E-GROCERY

A study of the e-grocery market in the region of Stavanger

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Foreword

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Nina Sofie Olsen

Abstract

The recent years there have been an increased interest in ordering groceries online because people prefer easier alternatives. For the companies, the only activities that are added for operating an online store compared to a traditional store are the processes required to pick, pack, and deliver the orders to the customers. There are many companies that have tried to survive in the e-grocery market, but unfortunately have failed since it has shown to be difficult to perform these operations efficiently and to obtain a proper number of customers. The unique thing about groceries compared to other products like clothes, interiors, furniture, etc. is that many types of groceries have temperature requirements, which makes the operations more difficult to perform compared to other firms operating online.

There exist many different models to offering grocery online. The models that will be investigated in this study is the attended home delivery, unattended home delivery, inside pick-up locations, and outside pick-up location, combined with either store-based picking model or warehouse-based picking model. The aim is to look at which model that will be the preferable regarding the long-run profit.

The results of the analysis showed that it is the store-based models that are the most profitable. These were more profitable than the warehouse-based models because the latter models have many additional costs that the store-based models do not have. Further, the company need many customers to make income, and therefore, the customers' preferences are one of most essential factors when deciding which model to use. The two home delivery models, attended and unattended, will probably be the models the customers prefer because the customers will save more time using these models compared to do the shopping in the traditional way by going to a store themselves. Out of these two home delivery models the attended model will be the safest for the company to choose since the unattended model have higher costs associated to the delivery boxes. Thus, in the unattended model, the number of regular customers need to be higher than for the attended model in order for the income to exceed the costs. The e-grocery market in Norway have many fluctuations, and it will be risky for a company to do large investments in this market.

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1. Introduction

1.1 Background

People are constantly seeking for simpler and less time-consuming alternatives since they want to make the most of their time and do things that make them happy. Because of this, there has been an increased interest in ordering groceries online, also called e-grocery. The first company that offers e-grocery services were a company named Grocery Express that was found in San Francisco in 1981. Not everyone had access to the internet at home back then, so the customers could in addition to the internet order by phone and fax (Punakivi, 2003). This was the beginning of a fast-growing industry. During the last decade, this industry has spread to Norway as well.

E-grocery shopping is appealing to many and can help people in a difficult life situation. The most common reason to why e-grocery have become so popular is because some people find it is difficult to find time to do the shopping due to a busy life (Hays, Keskinocak & López, 2005, p. 2). When the customers get the opportunity to order groceries home they do not need time to drive to the store, pick products, and standing in the checkout queue. Moreover, the society today consists of a lot of expectation and internet have created a pressure to show to everyone that you have a perfect life. People should spend a lot of time with the kids, participate in volunteer work, have a tied and cline home, work out, attend in social gatherings, work, and so on. The list is long. In addition, often what they really want is to sit home, relax, and do less of everything. There are also other reasons why people prefer to buy groceries online. Some people have physical and mental obstacles that prevent them from doing the shopping on their own. For instance, wheelchair users may have difficulty reaching the top shelves in the store, those with social anxiety may be afraid of doing the shopping on their own, and people who have partial sight or are blind can have difficulties of finding the right products. For those people, the industry can help to provide a better everyday life. Further, some people might not have convenient transportation opportunities available, or just like the idea and are willing to pay extra to get the products delivered to their home.

In basic, we can divide the customers into two categories; those who shop regularly and those who just try it a few times. All e-grocery companies aim to have as many regular shoppers as possible that frequently uses their services. The reason is that it becomes more predictable and easier to calculate the costs and how much products the company need to have available, and it will be easier to have the right amount of capacity as well. For instance, how many employees that are required to work at the same time, or how much storage that is needed.

There is still some potential hinder that may prevent customers from choosing e-grocery instead of traditional stores. Many people have the need to see, touch, smell, and feel products, especially with vegetables and fruits. This is because everyone has their own opinion and preferences about how some products should look and feel. Further, a research showed that 73 percent of the responders say that they are satisfied with traditional shopping, and do not see the added value of shopping groceries online (Warchun et al., 2012). Thus, another obstacle is that many of us do not think grocery shopping online is tempting relative to traditional shopping. In other e-commerce firms, the prices online are often smaller than in the traditional stores and the customer could then save money on online shopping. This trend is not found in the e-grocery market because there are a lot of costs of offering grocery online. Moreover, some people may be tempted by shopping for groceries online, but it cost money to get products picked and delivered, and not everyone is willing to pay for this.

The most common way of ordering groceries online is through a smartphone or a computer. The e-grocery web pages or apps work like all other online stores; you just click on the products you want to place them in the shopping cart, and when you have selected all the products, you proceed to the payment. This is pretty much the same for every company. The essential part is to make it easier to shop in an online store compared to in a traditional store. Traditional stores have had many improvements in their way of offering service to the customers. Many of the stores today have a barcode scanner and self-check-out desks that makes the shopping faster. Further, some companies have made it possible to make a shopping list in an app that organizes the shopping list according to the product placement in the store. Amazon is the company that has had the biggest innovations. They have recently opened a store without any staff. The customers just pick the products they want and walk right out. The company uses an advanced camera technology and sensors that track which products the customers have chosen and the payment happen automatically through an Amazon account (Dalseg, 2018). Thus, the traditional stores have made it difficult for the e-grocery companies because they continuously improve in order for the shopping to become easier and less time-consuming for the customers, which is exactly one of the reasons why people prefer online shopping.

On the other side, there are also many opportunities for the e-grocery businesses as well. From the article by Hays et al. (2005) it emerges that some e-grocery companies give the customers the opportunity to customize weekly shopping lists, have a list of frequently ordered products, have a personalized shopping aisle, and the customer could even preload a recipe on the company's webpage which helps to pick the needed ingredients. All these benefits allow the shopping to take place quickly and easily compared to the traditional shopping in ordinary grocery stores. It should be mentioned that something similar could be done in a traditional store as well. The main difference is that the customers must pick the products themselves, and of course drive back and forth to the store.

Further, there are many types of delivery methods that have been used in the past. For instance, the customers can get the products delivered to their homes or to a pick-up location. In addition, different specialized services exist in the industry. For example, some companies (e.g. adamsmatkasse.no and godtlevert.no) sells ready-made food boxes, which consists of a week menu of dinners along with the products needed to make them. While other companies (e.g. konolialen.no) works like a regular grocery store where you choose the products by yourself. A common factor for all the e-grocery companies is that it is difficult to deliver an e-grocery service in a profitable way (Proff 1, 2018; Proff 2 2018). Many may wonder why this is the case when some e-commerce companies manage this. The unique thing about grocery products is that some products have temperature requirements, in contrast to for example clothes. These temperature requirements makes the required operations to both process and deliver the products more difficult. The picking operations must be done in a certain order since some products could not stay in room temperature for a long time. Further, when the orders are picked and packed they have to be stored properly in relation to the different temperature requirements while waiting for transportation. Moreover, the profit margin on grocery products are relative low compare to other products. This means that they need to sell a huge amount to earn the same as companies selling more profitable products (e.g. electronics).

When it comes to the transportation, other online companies typically send the products through mail. This may not be an option for e-grocery companies because the trucks that delivers the mail do often not have temperature regulations. In addition, the mail goes through sorting centers before it is transported to the final destination, which make the transportation time long.

Grocery products is something customers buys when they need them, and the customer would expect to get them as soon as possible. If it takes too long time before they get the products the customers may choose to rather do the shopping in the traditional stores themselves.

The e-grocery companies have the opportunity to choose which products to include in their assortment. Thus, they can have a limited selection of products without temperature requirements which will make the operations to process and deliver the orders easier. There have been many different strategies in the past. Some companies choose to have a small selection of items available in the online store, while other have a large section. Some have even added additional products like book and clothes as well. As mentioned previously, the essential part of a business is to offer products and services the customers are willing to pay for. Thus, they need to use the customers as a starting point when deciding which product to include in their assortment and look at the costs of having a product or not. For instance, if they exclude a product they may get less customers.

Typically, people have a lot of habits and like to do things like they always have done it. To change this pattern, the companies need to deliver a service that is tempting for the customers and make them want to change their way of doing the shopping. Thus, an essential part of becoming successful in the e-grocery market is to offer something that is better than the traditional way of doing shopping. Therefore, the company needs to carefully decide how to perform the required operations to deliver groceries online.

As we have seen, there are many factors to consider when selecting strategy in the e-grocery market. Many companies have tried this way of doing business. Some have failed, and some have succeeded. It has not been a “walk in a park” for the companies that are operating in the market. In November 2017, the Norwegian company 123levert.no went bankrupt, and three months later also Marked.no had their last day of sales. The manager in Marked.no said that they had underestimated the market for groceries and that this market is far more demanding compared to others (Høgseth & Lorch-Falch, 2018). Further Høgseth and Lorch-Falch (2018) writes that Kolonial.no had to cut down every fourth of their employees in the same month 123levert.no shout down their operations. There are many examples of companies that have not succeeded in the market. The common factor is that they were not able to do the operations efficiently and that it is difficult to compete against the big companies in the grocery market.

Big and well-established companies have an advantage regarding prices since it is cheaper for them to order products from suppliers. In addition, they have a great market share.

