered that the picking speed needs to be improved and the current speed is not fast enough for sustainable online groceries. The picking speed has been tried to improve with software helping in the picking process but according to the interviews, the picker's personal performance affects even more. According to company B, some of the most efficient pickers can be twice as fast as an average picker. Usually, the case companies use a standard pool of pickers but as the demand varies, the other store workers need to be used too to fulfil the demand. Less experienced pickers have been noticed to be slower and create extra costs for the grocers. This issue of the lack of skilled personnel has been noticed also by Mkansi et al. (2018)

Many of the interviewees noted that the stores are not designed for efficient picking as the pickers need to walk through the whole store to pick the orders and most of the picking is done in following the order of the store. In the warehouse of the pure online player, the aisles are higher, and the products are set more densely. In addition, the warehouses are designed for the most efficient picking. For example, the best-selling items are close to each other and heavy items are close to each other to speed up the picking process.

However, as the warehouse-based model in picking should be more efficient than the store-based model, company D was not satisfied with the picking speed in the dark store. The interviewee stated that with the current fulfilment efficiency, the online channel is not profitable and thus changes should be made. However, in the country, the customers switch the grocer based on the service fees and utilize the fierce competition between the online grocery providers and thus decreasing the profitability of the online channel.

All the case companies had some software in use in the picking process. However, none of the companies was fully satisfied with the software in use to have all the helping information for efficient picking. The most common flaw was that the balances in the software were not up to date and the optimized routing for the picking was not available. In addition, insufficient data in the picking software has

been noticed to create too long picking routes if the locations of the products were not accurate or up to date. Some of the case companies had developed a picking software themselves to use in the picking process and others had procured it outside the company. However, it was stated that the current market for suitable software for helping in the store-based picking process is not sufficient and they needed to do a lot of compromises in the selected software.

Store-based fulfilment solution has enabled great scalability through the fast increase in the demand and companies without store-based solutions struggled to increase the picking capacity during the pandemic. Earlier literature has also identified the benefits of utilizing the existing store network for easy expansion of the online service (Wollenburg et al., 2018b; Hübner et al., 2016a). Thus, companies without store-based fulfilment have expanded to having in-store picking to improve the geographical reach and picking capacity. Like Mkansi et al. suggested (2018), the picking speed in stores was stated to be low and the picking is needed to be done in the mornings to reduce the congestions on the aisles. However, as the demand has increased, it has been noticed to limit the picking capacity after all the stores are in use. Still, picking software have been used to improve the picking speed and help pickers in the decision making but the design of the stores and inaccurate information is reducing the possibility for more efficient solutions. In addition, changing the flow of the store creates issues for the grocers as the stores have been designed for only one-way flow, from the loading area to the cashiers.

4.2.2 Availability for online store

Another issue that came up in the interviews was the availability issues in stores where the online fulfilment is performed. As discussed in the literature review, the stockouts are more likely to happen in the online channel where the orders are fulfilled in stores. This was confirmed in the interviews that the issue still exists. For example, company D decided to fulfil the orders only with the dark store due to the OOSs that happened in the store due to multiple channels consuming the same inventory. In addition, in warehouse-based models, the case companies stated that stockouts do not create as significant challenges as they created in stores.

However, unlike the literature would suggest, the companies did not have yet separate forecasts for online demand in stores but was planning to set up the system

to enable it. Thus, the online demand was forecasted and replenished like traditional B&M demand in ARS. Even though the demand has flattened after the beginning of the pandemic, the stores have not been able to adjust to the change in the sales patterns and stockouts happen often. Based on the interviews and earlier literature, the companies with a store-based picking model need to do the picking early in the morning due to the high number of customers in the stores in the afternoon. Thus, the deliveries of the date might not have been shelved yet, which leads to additional picking rounds after the shelving or OOSs if the delivery does make it to the order. The additional picking rounds were performed in the warehouses too if the items might have been delivered to the warehouse between the first picking round and the departure of the order. However, case companies with warehouse-based picking models are able to do the picking throughout the day which decreases the risk of too early picking on the same morning and reduces second picking rounds.

The additional picking rounds create unnecessary work and thus decreases the picking efficiency. Thus, up to date data about the inventory and possible deliveries should be available for the pickers and the picking software to help in the picking process. Then the decisions about substituting items for the customers could be done in the first round of picking and fewer second picking rounds are needed. However, the reason for the needed second round should be considered first. According to the interviewees, this happened mostly with the "ultra-fresh" items, for example, fresh bread, that is delivered almost every morning. Still, as these have been noticed to create many stockouts that are decreasing customer satisfaction, either the availability of the items in the online channel or the delivery schedule should be changed to reduce the OOSs in the online channel. One of the cases companies had changed to strategically deliver the products to the stores during the night to solve this kind of issue.

According to company A, the partner with the automated warehouses has an intelligent system that predicts the availability of the items at the time the order is picked and anticipates if they can fulfil the orders with the item. With inventory data that was updated every 15 minutes, the system can set the items unavailable on the online store fast, so OOSs were reduced in the picking phase. In most case companies, the inventory and sales data were updated less frequently, for example, once a day, which makes the online channel less reactive and more prone to OOSs.

The management of OOSs was conducted very manually in the case companies, which required a lot of work from the grocer. In many companies, the customer was called to confirm if they can substitute a product that was not available for picking and suggested the substitute. In most cases, the pickers need to use their own knowledge of the products to decide the appropriate substitutive product. Angerer et al. (2006) stated that OOSs were the most customer satisfaction decreasing factors in online groceries and Colla & Lapoule (2012) suggested that products with at least the same quality should be selected to be the substitutive products to maintain customer satisfaction. It was stated by the interviewees that OOSs are expensive for the grocer and even if the substitutes were good, customer satisfaction has been noticed to decrease. Only company A stated that their commercial team has selected a substitutive product for all items in the store to ease the decision-making process of the pickers. In addition, the partner of company A had their own system for deciding the substitutes in the automated warehouse and with the predictive inventory management, the partner has been able to have better stock integrity than company A has been able to have in stores.

In worst cases, OOS has led the system to increase the inventory of the substitutive product while decreasing the inventory of the original product with the stockouts. This has happened due to the increased sales and forecast of the substitutive product while the sales and forecast of the original product have decreased. Without a proper correction to the situation, this self-feeding behaviour of the substitution process OOSs of one product can create more OOSs in the future decreasing the customer satisfaction and profitability of the online channel. This might happen more easily at the stores where they do not have proper information of the sales and the online substitute sales cannot be seen in the system.

Company D has put extra effort in managing the forecast and replenishment of the online sales as even though other stores are replenished centrally with ARS, the dark store has its own replenishment planner which enables more focus on reducing OOSs. The interviewee stated that it helps the company to react to short term changes faster and increase or decrease the inventory accordingly. As the past year has been hard to forecast for online grocers, they have kept 15% larger inventories in the dark stores than they would have in regular stores to be able to increase the availability. The products that are not ultra-fresh and do not spoil fast can have larger inventories in the dark store to secure the sales.

It was noticed that the share or the focus to the online sales increased the company's ability to react to the OOSs and the companies with a lower-level focus on the online channel had greater issues with the availability. Without proper availability management for the online channel, OOSs seem to occur more often, and the grocer needs to spend more time on the substitution process. However, with the pure online player and the omnichannel company A with the most focus on the online channel OOSs happened still and the issue was not completely solved. Still, both were focusing on improving the availability by improving the delivery schedules and focusing on the online channel forecast.

Based on the findings, stockouts create the greatest challenges in the stores and dark store or warehouse-based fulfilment are not as prone for stockouts. The reason for the challenge of OOSs in the stores is due to the two channels consuming the same inventories (Hübner et al., 2016a). Despite the sales patterns have been noticed to be different in the online and B&M channels, the study finds that forecasting the demand at the stores happens only on one level leading to inaccurate forecasts for the online channel (Hübner et al., 2019). In addition, the visibility to the balances at the stores is lower as the item can be sold out between the purchase in the online store and picking. Picking in the mornings makes the inventories more vulnerable to late deliveries and the shelves might not be fulfilled early enough for delivering the online orders. Thus, adjusting the delivery schedules should be considered for store-based fulfilment.

4.2.3 Uncertainty in the online grocery market

The recent year has shown the unpredictability of the online grocery market. For a long time, it has been forecasted that online groceries will increase, usually, the share of online sales has been left far from the forecasted result. During the pandemic, online sales have increased and according to the interviewees, none of them had the capacity or capabilities to react to the demand. Now the demand has levelled, and the grocers have been able to adjust their supply chain accordingly. However, uncertainty has been hindering down the investments and has shown that the correct scale is hard to match.

All the case companies with warehouse-based fulfilment had issues with the increase in demand as the capacity in either ODC or dark stores could not meet the demand.

This led the case companies to either increase the warehouse capacity or use also stores in the fulfilment. The more, the company had focused on the online channel, the clearer the plans were to expand. This could be seen, for example, in the interview with company D. The company had wanted to offer online groceries and had set up a dark store for fulfilling the orders. However, now the dark store is overloaded and cannot handle online orders efficiently. According to the interview, their online store is not the cheapest or fastest, they do not offer the largest assortment, the range for the delivery is not the best, and the website is not convenient. Thus, their competitiveness is low in the market. It was also stated that if they would be able to design the dark store again two years ago, it should have been larger, and automation should have been considered. However, now it needed at least double the volume to the online store before building a new larger automated warehouse would be profitable.

Still, most of the case companies are looking for scaling up their online channel capacity and looking for new solutions to improve efficiency. The scalability of the store-based fulfilment model has helped the companies to get started in omnichannel sales but in the future, the stores will not be able to handle the flow of the goods. Even though the uncertainty of the demand of the future, the most focused to online channel had clear plans in expanding to the more automatized model for online retailing. Warehouse-based solutions were more popular according to the interviews to enable larger assortment to be automatically picked and to utilize the economies of scale to make the large investment more profitable.

According to the interviews, current backrooms are small, and further utilization of the backroom for online orders would be hard. Thus MFC-based solutions are hard to execute in addition to the expensive robotics which the MFC needed. In addition, setting up more dark stores were not discussed as an option because the picking in MFC is not the most efficient solution and still requires significant investments. Even though MFC-based picking would bring the benefits of shorter delivery times and increase geographical reach easily, large scale efficiency was considered to create more competitiveness in the business which customers are extremely price-sensitive. Based on the pure online grocer, company F, it is a competition between offering the best service level or being more efficient and offering the cheapest prices. Thus, they have decided to move to less but bigger warehouses in the future to improve the competitiveness in price and drive down the operating costs.

COVID-19 pandemic has had effects on every company's operating model which can be seen in the future too. For example, company C, which had the lowest focus on efficient online retailing due to the high-end products, needed to start providing home delivery service to maintain the customer base after the restrictions loosen. In addition, company E moved from the dark store-based picking to the store-based model which has been a profitable move. In the market of company E, the customers are extremely price-sensitive and like to utilize C&C services which encourage the company to continue with the store-based model. Furthermore, company D had put up a dark store to support the online model attached to the store so that less frequent items could be picked in the store. However, as picking in the store created OOSs more than expected, they decided to move to pick most of the orders only in the dark store. This decreased the assortment they could easily offer online and the capacity they will be able to pick in a day. Now the capacity is not enough to satisfy the demand, but no larger investments are planned to improve the service even though the online channel has been increasing continuously.

Uncertainty has been noticed to hinder investments. It makes it harder to choose the needed scale for new fulfilment solutions and the warning example of Webvan from the past decreases the rush in investing in automated solutions (Hays et al., 2005). In addition, Kämäräinen et al. (2001b) has emphasized the requirement for well forecasted and reasonably stable online demand to have a profitable warehouse-based online strategy. However, the leaders in the online grocery industry have already begun utilizing automation in the picking of orders successfully, which clearly increases the urgency for actions. Still, the online channel has been unprofitable for some and the demand varies between different markets. Thus, investing in automated solutions might not be profitable for all yet but will give a competitive advantage to the grocers in the future certainly.

4.3 Delivering the orders

As expected, the last-mile delivery of the orders was noticed to be one of the main challenges in online grocery retailing. Companies had different models for delivering the orders which divided the grocery retailers. Some of the companies had outsourced the last-mile delivery of the online orders and others had their own fleet to execute the operation. Even though the delivery of online orders was recognized to be one of the main challenges, the actions for more efficient deliveries were not as

significant as improving the picking process. Despite the picking model, all companies provided home deliveries to be competitive in the market. The significance of home deliveries increased during the pandemic so that people did not need to go to the store at all. As discussed in the previous chapter, the customers were now willing to receive the orders during the day while no other delivery slots were available. Thus, the pandemic did not increase the stress to the delivery system as much as it did to the picking model as the capacity for deliveries existed already.

A used model was to own the fleet and hire the personnel to deliver the orders to the customers. For example, companies A and C needed to procure the fleet after the pandemic started because they were not providing home delivery service from the stores before. Both companies operate in a market with home delivery as a dominant delivery model. Company A delivered home also through the partner, but the operations were separate, and the partner had their own model for delivering the order. However, the customer could not tell the difference between an order delivered by the partner due to the same logos used in the delivery process. The interviewee stated that the partner had significantly better key performance indicators (KPI) in the delivery process and the accuracy of meeting the delivery window was a lot better with the partner. Thus, their delivery model had a lower customer satisfaction level than in the orders that their partner fulfilled and delivered. Still, company A stated that the issue for not meeting the delivery schedule was mostly due to the picking efficiency and additional picking rounds that were needed to fulfil the orders.