Trade of groceries in Norway increase each year in form of money, and much of this growth is due to increased prices. The grocery market in Norway exclusive online shopping sold products for about 171 billion NOK in 2017, and the increase from the year before was about 1,9 billion. This is the lowest growth that have been for several years (Nielsen, 2018). Nielsen (2018) writes that the reason for this low growth is that there has been an increased interest of shopping abroad (especially in Sweden), shopping of grocery online, and that several stores offer grocery products (e.g. Nille and Europris). Another research conducted of Nielsen estimated the total e-grocery market were about 1,5 billion NOK in 2016, thus the e-grocery company have only about 1 percent of the total market this year (Nielsen, 2017).

It is a mystery how to make this form of business profitable in all the markets around the world. Despite some challenges, there are huge opportunities in this market. The demand for food is not heavily influenced by economic fluctuations because people need grocery on regular basis to survive (Kämäräinen, 2003, p. 9). Compared to traditional stores, e-grocery companies have the additional activities of processing and delivering the customers' orders, and if the companies find a way to perform these operations in a better way, they may become profitable.

1.1 Objective and research topic

So far, we have seen that it is difficult for companies to survive in the e-grocery market and that there are many things to consider before selecting their strategy. Thus, this study will investigate the different models to process and deliver groceries to customers through an online store. The purpose is to find the optimal model that will make the operations profitable and make it possible for the company to sustain in the market over time. The research topic is as follow:

- *Investigate models that can make an e-grocery company profitable in the long-run*

In total, eight models will be investigated. There are two different picking models; store-based model and warehouse-based model, and for each of these two models there exist four different delivery models; attended home delivery, unattended home delivery, inside pick-up location, and outside pick-up location.

1.2 Structure

This thesis is divided into five sections. First, in Section 2, relevant theory is given as well as a description of the e-grocery models that are analyzed later in the thesis. Next, Section 3 presents an overview of how the relevant data required for the analysis were collected. In Section 4, a combined analysis and discussion of the potential models the e-grocery companies can use to process and deliver grocery to customers are given. Further, the credibility of the analysis and discussion of results is criticized and defended in Section 5. Finally, a conclusion is given in Section 6.

1.3 Limitations and assumptions

In order for the study not to become too extensive, limitation and assumptions had to be made. This study was limited to mainly focus on the region of Stavanger; including Stavanger, Sandnes, Randaberg and Sola. Although there are many differences in the demographics in each market, the findings in this thesis may also apply to similar markets with equal demographics. Further, it is assumed that all the companies can perform the required operations to process and deliver groceries in a traditional store and that they cannot combine several models. Lastly, it is assumed that the company needs to do all the operations themselves. For instance, they cannot hire a third party to do the deliveries.

2. Theory

In this section, a theoretical basis is given in order to obtain a deeper understanding of the e-grocery business. Different terms, definitions, and models will be introduced, as well as given an explanation as to why these are relevant for this study.

2.1 Basics about profitability

In unprofitable company is one where the costs exceed the revenues, or in other words, they use more money than they make. To become profitable, they could either increase the income, decrease the costs, or a combination of both. A company's income is affected by the price level of the products; thus, the further question is how to set this level.

Firms can, in theory, be divided into two categories; those who sell products and those who sell services. The main difference is that a product is a physical thing you can see and touch, in contrast to a service, which typically is a job or a task that the companies offer their customers. An ordinary grocery store is classified as the first type of firm where the customer picks the goods they want, pack them in bags, and carry them home by them self. When it comes to e-groceries, the employees perform these tasks. Therefore, in addition to selling the products, they sell the services the work of picking, packing, and bringing home the products represents. An ordinary grocery store that starts with e-grocery will change from being a product-firm to a type of both products- and a service-firm.

In many ways, selling a service and product stand out from each other. The unique thing about a service is that it is "produced" when it is sold, and it is therefore difficult to know how long time each order will take to process. Without this information, they would not be able to know how much offering that service will cost them. Thus, they must estimate the costs and set a price they think would cover this. In addition, they need to consider the customers willingness-to-pay, which is defined as the maximum price someone is willing to pay for a product (Andersen, 2014). If the company's price exceeds this, the customer is not willing to buy the product. Every customer's maximum price is different, so although the company may sell products if they increase the price, they will most likely sell less products than before. Therefore, it is important that the management do calculations to find the optimal price that enables them to make the highest profits out of each product. Further, the management also need to consider the competitors prices. In this case, the competitors are both traditional stores and other e-grocery companies. Many people are price sensitive and are always looking for the cheapest products. Therefore, it is important that the prices the company offers are at the same level as the competitor's prices for identical products. If they offers prices that are higher than the competitors' prices, they will lose customers. Similar, if they offer lower prices they may obtain more customers, but they do not necessary earn more money because the income will be lower. Some customers may be willing to pay more for a product if there are shorter queues for payment, closer to home, if there are better service in the store compared to other stores, or so on. There exist many different strategies. For example, is it possible to deliver higher quality products to a higher price. This will not be looked further into in this study.

Now we know more about the income and the things the company should consider before they set the prices. Further, having knowledge about the costs are equally important. This study will mainly look at the costs associated with the operations needed for processing and delivering orders. Therefore, the further theory section targets the costs side of becoming profitable.

2.2 Capacity management

Several factors are important to be able to operate optimally and to reduce the costs, and one of them is the right amount of capacity. Capacity is defined as "the throughput, or the number of units a facility can hold, receive, store, or produce in a period of time" (Heizer, Render & Munson, 2017. p. 346). Capacity management is about having and using the optimal amount of capacity with the aim of becoming time- and cost efficient in the operations. The costs would have been huge if a company always use the maximum level of capacity available because this, for instance, would mean that they always have many people at work at the same time and that they have a larger building than needed. On the other side, it is important to have enough capacity to be able to serve the customers. The essential part is to find the optimal level of capacity.

Capacity is an important factor when deciding to do the picking in a store or at a warehouse. A store has less capacity than a warehouse because of the size difference, which means that if the number of orders becomes too high it would not have been possible to perform the operations in a store-based model. With some content, it is possible to increase the capacity, but there is always an absolute limit. For example, one option might be to hire more workers and build a larger store and storage. At some point, extending the workforce and buildings is no longer a possible option. There may not be space left for a larger building, and a store should not have too many workers in the store at the same time. Moreover, the costs of expanding the building and having more people at work at the same time may be too expensive for the company for it to be successful.

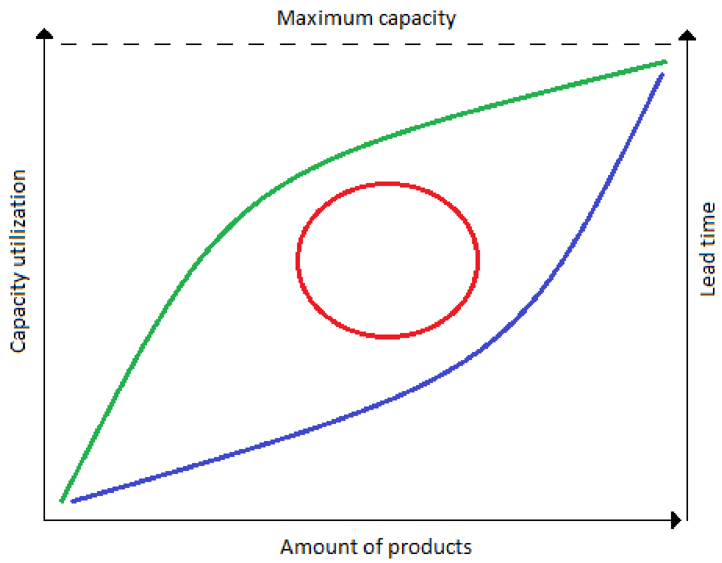

Figure 2. 1 – Relationship between the number of products, capacity utilization and lead time (Wiendahl, 1997)

Figure 2.1 shows the relationship between the number of products, the capacity utilization, and the lead-time. Lead-time is defined as "the time between recognition of the need for an order and receiving it; in a production system, it is the order, wait, move, queue, setup, and run times for each component" (Heizer et al., 2017, p. 608). In other words, lead-time is the time it takes the company to finish and deliver an order from the time they receive it.

The green line represents the amount of capacity needed for different numbers of products and the blue line represent the lead-time. From the figure, we can see that the need for more capacity and lead-time increased when the number of products increases. The difference between the capacity line and the lead-time graph is that these graphs go in opposite directions; capacity is diminishing, while the lead-time is increasing. This means that the required capacity to make each product decreases as the number of products increases, in contrast to the lead-time that increases with increasing number of products. If the company was going to use the maximum capacity all the time, it would require longer delivery time because the lead-time become considerably higher. The red circle represents the most optimal area regarding both capacity and lead-time where neither of them is close to maximum. The problem with selling groceries online is that the lead-time must be short to avoid the customers to go to the stores themselves. Thus, for the grocery sector, the most optimal point may be in the lower part of the circle.

2.3 Lean management

E-grocery companies need to do some adjustment in their way of processing orders and performing the deliveries to become profitable. Lean is about the ability a company has "to do more with less" (Sayer, 2012, p. 10), which is exactly what e-grocery company should do. They must find a way to deliver the same quality and standard to a reduced cost. The definition of a lean operation is to “eliminate waste through continuous improvement and focus on exactly what the customer wants” (Heizer et al., 2017, p. 676). This means that they always have to be open for changes and they have to set the customers in the centrum and use them as a starting point in planning and designing the operations. For example in the case of e-grocery companies, the management needs to consider the customers when planning which product to include in their online store and use them to design the delivery model. If the company cannot deliver the services customers wants, the customers will choose to do their shopping somewhere else.