Company D, in a smaller online market, stated that the customers are very price-sensitive and change the grocer based on the delivery prices often. In addition, it was stated that the order price limit for free deliveries can be very low and the delivery distances long leading to unprofitable deliveries. Company D had one of the shortest delivery ranges in the market because they did not have such a high focus on the online channel and longer deliveries would create more losses to the company. Thus, their competitiveness in the market was not great. The interviewee stated that the deliveries were not the greatest issues still due to the inefficient picking in the dark store with inadequate capacity. However, the company utilized separate pickup points with shared reception boxes which improved the delivery efficiency significantly. The competitors did not have the option of separate pickup points which increased the demand for their service. The separate pickup points were

located at gas stations or other locations where people are driving by, for example. This way the delivery slots are not as hard to manage, and the transportation distance decreases significantly. Furthermore, no other case company seemed to have active deliveries through separate pickup stations with reception boxes.

The pure online grocer, company F, and company B had outsourced the last mile delivery to a transportation company that operates under the brand of the grocer. Similarly, to the partner of company A, the delivery vehicles and personnel were operating under the brand of the grocer, so the delivery service affected the customer satisfaction of the grocer and not the delivery company. They stated that because the transportation business is not the core of their operations, it is more sensible to outsource the delivery service. In addition, the transportation business is a very competitive industry and thus the differences are not large, and the price is reasonable. The risk in outsourcing the delivery company is to have the needed quality in the delivery because otherwise, it will have an impact on the customer satisfaction of the grocer. Therefore, agreements with the transportation companies need to be done for having aligned interests.

Despite the home delivery model, the home deliveries were stated to be inefficient and needed improvements in the future. Still, the customers' needs for shorter delivery windows restrict the more optimized routing, and the price-sensitive customers are not willing to pay more for the service yet. Many of the interviewed companies had challenges to meet the delivery schedule during the busiest hours of the day and the unpredictability of the traffic created delays in the deliveries. However, the case companies were not worried about the delivery efficiency and focused more on the picking efficiency and their capabilities to offer more delivery slots through more efficient picking.

In the market of company E, the price-sensitive customers were not willing to pay for the delivery service extra and the grocers in the market were competing with each other by offering cheaper deliveries. Thus, the most used delivery method for company E was C&C which decreased the supply chain costs of the online channel. In the market, the customers were used to C&C service and find it convenient as it decreases the time used in the store. In other markets the home delivery has been preferred significantly more to C&C services, so grocers have had larger problems with home delivery. As stated in the case description, company F, the pure online

grocer, had a pilot considering the separate pickup points with shared reception boxes but due to technical difficulties with the supplier, they needed to end the service.

In all cases where customers used the C&C from the store or separate pickup points, the customers were satisfied with the convenience but still, the home delivery dominates the online grocery market. The issue with shared reception boxes was that the pickup windows were long which led to the maximal utilization rate of the boxes and disabled delivering more orders. If the windows were shorter, the most used reception boxes could have even larger order quantities during a day. This could be possible because usually, the slots were so long that the reception boxes were empty a large part of the time. Thus, offering shorter pickup slots for the reception boxes with slightly cheaper service costs would align the customers' interests for shorter pickup slots.

In the academic literature, the last-mile delivery has been suggested to be the most challenging part of online groceries and efficient last-mile logistics were considered to create the greatest competitive advantage (Boyer et al., 2004, p. 186; Hays et al., 2005; Martín et al., 2019). Even though the delivery costs can account for at least the same amount of costs to the picking, grocers do not perceive delivery operations as a central challenge as the fulfilment of the orders. The costs of the delivery service are still high, but the current models have worked and increasing demand has been able to be managed with current methods. In addition, outsourcing the delivery service is becoming more popular helping the grocer to only focus on the core of the business. However, if a lot of outsourcing is done, it decreases the possibilities of the grocer to affect the costs and might lead to not optimizing the delivery costs in the future. Also, pickup points have gotten a good reception from the customers and are a flexible option for both, the grocer and the customer. Thus, it is expected that the reception box-based model will have more attention in the future for more efficient grocery retailing.

4.4 Technology in OC retailing

Due to the newly developed market of online groceries, more advanced solutions and complicated networks are needed to improve the efficiency of OC grocers. Partnering and outsourcing have become more popular solutions to create value in OC

operations and enable a more efficient supply chain. The companies interviewed partnered with automated fulfilment solutions and IT solutions to help them manage the challenges that increased sales through the online channel have created. Already Hays et al. (2005) discussed the option of partnering to improve the supply chain efficiency.

4.4.1 Automated picking solutions

The only company interviewed with an automated picking solution in use had the option enabled by the partner. Automated solutions are expensive to develop and have high fixed costs which is why those need great sales volumes to maintain profitability. This has been stated by Kämäräinen et al. (2001b) also. Therefore, case companies had not invested in highly automated warehouses yet, but it seems to be the next step for OC grocery retailing. Tjon Pian Gi and Spielvogel (2021) discussed the examples and the pros of partnering with technology companies to benefit from the capabilities of the partner. Company A works as a great example of a successful partnership with a technology provider. Even though the partner has its own ways of operations and is very independent, company A has not felt that it would be taken advantage of. Conversely, the interviewee thought that the partnership has put the grocer in a strong position and enabled the early steps in online grocery retailing with low effort and great results. Partnering with a technological leader in the industry helped the grocer to get to know the needed processes in the area which was not familiar to them and did not require large initial investments.

According to the interviewee, the KPIs of the delivery times and accuracy of the partner are best in class and they have appreciated the performance of the partner even more after they have started picking themselves in the stores too. The stock integrity, picking speed and picking accuracy in the automatized warehouses have outperformed the stores. Even though the grocer operates more as a supplier than a close partner, the customer gets serviced under the brand of the grocer. In addition, the groceries are bought from the same website despite will it be picked in a store or a warehouse. The partner had their own forecasting and replenishment systems, and the partner managed their own delivery network, so the operations were not integrated. Integrating IT systems in the supply chain could have improved the supply chain performance but as the online channel of the grocer was set up only after the pandemic, providing a full online service sounded reasonable.

For company A, the partner did not offer only automated warehouses for picking but a complete online service. Therefore, the grocer was able to increase the online sales fast without a long process of analyzing the processes and deciding and implementing the selected model. They were able to start with one warehouse in the most densely populated area and expand to multiple warehouses and improved geographical reach. However, the beginning of the pandemic showed concretely the disadvantage of the warehouse-based model, the scalability. Until the demand increased steadily, they were able to set up new warehouses with the partner to expand the service but after the pandemic started, the grocer needed to start picking the orders in the warehouse and procure fleet for the deliveries to meet the demand and maintain the customer base.

In the future, multiple case companies considered utilizing automation in picking and as stated, the pure online retailer already had plans for a new large, automated warehouse. However, the warehouse will be their own and no straight partners are included. Thus, it was stated that the initial investment to the new warehouse will be large and they will focus on one larger warehouse instead of multiple smaller ones due to the investment costs.