All activities in the operations that do not add value to the customers are defined as waste since the customer then does not want to pay for it. Heizer et al. (2017) write that there are seven types of waste; overproduction, defective products, unnecessary transportation and movement, unnecessary inventory, over processing, and queues. In some way, all of these can be linked to the e-grocery sector, but some may be more important than others.

In the e-grocery business, it is important that they do not have too many products in storage as it is costly to have large storage spaces and it will create an indirect cost for the company. In addition, all product has shelf lives, which means that if the company does not have a regular flow of products the products can damage and have to be thrown away. It will, therefore, become a waste through both unnecessary inventory and defective products. Defective products also include returns. The biggest difference for customers when ordering online and buy products in a traditional store is that they do not get the opportunity to feel, smell and touch the products. Thus, it is more likely that the customers become unsatisfied when shopping groceries online. Therefore, it is important that the company have proper routines of controlling the quality of the products.

Further, the waste linked to transportation and motion are about moving products or people more than necessary. This could either be the transportation of products between building or just movement of products or people from work station to work station. Especially in the store-based model there will be a lot of transportation and movement of products because the products first need to be transported from the warehouse to the store, and then from the store to the customer. In addition, the products need to be unpacked and placed in shelves before the workers can start the operations of processing the orders. Lastly, if queues arise in or between the operations, the operations will take longer time. We will look deeper into this in the next section about queuing theory.

2.3.1 Queuing theory

Since queues is a type of waste, they should find a way to minimize them. To do that they need to know why the queues arise. Queuing theory is an essential concept in the study of the e-grocery sector. This theory is about waiting lines. There are many different designs of the queues depending on the number of servers (channels) and number of phases (number of service stops) (Heizer, 2017, p. 789). An e-grocery company would most likely use a system with a single server and a multiphase system. All the customers' orders need to go through many steps of operations, and the operations need to happen in a specific order, as shown in Figure 2.2. For instance, products cannot go to the packing station before the picking operation is finished.

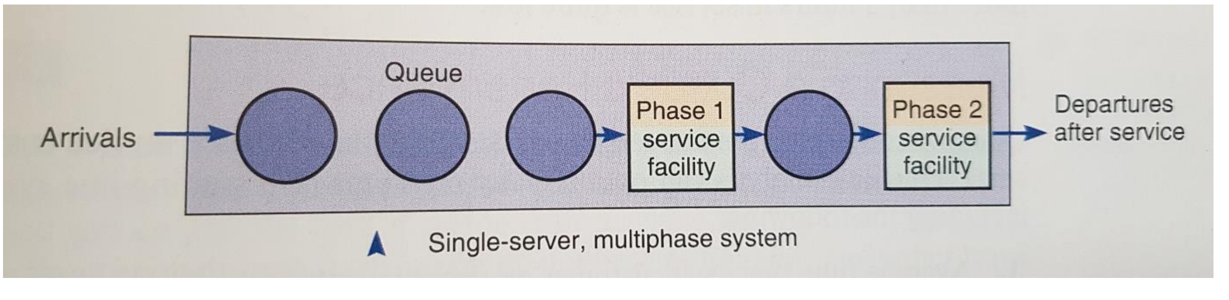

Figure 2. 2 – E-grocery companies queuing system: single-server, multiphases system (Heizer et al., 2017)

There may arise a problem if there is a bottleneck somewhere in the process since then some orders must wait and a queue arise. This will cause that the lead-time to get the orders ready will be longer. As mentioned previously capacity is a tool that can be used to influence the lead-time. All the phases need to have a proper amount of capacity for the customers' orders to flow nicely through the system. If there is too much capacity in the first phases and too little in the next the bottleneck would only move one step in the system. Therefore, it is important that the company find a balance of capacity in every phase of the operations. As mentioned previously, it cost money to use capacity. If they use a lot of capacity in one of the operations, and not in the others the costs will be high without a shorter lead-time.

2.4 Bullwhip effect and safety stock

Customers purchasing patterns are to some content predictable. Typically, peoples buying preferences changes with the season. During the summer customers, for instance, buys more barbecue products, around Easter many prefer lamb and oranges, at least in Norway, and in the Christmas the demand for Christmas cookies, ribs, and candy increase. Thus, the company has some information, but people's preferences can also shift beyond these typical known trends. A sudden and unexpected increase or decrease in the demand from customers can create something called the bullwhip effect. The definition is "the increasing fluctuation in orders that often occurs as orders move through the supply chain" (Heizer et al., 2017, p. 490). In other words, an increase in the customer demand would cause an even higher increased demand from the store to the warehouse, and so on throughout the supply chain. The essential part is that every section of the supply chain overreacts on the change in the demand. Thus, a little change in the customer demand may result in a huge change in the demand for the last section of the supply chain. The problem with this reaction is that it would cause overproduction, extra inventory, longer lead-times, underutilization, and so on (Heizer et al., 2017, p. 512). As we have seen, all of these are wastes for the company and would cost money. Another problem is if there becomes an underproduction because of an overreaction of the decreased demand, then it may be difficult to serve all the demanding customers.

There is always a risk for a company to get empty of a product because it is difficult to know the exact demand. Therefore, it also will be difficult to decide how many products the company should have in their stock. A solution to this is to hold extra units as a safety stock (Heizer et al., 2017, p. 546). The problem with a safety stock is that it cost money because the products need space for storage and as we have seen, storing large amounts of products can lead to products being damaged. This should be taken into consideration when deciding the size of the safety stock the company, in addition to the costs of being empty of a product. In some cases, the company can lose the customers loyalty if they do not have the products the customers want, therefore the cost of not having a safety stock may exceed the cost of having it. Therefore, they need to decide if it is necessary to have a safety stock, and in such a case, how big the safety stock should be.

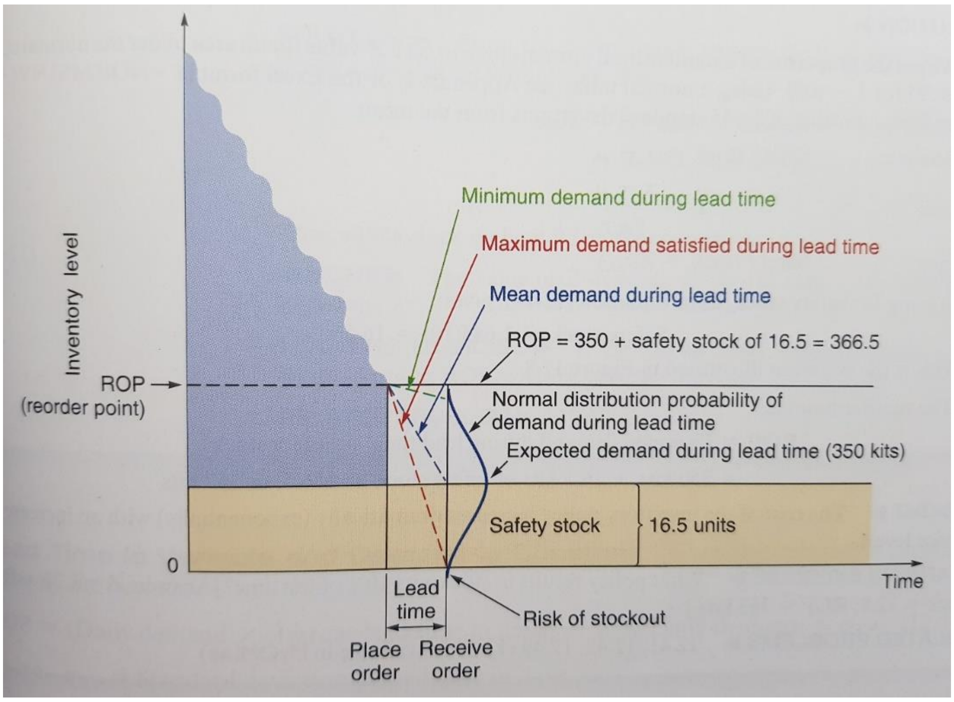

Figure 2. 3 – Safety stock model (Heizer et al., 2017, p. 547)

Figure 2.3 shows a basic ordering model when the demand is shifting and unknown. The blue area is the decreasing inventory level that fluctuates due to changes in demand, ROP is the point where the company needs to reorder and fill up their stock, and the yellow area is the size of the safety stock. The figure shows that the company needs to reorder from their supplier some point before they have used their ordinary stock. This is because it takes time to get products from the supplier. In this case, the safety stock is at a size where all the safety stock would be used when they receive the products from the supplier with a demand at maximum. This also shows that the time it takes to receive the products from the supplier is an important factor. If the lead-time had been longer, they would need an even larger safety stock to serve the customers if the demand was high.

2.5 Marginal costs and marginal income

To figure out if a model is profitable we can look at the profit, but to get a deeper understanding on how this profit change when the number of orders changes, the easiest way is to compare the marginal income and costs against each other. Marginal cost is defined as "the increase in the cost due to an increase in the production of one unit" (Riis & Moen, 2013, p.128), and the definition of marginal income is almost the same but with the increase in income instead of costs (Riis & Moen, 2013, p. 291). In the case of an e-grocery company, the marginal cost and marginal income give the costs and income associated with selling on more product or order. If we compare these two against each other, we can see if the company are gaining from an increased number of orders or not. If the marginal cost is increasing and the marginal income is constant, they are losing money on an increase in demand. This is especially important to have in mind in the decision of using a store-based or a warehouse-based model since the cost of performing operations in these models is different. This means that it may be profitable for one of the models to sell 1000 orders, while it is not for the case for the other model.

2.5.1 Costs of customer acquisition

To be able to calculate if a company should increase their market share is it essential to know how much money they should spend maybe obtaining one more customer. This is what the concept costs of customer acquisitions (COCA) are all about. In every market, there is a lot of competition between companies. The companies that are willing to pay the most to get more customers are the companies that will increase their market share. This is because they then have more money to use on making a delivery model that is preferable to the customers. The important part is to find the amount the company can afford to spend for this purpose, and how much each customer is worth for the company (Pittman, 2018). Pittman (2018) present a five-step model to calculate the costs to get one additional customer. The steps are as follow:

1. *Estimate how much a customer is worth.*

2. *Subtract refunds and cancellations.*
3. *Subtract costs of goods sold.*
4. *Subtract overhead costs.*
5. *Subtract desired profitability.*

The first step relates to how much money the customer will spend in the company over their life. Thus, it is the life value of the customers. Step 2 is self-explained. Step 3 and 4 is about subtracting all costs associated with buying the products from the supplier, operations required to process and deliver orders, labor, legal expenses, and so on. All companies want to make a positive profit. Therefore, the last step is to subtract the amount the company wants to have left after paying all the costs. Typically, the total life value for the customer needs to be four times higher than the COCA for the company to gain on the customer. The e-grocery market is still relatively small in Norway. Thus, the concept of COCA is an important part of investigating which model that would be preferable in order to become profitable in the long-run.

2.6 Proper logistic systems

A company in Norway named Brødboksen recently went bankrupt. The company was a type of e-grocery that offer home delivery of breakfast products. They have received some attention in the media after the closure. An investor said they were too busy to grow quickly, which the management in the company could not deny (Sundberg & Winther, 2018). Furthermore, it emerges that they grew eight hundred percent in one year. Almost all companies aim to grow rapidly and gain a greater market share, but one thing many forget is to have a proper logistic system to support this growth (Kämäräinen, 2003, p. 10).

The word logistics originates from the Greek word *Logistikos* which translated means the ability to resonate and calculate, and the term has been widely used in military contexts in relation to the efficient movement and supply of troops (Gården, n.d.). The American definition of logistics in relation to the business world is "the process of planning, implementing and controlling the efficient, effective flow and storage of raw materials, in-process inventory, finished goods, services and related information from point of origin to point of consumption (including inbound, outbound, internal and external movements) for the purpose of conforming to customer requirements" (Gården, n.d.). In other words, it is a system that connects all parts of the operations together, improving all elements of the operation and increase the overall effectiveness of the company. In the e-grocery industry logistics improvements can help decrease the lead time of the operations require to process and deliver orders, in addition to enhance the shopping experience for the customers (Minuti & Novazzi, 2017). The unique thing about the logistics is that the lowest total costs are not necessarily achieved by always choosing the cheapest logistic function (Punakivi, 2003, p. 25). Sometimes the company can save more by investing in, for example, technology that can reduce lead-time and labor costs. This would also make it easier to predict the costs in the future.

The important part is the logistics system that is required to sell products online. When customers have placed a product in the shopping cart and paid for it, they expect to get the product delivered at the agreed time. If the store or warehouse (depending on where the product is picked from) does not have these products they would not be able to deliver them on time, which could ruin the reputation of the company. Therefore, there is a need for a proper logistic system in every step of the process from the customers makes the order to they receive the order at home. The webpage needs to be easy to use regarding both the design and the usability as it essential for a good consumer experience. There needs to be a system that informs both the company and the customers when it is empty of a product and that makes it possible to send information back and forth between the company and the customers.

Further, logistics systems may include technologies that make the picking and packing of products more efficient. This would give more time to perform the transportations of the orders and increase the probability that the products are delivered to the agreed time. However, the perhaps most essential part of logistics is that the customers receive the right order at the right place and time. This links to the lean management concept of *just-in-time*, which is about having the products "where they are needed and when they are needed" (Heizer, 2017, p. 678). People do their grocery shopping when they need some products, and often they would prefer having them immediately. If they have agreed to wait, for instance, in twelve hours to get the products is it important that they actually get their products within this time. If not, the customers may want to use other companies the next time they are going to do their grocery shopping. Therefore, the timing is an essential part of operating in the e-grocery business (Kämäräinen, 2003, p. 25). In addition, it is also important that the delivery is user-friendly. The company needs to set the customers in centrum when planning the deliveries (ref. Section 2.2). Therefore, the choice of delivering model should not only be made based on the costs but also based on what the customers prefer. Preferable services for the customers can, for instance, be to include tracking of the orders in order for the customers to get information about where in the process the company is in processing their orders.

The system also needs to handle an increase in customers. Especially since there are a lot of fluctuations in the e-grocery businesses. More customer means that the e-grocery companies would get more orders, which again means that they would need more capacity in the required operations for both processing and delivering the orders. Lastly, they need to have a system that allows the customers to return damaged products or products that does not live up to the customers' expectations. As mentioned previously, returns are most likely more common in an online business than in a traditional store. If the company have a system that could handle all these parts in a good and efficient way, they can have a great advantage to the competitors.

2.7 Options for processing orders

Processing orders include every action to get the orders ready for transportation, including picking and packing. Essentially, there are three methods to perform these operations: use existing grocery stores, existing warehouses, or build highly automated centers.

Tesco in the UK uses the opportunity to do the picking from the existing supermarkets. The advantage with this is that the picking happens closer to the customers, and therefore, the transportation distance becomes shorter. Often, companies have several stores in one city, which makes them more available to more people. The problem with this is that the existing stores are not designed efficiently for this kind of a business. A warehouse is built and organized to make it efficient to pick products. For instance, the products are placed in a way that makes them easily available and easy to find. In contrast, a grocery store is strategically built for the customer to pass most of the products. Typically, customers must walk through the entire store to get everyday products like milk, bread, and meat. Some products are also exposed several times for the customer to better notice them. Thus, it is more time consuming to pick products from a supermarket compared to a warehouse. On the other side, the warehouse-based models have higher costs relative to the need for new buildings. Thus, the warehouse-based model should only be used when the company have reached a high volume of customers (Minuti &

Novazzi, 2017, p. 38), if not they would have difficulties with making profit because of the high level of fixed costs.

Kolonialen.no is one of Norway's biggest e-grocery company. Their strategy is to process and deliver all the orders from one huge warehouse. The challenges with this are that the transportation distance becomes longer, and they are not able to cover an equally large part of the market as the store-based picking option. An option for them is to use third part transportation like sending products through mail, but as we have seen this is difficult because of the temperature requirements.

Highly automated centers are a type of a warehouse that use a lot of robots and technologies to become more efficient in their operations. A company named Webvan in the USA used this type of warehouse instead of picking from ordinary warehouses or supermarkets (Kämäräinen et al, 2001, p. 42). Webvan used approximately $35 million US Dollars to build each warehouse (Hays et al., 2005, p. 9). Therefore, this is an extremely expensive option but maybe not that expensive in Norway because of probably less customers. As mentioned previously, the total costs can in some cases become lower if the company invest in better logistic systems. This would of course require a huge amount of orders each day because of the large costs. Thus, the break-even point in a model based on the highly automated centers would have been much higher than the break-even point in the store-based models, and it would probably not be profitable to use automated centers in Norway.

2.8 Delivery options

E-grocery companies have several potential delivery options. Some companies operate with home delivery, where the products are delivered to the customer at their home. For the home delivery option, there exist two different methods; attended and unattended (Minuti & Novazzi, 2017, p. 77-78). The former refers to a delivery method where the products are delivered directly to the customer, which is the most common method. A downside of this method is that it requires that the customers are home and able to receive the products in person. Most people go to a job and other activities during daytime and are not always available in their home. This means that the home delivery has to take place in a specified delivery window, which typically is a period of time of 2-4 hours that the company and the customers have agreed upon in advance. Therefore, if there are several orders that have to be delivered on the same day, the transportation drivers have a tight schedule they must follow. If the customers do not get the products at the scheduled time, they might choose to go to the supermarket by themselves the next time they need new products.

In the second delivery method, the unattended method, the company deliver the products to a locked reception box placed in the yard or garage to the customer. A company named SOK in Finland have used this method (Kämäräinen et al., 2001, p. 41). This method makes it easier to perform the deliveries because the delivery window gets bigger. The companies get more flexibility in their delivery schedule, which makes it possible for the transportation drivers to optimize and drive a more efficient route (Kämäräinen, 2003, p. 9-10). Each box needs to be large enough to fit all the products each customer orders and as some products can be sensitive for low or high temperatures, it should be possible to adjust the temperature inside the boxes. Therefore, this method is a costly investment, and it will take time before the cost is covered by the income.