The uncertainty of online groceries has hindered down the investments and this can be seen especially in the more advanced solutions. Despite the market and the case company's focus on the online channel, automated solutions in the picking have been considered but before COVID-19, the growth of the market was insecure and the correct scale for an automated warehouse was hard to decide. In addition, before the pandemic, there was not enough online grocery demand for automated solutions in many markets in Europe.

Now the demand for online groceries have increased to a sufficient level and OC grocers need to actively improve their efficiency to remain competitive. Thus, automated picking solutions need to be emphasized when investment decisions are made. The interviews have shown that dark store-based models are not sustainable, and the advantages of dark stores are not significant when compared to store-based picking. Because the picking speed will not be significantly improved with manual picking in the dark store, more advanced solutions should be considered. Thus, creating partnerships with technological leaders in the industry can help OC grocers to improve their competitiveness without significant investments and smaller risks.

According to Begley et al. (2020), the technical talent gap creates challenges for OC companies to develop new solutions and in-house knowledge of technology might be scarce. Therefore, partners should bring knowledge and understanding of the technology and processes, so the incumbent did not need to develop the knowledge themselves.

Even though the store-based model has been an enabler for all the case companies, the grocers have short or long term goals to invest in more automated picking facilities to improve the competitiveness in the industry. The automated picking solutions have become more attractive and increased demand enables grocers to invest in larger automated facilities. Despite the scalability of the store-based picking that has enabled the fast expansion of the online channel for many grocers, the picking capacity in stores is meeting its limits due to the slow picking that needs to be done only in the mornings. Furthermore, grocers are focusing on more efficient solutions instead of improving the service level. This can be seen as the focus on larger automated solutions and not being so interested in MFCs despite the advantages. Besides, middle-level solutions of manual warehouses and dark stores are losing their attractiveness as the efficiency improvements are not seen significant enough.

4.4.2 IT solutions

In addition to the automated picking solutions, IT solutions for more efficient operations should be used by OC grocers. As discussed in the literature review ARS have improved the supply chain performance during recent years and reduced the workload from the managers. After online groceries have become more popular, new decision-making processes have emerged and grocers have needed to do a lot of manual labour due to new processes. Similarly to automated solutions, grocers usually do not have the technical capabilities to create these solutions themselves and thus IT solutions should be procured outside the company or by partnering with technology companies. However, data scientists and technical engineers are more and more needed in their own development so their own technological capabilities should not be forgotten.

Based on the interviews, case companies have struggled with the decision making processes in store-based picking and the personal experience and characteristics of

the pickers affect the picking efficiency and accuracy significantly. Every case company had some kind of software in use to help the pickers but none of the case companies was fully satisfied with the solution. According to company B, the offering for suitable picking software is scarce and the functionalities are not adequate for the needs. Thus, many of the case companies have needed to develop the picking software themselves. However, the solutions used are not still performing well and company B said that no significant improvements to the picking speed has been gained.

Close relationships with service providers will help the companies to develop and customize solutions that are suitable for them and the service provider will bring the technical knowledge to help to solve the issues. Even though automated picking will become more popular in the future, store-based fulfilment will be used for maintaining the geographical reach and helping in capacity management of the online channel. Thus, picking software will be needed in the future too.

Furthermore, companies will need advanced solutions for order management in the future because currently, the simple order management methods create OOSs and inaccurate replenishment as the picking happens at a different time to actual sales of the item. For example, optimizing delivery schedules for the picking locations need to be reconsidered as the late deliveries create unnecessary picking rounds to fulfil the orders.

4.5 Actions in decision-making processes in OC retailing

While the online channel sales have increased fast, the development of ARS functionalities has not gotten as significant attention. In this chapter, the possible decision-making processes which created issues based on the interviews and that could be solved with IT solutions are discussed more thoroughly. As the industry has developed, IT solutions need to take more factors into account and all processes in the OC retailing are not the same as they are through the B&M channel.

According to the interviews, ARS was used for the online channel quite similarly to the B&M channel and in store-based fulfilment, the online sales were not forecasted or replenished separately yet. However, company A, which had the highest focus on the online channel amongst OC grocers, was planning on setting up separate online

sales forecasting in the stores as they had expanded to the in-store picking recently. Different sales patterns and trends through the online channel have created issues with inventory management and OOSs happen more often. In addition, if OOS happen after the item is already bought, it creates more significant issues for the grocers due to the substitution process. If OOS happen at the store to a traditional B&M shopper, the customer can easily decide on the substitute item.

In addition, an increasing trend in grocery retailing is to offer meal packages to the customers through the online channel so customers can order readily planned meals and recipes from the grocer. Based on the data, three of the six grocers offered these meal kits for the online customers which consisted of multiple different items and included the recipes. These were rarely forecasted separately, and for example, company E required the orders for the meal kits so early that they could pick the inventory of the items in the kit very close to zero in the dark store every day. However, when the demand for meal kits increase, separate forecasts should be created for the kits to secure the availability of the kit components in the warehouse and being able to deliver the meal kit components to the picking locations.

The emphasized issues in the online order fulfilment process were the inventory management and OOS, reduced visibility to online orders and the clumsy picking software. These are discussed more below.

4.5.1 Availability challenges and substitution process

As the literature review suggested, OOSs create significant challenges for the OC grocers, and it was confirmed by the interviews conducted. OOSs create issues for omnichannel grocers especially as the shared inventory for online and B&M channels in the store is less predictable and the sales do not happen at the same time as the item gets picked. Thus, OOSs happen often and with large basket sizes, many of the customers are not able to get the items ordered. This decreases the profitability and the customer satisfaction of the online channel hindering down the growth of online groceries. Thus, reducing OOSs should be emphasized in the future before further improvements to the picking speed are considered to give the customers a great experience of online shopping and gaining the trust of the customers.

Based on Aastrup and Kotzab (2010), minimizing OOSs has not been the optimal solution to the issue but optimizing the on-shelf availability (OSA) should be done instead. They state that improving OSA could be done by optimizing the following parameters: *"costs of overstocking, costs of understocking and demand uncertainty"*. Earlier, the cost of understocking has not had such a significant impact on profitability and customer satisfaction as the customers have been able to pick the substitutive item themselves. However, in the online channel, the cost of understocking and the demand uncertainty have increased leading to a nonoptimal replenishment method for the channel. Based on the interviews, the challenge of managing OOS in OC retailing consist of three levels:

- Reducing stockouts with improved availability.
- If stockout happens, the item should be unavailable for the customer on the website so the customer can select an alternative item.
- The customer has been able to order an item that is OOS at the time of the picking which leads to the substitution process by the grocer.

Thus, grocers should concentrate first on decreasing the stockouts in the online channel by reanalyzing the safety stock levels of each item and taking the increased uncertainty into account with the cost of overstocking and possible spoilage. Most of the grocers did not have any separate sales data or forecast for the online channel and all POS were considered as store sales in ARS. Thus, in the future, a separate forecast for the online channel should be analyzed in store-based fulfilment to improve the replenishment performance. In addition, more focus should be put on analyzing the replenishment KPIs. For example, company D had put more focus on online sales by having a separate replenishment planner for the dark store to analyze the online sales only.