Further, Minuti and Novazzi (2017) write about another delivery option, which is the use of pick-up locations. This refers to a method where customers pick up the products themselves at a location. These locations could be either inside a store or at another place not directly connected to the store. This depends on where the picking operations are performed, and maybe also the placement of the store. A pick-up location should be a place that is easily accessible for potential customers, and from a lean perspective, a place where the products do not need to be moved or transported more than necessary. From the customers' point of view, this may not be as easy as getting the products delivered at the door, but it may be a less expensive alternative.

Although there exist several delivery options, every market is different in relation to population density, geography, and existing competitors. All these factors affect the efficiency and effectiveness, which makes the suitability of the various options strongly related to the specific market (Minuti & Novazzi, 2017, p. 77). This applies to both the picking and the delivery options. Therefore, the operational methods should be chosen carefully. The most essential factor when it comes to the delivery is the delivery time or, in other words, how fast the customers would like to receive the products. Longer delivery time means that the company has more time to process the order and transport the products, which makes them more flexible.

2.9 Region of Stavanger

Demography is a statistical description of the population, which often includes the population size, and age, gender, and geographical distribution. The total population in the region of Stavanger is 246 705 (SSB, 2017). When explaining the changes in demographics are factors like ecumenical relationships, health, and social forms are important factors (Solerød & Tønnessen, 2018). The demography is important for the study of a market because there are differences between people. In this case, for instance, the age distribution for the populations can give indications of what people prefer to buy. Typically, young people eat more foreign-inspired and ready-made food than the older part of the population. Furthermore, the number of families in the region can give indications about the average size of each trade. The geographical description is also important. In the sector of e-grocery, the companies must deliver the products to the customers. Thus, the geographical descriptions can be used to estimate the distances between customers, and thus how long it will take to deliver the orders.

3. Method

In order to perform this study, that aims at analyzing the different models that e-groceries can use and hopefully be able to conclude on the most profitable model, relevant data had to be collected. In this section, the method that was used to collect this data will be described, as well as an explanation of why this method was chosen. Furthermore, the work of the study is also illustrated in this section.

Collecting data can be done in many ways, but in basic, the data retrieval can be divided into two categories; first-handed and second-handed data. First-handed data are data that is received by the researchers themselves. This could be done in form of observations, interviews, experiments, and so on. Second-hand data refers to data that others have collected, which for instance could be publicly available statistics or other researchers published work. The method that is most optimal for a given case depends on the research topic. In some cases, there may be a lot of second handed data that fit the study, and especially publicly available statistics may obtain information that would not be possible for an ordinary person to obtain through observations himself. In addition, it takes time to collect the data yourself even if it was possible. In other cases, there may not be relevant second-hand data available and the researcher has to collect the data himself. The most essential part with the selection of data collection method is that it is reliable. If not, it would be hard to make a reliable conclusion of the research topic.

3.1 Data retrieval

Performing experiments is a common way of conducting research, and it has been one of the most important methods for obtaining answers to questions that have arisen over the years. Experiments have been used for centuries, but it was during the scientific revolution (in the 1500- and 1600's) that experiments really gained recognition as a key element in scientific methodology (Kaiser, 2015). An experiment is an arranged situation that simulates the relationship between different variables, often how one variable change in relation to some other variables (Sundbye, 2017). Experiments are often conducted in a locked and controlled environment where the researchers select which variables that should be included in the experiments or not. In addition, the researchers get the opportunity to see how a situation change if, for instance, one of the variable change during the experiment.

Performing experiments are used as the main method for collecting data in this study. Two experiments have been conducted; one to estimate the time to perform picking operations, and the other to estimate the time to perform the packing operations. The first experiment was conducted in a traditional store in order to get information on the time to pick different order sizes in a store-based model, and the second experiment was conducted at home since there was only need for different number of products to get information about the time to pack orders at different sizes. The purpose of the experiments was to get an indication of the time it takes to perform the picking and packing operations with different average sizes of the orders. Both experiments were relatively simple, but they gave a good estimate on the time it takes to perform certain operations. Although the experiments were performed in a traditional store, the results on picking speed were also used to estimate the time it would take to perform the picking operations in a warehouse-model. One negative aspect of the performed experiments is that they were highly affected by my actions. For instance, there is a huge difference between workers work speed, the sizes of the different stores, and so on. Thus, these time estimates may not represent all companies equally good.

Another more accurate method to get time estimates for the picking and packing in a store-based and warehouse-based model would have been to get information about the average time to pick and pack orders from existing e-grocery companies in Norway. The advantages of this method are that it would have been more reliable because the data is collected from real-world e-grocery companies and would provide a good estimation for similar future companies. The problem with getting the data from existing companies is that the e-grocery market in Norway is a relatively new concept, and therefore have a relatively small portion of the grocery market. Thus, there exists little publicly available data on the topic, which made it impossible to use such data for the analyses in this study. To increase the reliability of the experiments performed in this study there has been an attempt to collect data from existing companies that offer e-grocery services in Norway. In total eight companies were contacted, but four of them did not want to give away any information other than what is already written on their web pages, while the four remaining companies did not reply at all.

In order to get information about which delivery distance limit the e-grocery companies should have, the placement of the stores that belong to a Norwegian company named Rema 1000 where used as a starting point. These where later compare against the placement of a pizza company that offers home delivery in the region to get an approximate idea of how many stores that it is optimal to use in a store-based model. Further, the decision on which delivery model the e-grocery companies should choose was also decided based on results found in articles and previous master's theses, in addition to the results of experiments and other observations. The articles and master's theses were mainly found through the University of Stavanger's own database or at google scholar. There have been many studies of e-grocery companies aboard. The market abroad may not be the same as the market in Norway, but it gives a picture of the possible opportunities and issues that may arise in the Norwegian market.

Further, this research investigates most of the factors that affect the profitability of the e-grocery companies, and the results are mainly based on first handed data received through experiment and assumptions made based on discussions. Thus, this is a qualitative study that look deeper into the required operations needed to deliver an e-grocery services.

4. Analysis and discussion

In this section of the study, strategies of starting up and running an e-grocery service are analyzed and discussed. In the first sections (Section 4.1, 4.2, and 4.3), different factors that are important to consider for an e-grocery company before selecting strategy will be discussed. These factors includes the number of potential customers, which products to include in their assortment, and which logistic systems to implement. In Section 4.4, a closer look is taken on the operations needed when offering an e-grocery service. These operations include picking, packing, and transportation of the products. Figure 4.1 shows the two different ways of doing the picking operation that will be analyze; store-based and warehouse-based. The main difference is that the store-based model requires more work. First, the products must be transported from the warehouse to the store, and next, further to the customers. In the warehouse-based model, the flow chart of the products is shorter because the products go directly from the warehouse to the customers. Despite this, store-based model may be a better option under some circumstances. Further, in Section 4.5, the different delivery options the company have is analyzed. This section will focus on attended or unattended home delivery, and inside and outside pick-up locations (ref. Theory Section 2.8). These delivery options are presented in Figure 4.2. In Section 4.6 and 4.7, examples are given where calculations needed to see which model that is most preferable in case of the profitability are performed. In the end, a further discussion of the results is given. Finally, the last section (Section 4.8) there is a further discussion of the e-grocery market.

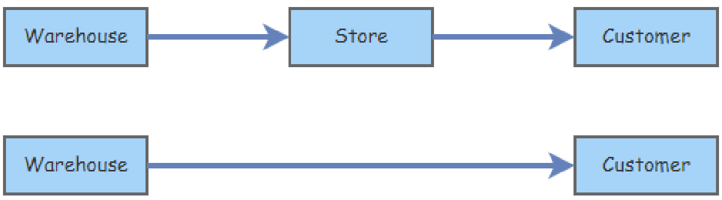

Figure 4. 1 – The two different ways of processing orders; store-based and warehouse-based model

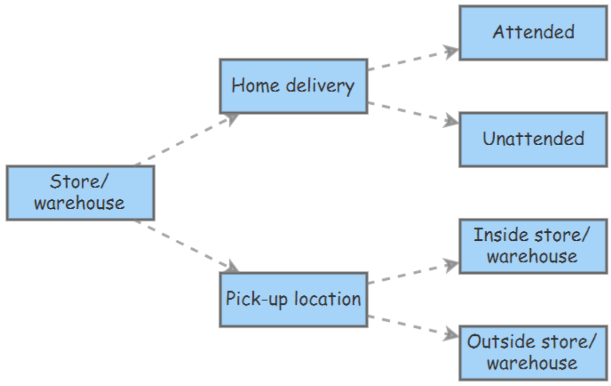

Figure 4. 2 – The four different delivery options; attended and unattended home delivery, and inside and outside store or warehouse pick-up locations

4.1 Potential customers

To get some information about the profitability for each of the eight models that are going to be investigated in this research we need to know approximately how many orders, and therefore how many potential customers, a e-grocery company in the region of Stavanger should expect to have. This is because the income and costs are highly correlated with the number of orders that are going to be processed and delivered.

To get some information about the potential customers we need to look at the demography of Stavanger (ref. Theory Section 2.9). For ordering groceries online, some knowledge about smart phones or computers are required, in addition to internet access. It is only a decade ago since it became normal for every household to have internet access at home. Thus, the older peoples of the population are most likely less familiar with internet than the rest of the population since most of the older peoples have not felt a need to learn how to use computers. In the other side of the age distribution, the younger does not buy groceries at all. Therefore, the potential customers for e-grocery companies are most likely between 20 and 59 years. The age distribution in the region is present in the Figure 4.3. By summarizing the percentage of the populations between 20 and 59 years, they constitute 59 percent of the population. Further, the numbers need to be adjusted for the people that live together in the same household since they would buy everything together. Thus, approximately 40 percent of the population are potential e-grocery customers, which correspond to about 100 000 people in the region (with a total population of about 246 705).

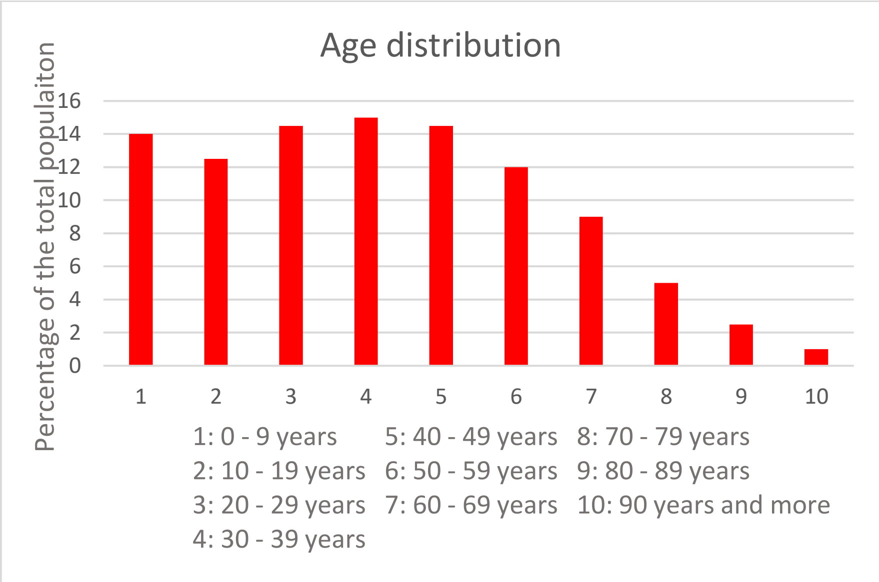

Figure 4. 3 – Age distribusjon in Stavanger (Stavanger Kommune, 2017).

Potential customers are not the same as the actual customers that will be using online grocery shopping, but an estimate of the number of customers that might will use it. The percentage of people that use online shopping of groceries are relative small compare to those who do not. In addition, all the potential customers are divided at all the companies that offer online shopping of groceries in the region. Moreover, not all the customers will be in the delivery distance from the company since the region are widespread, which makes the distances long. Thus, the company may only be able to make about five percent of the potential customer to actual customers, which corresponds to a total of 5000 customers. Furthermore, the customer will probably not order groceries every day due to the extra cost of getting the products delivered compared to traditional shopping. If the average customer orders once each week, the company will have between 500 and 1000 orders each day depending on the day and time in the week. Typically, most of the population shops on of the last days before the weekend.

The study of the potential customers can also give information about the order size which will affect the total time of performing the picking and packing operations, and therefore the costs. People in the age between 20 and 39 years are the part of population that are in the fertility age, which means that they are more likely to have children. In addition, people between 40 and 59 years may still have children that live home. These groups of peoples are most likely a large portion of the potential customers. If it is a family that orders from the company it is more likely that the orders are bigger compare to a single person or a couple of two since they need to feed more people. Families is also the part of the populations that may have the most struggle with time. Thus, they should be the main target for e-grocery companies.

4.2 Selection of products

In addition to the number of orders, the composition of products the company include in their assortment will affect the time to perform the operations needed to process and deliver orders to the customers. Moreover, it will affect the number of customers as well (ref. Introduction Section 1).

Since the families are the most likely customers for the e-grocery company, they need to offer products that these customer wants. A Norwegian diet typically consists of varied products. Thus, the company need to consider including fresh products like vegetables and fruit, cold products like dairy and meat products, frozen ready-made dinners products, as well as dry and canned products in their assortment.

Some products are more complicated than other products to deliver for e-grocery companies, which is the case for example with chilled and frozen products. These products should be picked at a late stage to reduce the risk of the products being damaged by the heat. In store-based model, this would mean that the most efficient picking route might not should be used because these products often are scattered throughout the store. The picking process may have to be performed in two rounds, where the products without requirements are picked first, and afterwards the products with such requirements. This implies especially for big orders that takes longer time to process. In the warehouse-based model, these issues can be considered during the planning phase of the layout. By designing the layout to be well suited for efficient picking processes, will the picking speed not be as affected as for a store-based model. Further, chilled and frozen products will also complicate the packing and deliveries both for store-based and warehouse-based picking. Some fruits and vegetables can be damage by too low temperatures, and therefore, must be packed in separate boxes. In addition, products that are temperature sensitive requires that the transportation cars can control the temperature during transportation and that the temperature is taken into consideration during the deliveries between cars and locations.

Another important factor when deciding which products to include in the assortment is that food products have different shelf life. This factor is especially important when the company only use the warehouse-based model. A store-base model has traditional customers in addition to the online customers, which a pure warehouse-based model do not have. Thus, in periods with few customers, the products will stay longer in storage. Dairy and meat products typically have short durability, which means that these products must be sold in a regular basis in order to avoid products being damaged. Defective products are one of the seven wastes and does not add any value for the customer. Therefore, these products should be removed or kept at a minimum, as these products cannot be sold and represent lost money for the company (ref. Theory Section 2.3). This would especially be a problem if they have a huge selection in brands of these types of products. Some people are very brand-minded when shopping, but this does not imply for everyone or for every product. Further, it is also essential that they do not have too many of each product in storage, but rather order these types of products regularly. There are also some products with longer durability. This implies especially for canned and frozen products. Therefore, the most optimal choice for the company regarding the shelf life is to only offer these types of products, but this will not give many customers.

From a customer point of view, it is important that the store have a wide selection of products. For instance, if the company have a small selection of dinner products the customers would be fed up with these products because people like to vary what they eat. Furthermore, people like to buy everything they need and want at one place. In traditional stores, we can buy everything from shampoo, toilet paper, baking paper, plastic bags, and so on in addition to groceries. If the online store does not have these products, the customers would still need to use the traditional stores. The problem for the e-grocery companies then is that the customer may end up buying more when they already are in the traditional store, which means that they order less online. Moreover, an e-grocery firm also compete against other e-grocery firms. Thus, it will be difficult for the e-grocery firm to increase their market share with a limited selection. On the other side, the company need to consider the costs of having a product compare to not having this product.

Almost every shopping trip consist of at least one cold product because these are used in almost every dinner that Norwegian families normally makes. Therefore, it would have been a disaster not to include cold products in the selection because the customers then would need to buy them somewhere else. Frozen products have also become more popular the recent years because of longer shelf life, but there are normally substitutes for these products. Thus, the frozen products are not as important to include as the cold products, although it can be an advantage to have these also if customers do not want to use substituting products. Further, the advantages with dry and canned products are that they have a long shelf life, do not have any specific temperature requirement, and they are easy to pick, store, and deliver. Therefore, these products are a clever choice to include, as they do not affect the costs other than the increased need for storage.

4.3 Logistics systems

Logistics are an important part of operating efficiently because it connects all the operations together (ref. Theory Section 2.6). In order for an order to succeed during processing and delivering to a customer, it is essential that every product on the order is available in the store or warehouse. Therefore, there is a need for a system that tells the customers if the products they are looking for are available to buy or not. This is a system that every e-commerce company use, and a system that a warehouse-based company have the option to use. The system need to be slightly different for a store-based picking process. Although every store has systems that tells how many numbers there are left of each product in the store, there are uncertainties associated to these numbers, as it is difficult to have an exact number of available products due to the traditional shoppers in the store that might pick these products. If the products are laying in the shopping basket of one of the traditional shoppers, and not payed for, they are marked as available in the system even if they in reality are not. Moreover, the products can be sold out in the time between the order are complete and before the order are processed by the workers. Thus, the store-based picking companies need a system that considers this. The easiest way is to make the products unavailable online when there are just a few products left, and by that having a safety stock in case there are something wrong with the system.

Further, every system fails sometimes, so they also need to have a solution on what to do if they cannot deliver a specific product. If a traditional store is empty for a product, the customers may choose another similar. Online customers do not have this opportunity. The company could call the customer and ask if they instead want another similar product, but they may not get in contact with the customer. A possibility may be that the company buy the product from a traditional store. The problem is that this will take time, and they will most likely pay more for the product in a store than they would pay if they bought this product from their supplier. If customers are encouraged to complete the orders some days before they want to receive the products, they would get more flexibility and an opportunity to order an express delivery of products from the supplier. This could be done with a reduction in price, discount tickets or similar actions. In addition, the more customers they are able to encourage to order some days in advance, the better prepared they would be if the demand of a product suddenly increase, as they would be able to order a higher number from the supplier.

Furthermore, there may be a need to increase the safety stock when a company start offering products in online stores in addition to the traditional stores because they may attract more customers than before. Customers are often loyal to stores that are close to their home, but when they get the opportunity to receive the product at home they may shift their preferences about which company to use. When the safety stock increases the company would need to order more frequently because they still have limited space in the store, thus they cannot have unlimited number of products in the store. Therefore, the store-based companies may need to change their ordering schedule. Having more frequent ordering may also protect the company from overreaction in a suddenly increase in demand because they do not need to order large quantities in one order, but instead adapt the quantities to the demand for each order.