In addition, according to the interviews, optimizing delivery schedules and reanalyzing the analyzing the costs of understocking could improve the availability in online stores. In ARS-based replenishment, the system should take the timing of the delivery into account to be able to calculate optimal delivery times and improve availability in the mornings when the online orders get picked. Furthermore, the ordering and delivery schedules should be adjusted for more stable inventory levels. At the moment, multiple case companies stated that they have had issues with high

variation in delivered quantities to stores or ODCs due to the cost optimization for transportation. However, the high delivery quantities have led to situations where the deliveries are too large to fit in the available shelf space or too late deliveries have led to OOSs. Thus, ARS should be adjusted for a more stable delivery flow to enable efficient store operations.

The costs of understocking should be considered when the safety stocks are optimized. Based on the interviews, the classification of the items was calculated similarly with the traditional ABC classification and the safety stocks were calculated accordingly. However, the classification was calculated based on the store total sales and the online sales of the item did not affect the decision making of the ordering parameters. According to Mkansi et al. (2018), grocers should increase the inventories for improved availability and customer satisfaction. Taking online sales separately into account would enable analyzing the uncertainty of the online demand and the cost of understocking compared to the cost of overstocking. Therefore, OC grocers would be able to improve the stock integrity in store-based fulfilment of online orders.

Second, like Colla and Lapoule (2012) suggests, up to date data plays an extremely important role in OC availability management in the online channel. Unlike warehouse-based fulfilment, in store-based fulfilment, one inventory has multiple channels consuming the inventory leading to inaccuracy in the balances shown online. This means that people have been able to order the item online even though it might have been sold out in the store. Furthermore, even though the balances were up to date, the item might be available at the time of the order but OOS at the time of the picking. This might happen because the picking is performed usually the next morning and thus shoppers in the store might have bought the item. Thus, first focusing on up to date balance data is extremely vital in online retailing. At the moment the balance data was not updated often enough to have accurate data in the online store. More accurate data would show the unavailability of the items early enough for the customer to select the substitute items themselves leading to better customer satisfaction. Based on the interviews, the up to date data is seen as important but did not get a great focus on improving the online sales performance.

The most advanced ARS solution with company A's partner where the system had a predictive model for the availability of an item. The system in use calculated the

probabilities for the items to be in the stock at the time of the picking even though the item would not be available at the time of the order. Conversely, the item could be set to be unavailable in the online store if it was probable that it was OOS at the time of the picking. However, the latter does not happen as often in a warehouse-based model due to only one channel consuming the inventory. Still, the latter example would be an important functionality for OC grocers to utilize in online retailing. The partner's system also had heuristic functionalities to set the item unavailable in the online store automatically if the item is OOS in consecutive orders despite the balance information in the system. These kinds of solutions should be used in OC retailing too to improve the OOS management with IT. Due to the multiple channels, inventory management is harder for OC retailers and thus predictive models of the balance data should be used in the online store to predict the balance at the time of the picking.

Third, if OOS happens after the customer has been able to order the item, the substitution process should be streamlined and fast to maintain the picking efficiency and reduce the costs of OOS. This was also marketed by Naveo Commerce (2021). Most of the interviewed online grocers had no special substitution process if OOS was noticed at the time of the picking and usually the picker was responsible for deciding the substitute item or the customer was called about the issue if they wanted the substitute item. Only company A stated that they had already decided the substitute items for each item. All the online stores in the case companies had the option for customers to select if the grocer can decide the substitute item without separate confirmation but the customers were not using the option actively. When the customers are called and asked permission to substitute the item, the customers usually accepted the substitution. Thus, the online stores should be modified so that the customers accepted substitutes automatically unless they separately select the items that they will not accept substitutions on.

In addition, the substitution process based on the personal experience of the pickers was noticed to create issues as some of the pickers were clearly better in selecting the substitutes than others. Similar results were reported by Mkansi et al. (2108). Therefore, for maximal customer satisfaction, the substitute items should be decided already, and the picking software should suggest an available substitute item automatically. The automatized substitutes could be updated by the success rate and customer satisfaction to the substitute items with customer feedback.

Furthermore, the OOS should be shown automatically during the picking round if the inventory in the system is zero. Most of the interviewed companies did not have live data of the inventory in the picking system which led to unnecessary picking attempts and additional picking rounds if OOS occurred. If the picking software showed the balances of the items to be picked and knew the delivery schedule, it could suggest substitute items in the first picking round already or tell the possible next delivery for the item which is OOS to make possible additional picking rounds. Managing OOS efficiently will improve customer satisfaction and make the process more efficient. As long as the picking is done in stores, OOS management stays as a significant issue to solve.

The most extreme behaviour in OOS management happened with company A where a stockout led to incorrect replenishment decisions in the future. In this example, item A got OOS in a store and thus a substitute B were sold in online orders instead. Similar effects were noticed at other companies too but not as radically. ARS system thought that because the sales of item A decreased and sales of item B increased, the inventories of A should be decreased, and the inventory of B increased. This incorrect behaviour of the system led to an increased number of OOSs and did not represent the actual demand. Thus, OC grocers need to adjust their systems to take into account the items that people have tried to buy in addition to the sales of the substitute item. These sales need to be corrected accordingly to enable more accurate replenishment in the future with accurate online sales data. The summary of the solutions is represented in Table 7 below.

Table 7: Summary of the solutions for advanced OOS management for OC retailers

Issue	Solution	Why?	How?	Wanted or used by
OOS prevention	Separate forecast for online sales	The demand patterns differ in different channels	Using the data from the online store in forecasting	A, B, D, F
	Optimizing delivery schedules for online orders	Late deliveries have led to OOS in the mornings	Changing the delivery schedules to deliver earlier in the morning or managing the delay in the replenishment planning	A, B, C
	Analyzing the cost of understocking	Inventory levels based on the store sales might not match the importance of the item online	Analyzing the item classification again and adjusting the replenishment parameters accordingly for items online	D
Managing online balances	Up to date data in the online store	Prevents customers from ordering OOS items	Showing as up to date data in the online store as possible	A, B, D, E, F
	Predictive models estimating the availability	Picking does not happen at the same time as the order so OOS can occur in between	Forecasting the possible balance at the time of the picking to show more accurate estimated availability	A
Managing OOS in picking	Automatically suggested substitutes	The personal skills of the picker affect the success of selecting suitable substitutes	Gathering data from successful substitutions	A, B, D, E, F
	Up to date data in picking software	Reduces picking time used in searching OOS items	Providing the picking software live balances and possible deliveries to make decisions about substitutions or additional picking rounds	A, B, C, D, F
	Correcting the sales of the item with OOS and the substitute	Inadequate sales correction leads to inaccurate forecast and replenishment	The original item should have the lost sales adjusted and the substitute's sales should be adjusted to the level without OOS of the original item	A, D

4.5.2 Utilizing the possibilities of the online store

As discussed in the literature review, long lead times decrease the customers' perceived convenience of online groceries and thus grocers need to have as short lead times as possible (Chintagunta et al., 2012). This has led to offering at least overnight deliveries by all the grocers interviewed and the best-performing companies were able to provide same-day deliveries to the proximity of the warehouses. However, the interviewees stated that as the demand for online groceries has increased, customers have started booking the delivery slots earlier and making preliminary orders multiple days ahead. However, as the customers are able to modify the order until the last night before the picking, the preliminary orders are not utilized in replenishment planning. Still, as the orders usually are mostly reflecting the final order, there could be potential in using the preliminary orders in replenishment according to the interviews.

Utilizing the online orders in replenishment could improve the supply chain efficiency and help the OC grocer to deliver the needed items to the store more accurately reducing OOSs. Even though all preliminary orders are not stable and can change a lot, probability calculations on open online orders could predict the locked orders well. In addition, if the open online orders are used, the short term forecast and replenishment decisions should take the open online orders into account to help to deliver the stores the needed items. Some of the interviewees stated that due to the increased demand people have also locked their orders earlier in addition to only reserving the slots early. This has led to decreased spoilage and the number of OOS in the stores due to less deviation in the demand. Thus, it could be reasoned that utilize open online orders could have similar effects on helping the grocers to have more accurate forecasts. Based on the interviews, the benefits of this kind of solution would especially help the stores to fulfil successfully orders with large volumes of some bulky item, which is more usual through the online channel. This could be easily done by motivating the customers with reduced delivery fees for orders that are locked earlier. Thus, the most price-sensitive customers could be willing to lock their orders earlier and improve the performance of the grocers' supply chain.

Second, the need for the high quality of fresh items has decreased the grocer's possibility to put any items into the order which are close to spoiling. The replenishment of fresh items has been hard already as different batches spoil at

different times and customers in stores are hard to guide selecting the older items with less shelf life left according to the interviews. Furthermore, the case companies stated that managing the customers' expectations on the freshness of the items has been hard and led to disappointed customers. The challenge is realized in stores when the system has enabled customer orders of a specific item, but the store has only items with low shelf life left. Thus, they have needed to send the item to the customer even though it would not match the standards of the company.

One interviewee suggested that using batch balances in online sales and fulfilment would help the OC grocer to reduce waste and improve customer satisfaction. The system could show the grocer the probable balance of batches that have different shelf life left and thus offered online customers reduced prices for items with low shelf life left. In stores, this kind of dynamic pricing has been hard and requires a lot of manual work to have a separate price for each batch. However, in online sales, the workload needs to be performed only if the item with a lower shelf life is bought and the picker selects the specific kind of item from the existing inventory. Thus, the customers could save by ordering items with lower shelf life without decreasing customer satisfaction. Still, accurate batch balances require batch-specific identification with RFID technology or similar. This kind of solution was studied by Kärkkäinen (2003), but the low standardization of the technology and new emerging technologies increased the uncertainty and reduced the attractiveness of the solution. In the future, the benefits of RFID could increase through online retailing and the possibility for dynamic pricing in groceries so the opportunity should be researched further. The summary of the solutions for utilizing the opportunities of online store are represented in Table 8 below

Table 8: Summary of the solutions for utilizing the online channel opportunities

Solution	Why?	How?	Wanted or used by
Utilizing open online orders in the replenishment	Orders can be filled early	Enabling ARS system to read in open online orders to estimate the demand in the near future	A, B, D, F
	Decreases the number of OOSs	Stores can be replenished with online orders in addition to the forecasted store demand	
Using batch balances in the online store	Customers require only items with long shelf-life left	The online store could show only the balance of fresh items with sufficient shelf-life left available to order	B, F
	Enables selling online customers items with low shelf life with reduced price	Batch balance data for different baches needs to be enabled with RFID technology or similar	

4.5.3 Improving picking performance

Finally, the picking performance in the stores should be improved to improve the profitability of the online channel. As discussed in the results section earlier, both the literature review and the interviews emphasized the challenges created by the low picking speed in stores. Furthermore, manual picking has been noticed to be slow in the warehouses by companies D and F which had the dark store and warehouse-based picking models. Even though the trend is focusing more on automated picking solutions, in-store picking will be used as a complementary picking model by the case companies for a while because automated solutions are slow to set up and large investments are needed. Thus, improving in-store picking will benefit OC grocers for a while and new solutions will create value.

First, there is a need for improved picking software. Based on the interviews, most of the companies were not satisfied with the current picking software despite the focus on the online channel. The only exception was the high-end grocer, company C, which focused more on quality than efficiency. One interviewee mentioned that at the moment the supply of picking software is scarce, and compromises were needed to be made when the solution was selected. This was also noticed by other interviewees as they have needed to develop the solutions themselves.

Even though Naveo Commerce (2021) reported a significant increase in picking speed when suitable picking software is used, the case companies had not noticed similar increases with the software in use. Furthermore, only one of the companies had picking software in use that guided the route and picking sequence of the items. Based on the interviews companies have quite inaccurate location data of the items in stores or warehouses which decreases the possibilities for optimized routing. Thus, grocers should first focus on creating accurate floor plans to enable improved picking software. However, as accurate floor plans are not always available, picking software should estimate the optimal picking route with product categories and approximate locations. Furthermore, as discussed above up to date data should be provided to the system so decisions of substitute items can be made on the first picking round. In addition, picking software should suggest substitute items automatically if OOS occurs to streamline the process and improve the success rate in selecting substitutes.

Second, forecasting the workload was perceived to be a needed solution for driving down the picking costs and help the operations chain planning. This was mentioned in most of the interviews conducted. Similarly to picking software, the need for workload forecasting will remain important as long as picking is conducted manually. Only two of the case companies was forecasting the workload of picking on some level currently. Company F had a very simplistic forecasting process conducted with Excel that calculates the forecasted number of sold items and estimated the need for picking workforce in the warehouse accordingly. In simplicity, with online sales forecast, this type of forecasting could be done in any OC retailer easily when the estimate of picking speed is known. Still, as the separate online sales forecasts were only calculated on retailers with separate fulfilment centers for online orders, OC retailers need to first enable online forecast in store-based fulfilment. Furthermore, more accurate hour-specific optimization requires more advanced solutions to optimize each shift based on the employer skills and picking need.

Based on Mkansi et al. (2018), the shared resource pool of pickers and other store workers has created issues in managing the workforce in stores. However, workforce optimization can decrease the costs of the operations and helps in solving the issue of shared workforce resources (Ernst et al., 2004; Güney, 2019). Based on the interviews, picking speed is not the only important factor for efficient operations.