4.4 Processing orders

So far, we have been through the basic parts that need to be considerate before selecting which model to use. In addition, the previous sections of the analysis had some information that will affect the time to perform the needed operations to deliver an e-grocery service. In the further analyze the different model that are requiring to process and deliver the orders will be the mainly focus. To investigate which model that make the e-grocery companies in the region of Stavanger profitable we need to know something about the time to do the operations because the time affect the labor costs, and the labor costs affects the company's profit.

This section will look at the time it takes to do the operations required to process an order, namely picking and packing. Figure 4.4 gives an overview of the factors that affect these operations, which will be analyzed and discussed throughout this section. All factors imply for both a store-based and warehouse-based model, except the factor with a yellow circle marked namely “traditional customers”, which of course only would affect the processes in a store. This part will be divided into different sections. First, we will look deeper into the store-based model.

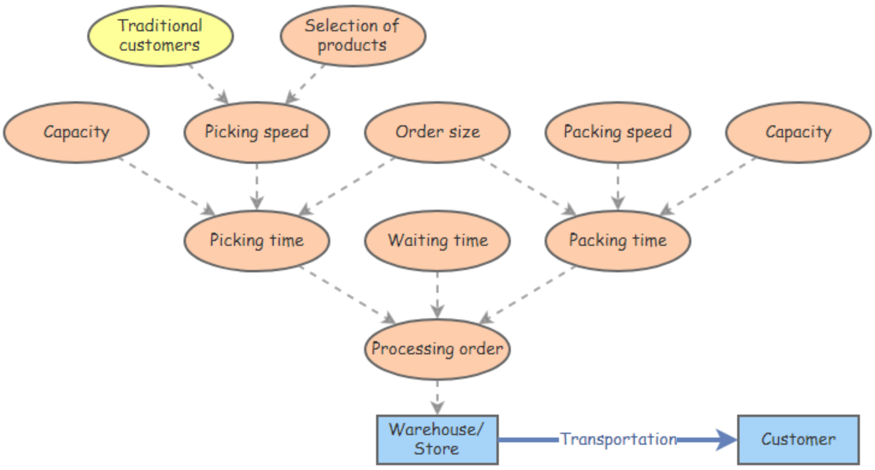

Figure 4. 4 – An overview of the factors that affects the order processing.

4.4.1 Store-based picking

Typically, e-grocery companies do their picking from the local and existing supermarkets. In many ways, this may be logical as they already have a wide range of products close to potential customers They only need someone to perform the picking and delivery operations.

The time it takes to pick products depends on three factors; picking speed, number of product at each customer order, and capacity (ref. Figure 4.4). Picking speed refers to how fast the workers can pick each product. Since I do not have any number available from the real world, I conducted an experiment to make an estimate. The experiment started with six shopping lists, which each had five to thirty products. The shopping lists contained different “every-day products” like milk, bread, meat, and vegetables (these lists are presented in appendix 1). In advance, these lists were organized in accordance to the placement of the products in the store to make the picking as efficient as possible. Further, the experiment was conducted in a store I were well familiar to for the experiment to be as realistic as possible. In addition, the walking speed had to imitate what a real worker would do in about eight hours (a normal length of a workday in Norway), which most likely is an agreeable and comfortable speed. Although the management wants all their employees to work as quickly and effective as possible, most people will work in a comfortable speed. The experiment was conducted on a Friday at 1 PM. There were many customers in the store, but this is something that they should expect when performing the picking in stores; sometimes there may be more and other times fewer customers. The purpose of the experiment was to get a pattern in the time it took to pick the different number of products.

The shopping lists contained both chilled and frozen products, but the temperature requirements were not adjusted for during the performance of the experiment. Therefore, the picking time would be longer if these types of products were to be included in a real-world scenario. Further, the composition of the order will also affect the picking time. The lists in the experiment consisted of only different products. In a real-world scenario, there might be orders that have some identical products as well. For instance, some people drink a lot of milk and need one carton of milk every day, or a big family may need several packages of meat when making dinner. In these cases, the picking time for each product will be even lower than in the experiment because it takes approximately 2 seconds to pick an additional identical product. The same would be the case if there were many products from the same product category. As an example, are dairy products often placed close to each other in the store, which makes the walking distance between these products short.

Table 4. 1 – Result from the experiment on picking time in a store-based option.

Number of products	**Total time in seconds**	**Time each product in seconds**
5	59	11.8
10	86	8.6
15	126	8.4
20	163	8.2
25	178	7.1
30	185	6.2

Table 4.1 present the results from the experiment. When the order size increases, the time it takes to pick each product decreases. This was expected as more products mean that the distance between the products is shorter. It is therefore an advantage for the company if customers order many products at the same time. On the other side, the difference between the scenarios of 10 and 20 products is only 0.4 seconds picking time per product. Thus, the time is almost the same. The advantage gets bigger if the orders increased from 5 to 10 or 20 to 30 products. Then they would save 6 and 2 seconds, respectively, for each product. This is demonstrated in Figure 4.5. Here we clearly can see shifts in the trend of the graph at order sizes of 10 and 20 products.

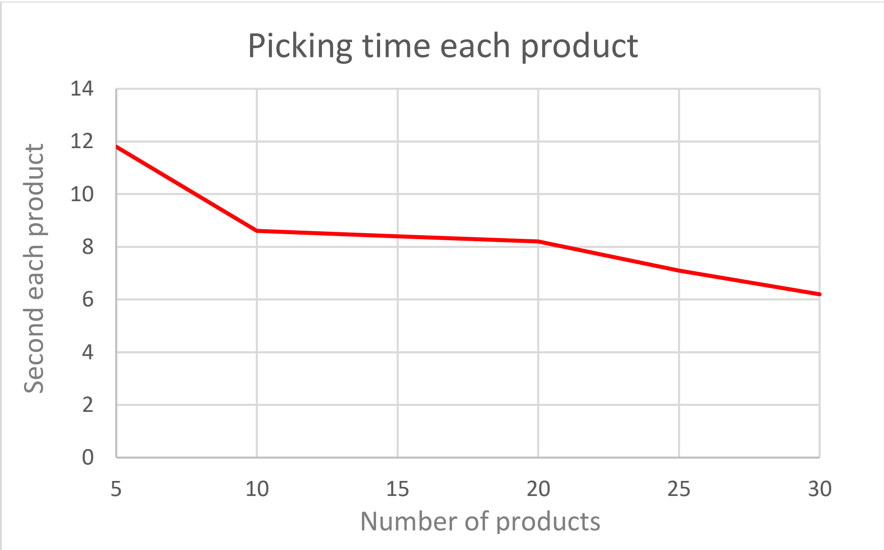

Figure 4. 5 – Picking time each product in a store-based model.

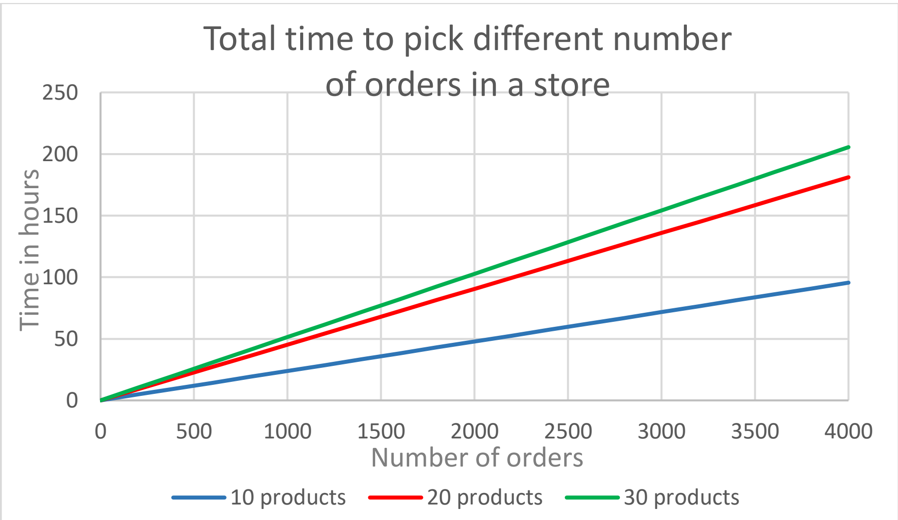

Figure 4. 6 – The total time of picking different number of orders in a store-based model.

Figure 4.6 shows the total picking time for orders of different numbers of products if the average number of products for each order was 10, 20, or 30 products. If we compare the graphs against each other, we can see that the advantage of a higher number of products is lower when increasing the number of products from 10 to 20 compared 20 to 30. If a store-based company have 4000 orders, it would take about 95 hours to pick all orders if the order size was at 10 products per order. The number of hours almost double to 181 if the order size is twice as much, which is an increase of 91 percent. In comparison, it takes only 205 hours to pick the same number of orders with an average of 30 products, which in an increase of 116 percent from the scenario of orders of 10 products each order. This makes a difference of only 24 hours between 20 and 30 products.