The pure online grocer, company F, emphasized the importance to measure all working hours of warehouse employees compared to the number of picked orders. Therefore, workload optimization plays an even more important role as there should be always enough but not excess workforce for the tasks performed. Thus, workload forecasting and workforce optimization will be important tools for OC grocers, for which driving down the fulfilment costs of online orders has been a great challenge.

Table 9: Summary of the solutions for improving the picking speed

Solution	**Why?**	**How?**	**Wanted or used by**
Improved picking software	Companies are not satisfied with the current software in use	Enabling accurate floor plans for optimized routing for picking	A, B, D, E, F
	Picking software reduces the effect of the difference in personal skills and improves the picking performance	Up to date data of balances and deliveries and automated substitute, suggestion reduces the decision-making processes for the pickers	
Workforce optimization	Managing the workforce has been acknowledged to create challenges	Forecasting the need for picking workload from the online sales forecast	B, D, F
	Personal skills affect the picking performance	Optimizing the allocation of tasks for the employees improves the picking performance	

5 Conclusions and discussion

Finally, the key findings of the study are discussed. This will be done by first answering the research questions and then analyzing the theoretical and managerial implications that were conducted from the results. Finally, the reliability and the limitations are discussed.

5.1 Key findings

Key findings are represented by answering the research questions.

RQ1: *What are the different omnichannel fulfilment methods in grocery retailing and what are the advantages and challenges?*

Different omnichannel fulfilment models for online orders have been studied earlier and the models can be divided into store-based picking and warehouse-based picking. The store-based fulfilment model has been used the most due to the low entry barrier. OC retailers have already a wide supply chain network of stores which improves the attractiveness of the solution to enter the online business with. In addition, store-based fulfilment does not have high fixed costs and the picking capacity can be easily scaled based on the demand. The empirical research also showed that scalability has been the main advantage when the demand increased fast and warehouse-based models have had issues keeping up with the demand. However, in-store picking has multiple challenges which decrease the attractiveness of the solution. First, the manual picking in stores is slow and the stores are designed for B&M customers, which increases the travelled distance. Second, stores have been noticed to have more issues with availability due to the multiple channels consuming the same inventory. Thus, increased demand has led to an increased number of OOSs and decreased customer satisfaction, especially with store-based fulfilment.

Thus, automated solutions in a separate warehouse for online orders have been increasing their attractiveness and companies have planned to invest in automated solutions. Due to the increased demand, a middle model of the dark store, a separate warehouse with manual picking, has not been widespread and it does not solve the issue of slow picking operations either. However, automated warehouses require significant initial investments and have high fixed costs. Based on the study, OC

grocers are aiming for improved efficiency in the future and service level and lower delivery lead times have less focus. Due to the increased issues in store-based picking, automated warehouses are planned to enable the economies of scale in picking and store-based fulfilment will be used as a buffer in the picking capacity.

RQ2: *How should the forecasting and replenishment systems setup take the fulfilment methods into account?*

The literature review showed that by utilizing ARS, companies have been able to decrease inventory levels and improve availability. In addition, automated replenishment has helped the managers to spend less time in making decisions for fulfilling the stores (Angerer et al., 2006, p. 165, 148). However, as online demand has been noticed to have different sales patterns to B&M sales, adjustments to forecasting and replenishment systems could be made. The issue increases its significance especially in the store-based fulfilment model as the stores rarely have a separate forecast for the online orders. In addition, as the picking needs to be done in the mornings, the deliveries to the stores might not make it to the picking which can lead to stockouts. Therefore, analyzing the delivery schedules and forecasting the online sales should be considered in the future while the demand has increased.

Furthermore, the cost of understocking has increased in online groceries because the substituting process at the time of a stockout is expensive and stockouts have decreased customer satisfaction. Having larger safety stock in the stores for items that are often ordered from the store could decrease the total costs of the online channel. In addition, ARS should take the original sales into account in case of an OOS due to unintended sales of the substitute item. Only using the data on what the customer has tried to buy should be used in the replenishment to get a realistic view of the demand.

The online store has also created opportunities for a more efficient supply chain. The online customers only accept items with long shelf life left, which is why it would be important to enable batch balance data for the online store. Thus, only the balance of items with sufficient shelf life left would be shown to the online customers and items with low shelf life could be sold at a decreased price. With batch balance data the spoilage of fresh items could be decreased utilizing dynamic pricing. Also, OC

grocers could utilize the open online orders in the short term replenishment and improve the availability when the customers fill the orders in advance.

RQ3: *How should grocery retailers improve the efficiency of omnichannel operations?*

According to the results, automated solutions for picking will be used in the future to enable more efficient picking. However, store-based fulfilment will be utilized in the future too due to the scalability. Thus, in-store picking operations for more efficient manual picking should be improved. The case companies were not satisfied with the current picking software in use and picking speed has not been increased significantly with the software. Thus, new solutions are needed. The improved picking software should provide optimal picking routes for the pickers and guide the picker with automated suggestions if OOS occurs. Furthermore, up to date data should be used in the picking software so decisions about the OOS process could be done in the first picking round and an additional picking round is suggested only if the item is expected to be delivered to the store in the morning. Thus, the personal skills of the pickers have less impact on the performance of picking which is expected to improve the efficiency.

Second, workforce optimization could be enabled by forecasting the workload for picking and allocating the picking tasks based on the need. Thus, stores would have always a sufficient number of pickers and deliveries would not be missed due to the shortage of pickers. Conversely, the excess workforce would be decreased leading to improved cost efficiency. However, this would first require the forecast of online orders to the stores to enable forecasting the workload.

5.2 Theoretical implications

The theoretical contribution of the study was to examine the current fulfilment models used in OC retailing and analyzing the attitudes of OC grocery retailers. The study first conducted a comprehensive literature review of the solutions used in online grocery retailing and the challenges that online grocers have faced. Furthermore, the study investigated how the current pandemic has affected online groceries and how the sudden increase in demand has changed the industry.

The study found that OC grocery retailers still have similar issues with online groceries as academic literature has suggested. However, the recent year with the pandemic has increased the online channel sales in groceries significantly leading to new issues and enabling new solutions to be used in online groceries. Earlier, the possibility for automated picking of online orders was much speculated in the literature, but examples of failed online grocers decreased the attractiveness of the solution (Hays et al., 2005).

Based on the thesis, it seems that the change in the dominant picking model will be seen in the relatively near future when automation becomes more popular. Still, in-store picking has proved its value during the pandemic with the ability to scale the online service geographically fast and increase the picking quantities without significant investments. However, the increased picking quantities are now facing the limits stores can handle without further adjustments and OOS and picking capacity are starting to create issues for stores. In addition, the reversed flow of the items sold online overloads the backroom space which has been designed to be small for traditional grocery retailing. Thus, also OC companies with a lower focus on the online channel have been interested in investing in more efficient picking solutions.

Interestingly, earlier the research focus on online groceries has been focusing on the last-mile delivery issues and decreasing the last mile costs. However, the study finds that the last-mile challenges are not considered as critical for grocers at the moment as multiple companies had already outsourced the transportation service to focus on the core operations. Thus, fulfilment operations have gotten increased attention from OC managers. However, the delivery operations are costly and not improving the performance will reduce the possibilities for profitable online grocery retailing.

The study found out that OC grocers should focus on the challenge of availability in stores due to the increased issues when the demand has increased. Based on the study, reducing OOS requires a significant focus from OC retailers at the moment due to the expensive substituting process and decreased customer satisfaction. The study suggests that OOS management should be improved on three levels:

- Reducing stockouts with improved availability.
- Managing stockouts in the online store and reducing the need for picking substitutes.

- Managing stockouts in the picking phase by automated substitution selection.

Because store-based fulfilment is more prone to OOSs than other OC fulfilment models, the study emphasizes the need for a separate forecast for online sales in stores. Furthermore, the cost of understocking has been noticed to increase in the online channel and thus increased safety stock could be used for items bought online often. The solutions for improving the availability with these steps are discussed more in Table 7 and managerial implications. Furthermore, the study found out that even though picking software should improve the picking efficiency, case companies have struggled with the software utilization. Thus, new solutions for the industry are needed and enable optimized routing with an automated substitution process for decreasing the effect of the picker's personal skills on the performance.

5.3 Managerial implications

The store-based model has enabled a more scalable solution for picking the online orders for OC grocers and thus is the dominant picking model within OC grocers. However, the increased demand has increased the issue of OOS, and the stores are at the limit of picking volume they can handle. Furthermore, as the picking in stores create more issues when the demand increases, automated solutions have become more attractive and OC grocers are planning to invest in automation.

The highest automation level was noticed to be achieved by creating a partnership with a technology leader in the online grocery industry. Creating automated solutions by the grocers was noticed to be expensive and slow, which has decreased the attractiveness of the solution. Thus, the fastest results were gained by the partnership. Despite the discussion of dark stores and MFC-based solutions, the OC grocers seemed to be more interested in larger automated facilities to enjoy larger effects of the economies of scale and drive down the cost. Even though automation is increasing its attractiveness, store-based picking will not be replaced completely in the near future due to the advantages of the model. The geographical reach and the option for adjusting picking capacity will maintain the importance of in-store picking for a while. Thus, solutions for improving picking performance in stores and reducing OOS need to be solved for more efficient OC retailing.

The OOS has been noticed to decrease customer satisfaction and the workload-heavy process of substitution increase the picking costs. Thus, actions for improving the availability are needed fast.

The main actions are creating a separate forecast for online sales, providing up to date and predictive data to the online store and having automated suggestions for items OOS. The suggestions for managing the three levels are summarized in Table 7. Like the literature review suggested, the picking speed in stores creates significant issues for OC grocers. In addition to improving availability management, the picking efficiency should be increased to drive down the costs of the online channel. This could be achieved with advanced picking software that helps with the optimal picking route and selecting the substitutes. Thus, the location data in stores should be updated and live balance data enabled in the picking software. Furthermore, workforce optimization should play an important role in store-based order fulfilment in the future as most of the picking costs are created by manual labour. Thus, forecasting the workload and optimizing picking shifts could decrease the total costs of picking.

Finally, the online channel has created new possibilities for OC grocers to improve their services and operations. Utilizing the open online orders before the picking date could help the grocers replenishing the stores and reducing OOS. However, as the customers can modify the orders until the last day, the open orders could not be used as such and a predictive model should be used naturally. In addition, the batch balance data could be utilized in online groceries with the dynamic pricing of fresh items to reduce waste and not decreasing customer satisfaction with items without the full shelf life left.

Even though challenges in the last-mile delivery have not had much focus recently, OC managers need to concentrate the whole supply chain costs for the best total performance of the supply chain and winning the battle of OC grocery retailing. With advanced delivery methods, the delivery costs can be decreased with great customer satisfaction.

5.4 Limitations and further research

The study has focused on exploring the online grocery industry and analyzed the current perceptions of the dominant challenges in fulfilling online orders. Furthermore, the study has suggested multiple solutions for improving the replenishment and picking operations for a more efficient OC supply chain. However, the solutions have not been tested and thus positive results are not guaranteed without further research.

The main limitation of the study is the varying environment of online groceries. Thus, all solutions are not possibly the most efficient in all situations as the share of online sales and customer preferences vary based on the market. Furthermore, the sample included only European retailers and thus, further research with Asian grocery retailers should be conducted to analyze the challenges and solutions in the market with the largest share of online sales. The current pandemic also affects the results as the share of online sales after the pandemic is not known and a possible decrease in online grocery sales could change the attitudes of grocers and decrease the urgency of new solutions.

Even though the share of online groceries is expected to have a minor decrease after the pandemic, online grocery sales have been increasing every year and the level of online sales still remains higher than it would have been without the pandemic (Statista, 2020; Günday et al., 2020). Thus, the development of the supply chains of OC grocers seems inevitable and the findings of the thesis require further research. Especially, the challenge of availability management with in-store picking should have a focus on further online grocery research as the OOS issues are significant for OC grocers. Furthermore, picking solutions in-store should be analyzed more thoroughly as most of the available literature of the solutions were commercial material. Further studies should focus on quantitative research on solutions suggested to provide validity for the solutions and see how the solutions perform in practice.

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Appendix

Appendix 1 – Interview template

Could you briefly describe your current role in the company?

- How it is related to the online channel?

Could you briefly describe the omnichannel model and the online strategy of the company?

Please describe shortly what are the advantages of the chosen online strategy for the company.

How is the assortment of the online channel compared to the traditional store assortment?

What investments have you made into online services and your fulfilment network in the recent couple of years?

How do you see the scalability of your fulfilment network? What changes do you see that would be needed to be done to enable a) short-term growth b) long-term growth.

What are the challenges in fulfilling both channels in the same supply chain?

How the picking of online orders is performed? Where? Why?

- How automated and optimized is the order fulfilment and picking
- Do you use software to optimize picking batches or routes?
- If picking is done in the warehouse, how online picking affects the design of the warehouse?

How the backroom storage of stores is utilized with online orders?

What do you see as the greatest challenges regarding your online order fulfilment?

How out-of-stocks are managed? How the substituting products are decided?

Have you considered online order picking and processing workload when you plan the workforce, shifts and tasks for the store personnel and how? Do you see improvement potential here and why / why not?

How the online orders are delivered? What are the provided delivery services?

Who ships the online orders to customers? Do you have your own fleet, or have you outsourced the service? Why?

What are the greatest challenges for the retailer in delivering online orders?

How the online orders are forecasted and replenished? Does it differ from the brick-and-mortar sales forecasting somehow?

Do you think that the forecasting and replenishment processes are sufficient for the online channel? How the operations could be improved?

How [the company] could utilize ARS more in online sales forecasting and replenishment?

Are there any decision-making processes where IT solutions or analytics could help in the future related to omnichannel retailing?