They would need about 28 people working 7.5 hours shifts to perform the picking operation required to deliver 4000 orders of 30 products each. If the company offers same-day delivery to the customers, there may be days where the demand is higher. Therefore, they may need more workers. If over 28 workers were performing picking operation at the same time, they may be in the way of each other, so the picking time could might even increase in this scenario.

On the other side, the advantage of store-based picking is that there may be many stores from the same company in a city. Therefore, not every store may have as many orders to process as in the example. If they have ten stores in a city with a population of 100.000 people, and five percent of these use the e-groceries service to the company daily, they would have around 500 orders at each store. In this case, each store only needs four workers to perform the picking if the order size is 30 products on average. Moreover, if the average order size is only 10 products they would only need two workers compared to 13 if they had 4000 orders each. If there were two to four workers performing the picking operations the likelihood that they are in the way of each other are less compared to if they were around 13 and 28 picking workers. Another important factor is that store-based picking can affect the traditional shoppers in the store. Many customers prefer to go to the store during periods of the day when there are few customers. If there are many workers performing order picking in the store at the same time, they may be "in the way" for the traditional customers. Today, e-grocery have only a small part of the entire grocery market in Norway, therefore, it is important that the companies still do everything to keep the traditional customers satisfied.

In a customer point of view, there should not be more than one to maybe three workers, depending on the sizes of the store. Thus, a store should not have much more than 500 orders for the operations to optimal when both the time factor and the traditional customers are taken into consideration.

The picking speed would also be affected if the employees at work swapped between doing picking operations and traditional store tasks. If all the workers are wearing the same clothes the traditional customers may distract the picking for asking the workers questions, and this would make the picking time more uncertain. This would especially be a problem if they have short-time deliveries. The most optimal way to make the picking time short and to some content predictable is to have workers with normal clothes who only have a responsibility to performing these tasks. Then the traditional customers would rather ask other workers when they need help.

4.4.2 Warehouse-based picking

Warehouses are custom designed to do picking efficient. Thus, the time it takes to pick products from a warehouse will be lower compared to a store. The estimated time to do warehouse-based picking is presented in Table 4.2. These numbers are estimated based on the results from the store experiment (ref. Table 4.1). It is assumed that the time to pick each product decreases with a higher order size, but most likely will the difference not be as huge as in the store experiment because of a more efficient placement of products.

Table 4. 2 – Estimated picking time in a warehouse-based model

Number of products	Total time in seconds	Time each product in seconds
5	30	6
10	55	5.5
15	80	5.3
20	100	5
25	115	4.6
30	125	4.2

Figure 4.7 shows the total time it takes to perform the picking operation with orders of 10, 20, and 30 products, like Figure 4.5 in the store-based model. If the company have 4000 orders it will take 61 hours if the average orders consist of 10 products, 111 hours if the orders consist of 20 products, and 139 hours with 30 products. In the store-based model, there was a percentage increase of 91 and 116 when the average number of product each order increased from 10 to 20 and 10 to 30, respectively. In this model, the corresponding percentage increase is 82 and 128, respectively. Thus, there is less difference between orders of 10 and 20 products than between 10 and 30 products, which means that the time of picking orders at different sizes are more evenly distributed in this model compared to the store-based model.

Figure 4. 7 – The total time of picking different numbers of orders in a warehouse-based model for orders with an average of 10, 20, and 30 products per order

Further, there is some difference if the company choose to perform the picking from an existing warehouse or if they choose to build a new one. If they could use existing warehouses they may get some of the advantages that are with a store-based model, like that the start costs are lower, no problem with the shelf life of products (if the warehouse delivers products to other stores as well), use existing capacity, and so on. On the other side, this strategy may affect the picking time if the warehouse contains other products than the e-grocery company offer as the distance between the products then would have been longer.

There are also many opportunities if they build a new warehouse, like that they can build a highly automated warehouse that is customized to do the picking of products efficiently, for instance, with help of robots and modern technology. Thus, they are able to save money on the process needed to get the orders ready for transportation. They also get the opportunity to decide how big the warehouse should be for it to be as optimal as possible. A large warehouse and/or a warehouse that consists of products other in their assortment would make the picking time longer. The problem is that it costs a lot of money to build a warehouse, and if they do not have enough customers it will be difficult to cover these costs.

4.4.3 Comparison of store-based and warehouse-based picking

Figure 4.8 present the estimated picking time per product for both a store-based and warehouse-based option in separate graphs. If we compare these two against each other, we can see that there are some similarities and differences. The time it takes to pick each product does decrease as the order size increases in both models, where the main difference is that the time decreases faster in the store-based model. When the order consists of five products it is a time difference of 6.2 seconds, and when the order size increase to 30 products the difference decrease to only 2 seconds. This means that the company would save more time of performing the picking operations in a warehouse when the orders are small compare to a larger order size, or on the other side, that the store are able to become more efficient in the picking when the number of product at each order increase.

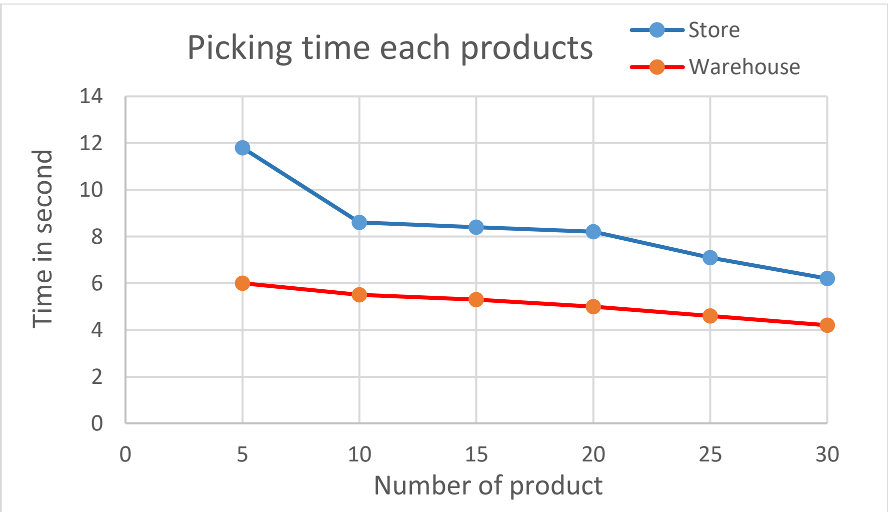

Figure 4. 8 – Comparison of picking time each product in a store-based and warehouse-based model.

Further, the picking time is more unpredictable in a store than in the warehouse. There is clearly shifts in the graph at 10 and 20 products for the store-based model. One reason would probably be that the traditional customers affect the picking time in a store, in addition to that the composition of the order also play a part. For instance, the distance between the different products categories are longer in a store compare to a warehouse. Thus, the picking time is longer in a store. But if the order only consists of dairy products the time will probably be more equal between the store and the warehouse, which may be the reason for the sudden shifts. Because of this, the store should probably calculate some extra time in the picking operations.

It is also interesting to look at the difference between the time to pick each order in a store and warehouse. These number are present in Table 4.3 The largest difference is at 63 seconds between order sizes of 20 and 25 products. If an employee costs 150 NOK per hour on average, it would make a difference of approximately 2.5 NOK each order. This may not look so much, but if the company have 500 orders at this size it would make a difference of almost 9 hours, which means it would have been 1 350 NOK more expensive to do the picking in the store regarding the picking costs.

Table 4. 3 – Time difference between a store-based and a warehouse-based model

Number of products	**Total time difference**	**Time difference per product**
5	29	5.8
10	55	5.5
15	46	3.1
20	63	3.2
25	63	2.5
30	60	2

The costs of a store-based and warehouse-based model are very different. A store has the advantage of using existing buildings which means the building already are paid for of the income from the traditional stores. This implies also to companies that have stores but perform the picking operations in the warehouse instead. For them, it would not need many adaptions to perform the picking. Generally, they would only need some extra workers to perform the picking. In contrast, if a company build a warehouse, or even rent a building, these costs need to be fully covered by the online business if they do not use the warehouse for any other business. Therefore, it may be more expensive to use a warehouse-based model regardless of the picking costs.

4.4.4 Packing products

Packing of products depends on order size and the packing speed. Like picking speed, packing speed refers to the time it takes to pack each product. In contrast to the operation of picking, I assume that the packing speed is about the same for both store-based and warehouse-based packing. As mention previously, the picking speed is faster in warehouses compare to stores because warehouses are customized for efficient picking. In contrast, the packing does not need many adaptions. They need to have a proper packing station where there is enough space for all the products aa well as having the boxes easily available in case there is a need for more than just one box. This can be done easily in both stores and warehouses at a low cost.

To find an estimation of the packing speed I conducted an experiment, where a stopwatch, various products and some plastic bags were used to conduct the experiment. Often products are delivered in a box when ordering from e-grocery companies, but the important part was to measure the time it took to move products from one point to another. In addition, the products were of different sizes and weight to imitate a real customer order. The results are present in Table 4.4. In contrast to the experiment on picking speed, the number of products in each order does not really matter in this case. The time varies with only 0.5 second at the most, which is a relatively small number in this context.

Figure 4.9 presents a graph over the packing time per product. The figure does not show any trend that it is an advantage with large customer orders. For instance, the time to pack each product in an order of 25 products was higher than with an order of 10 products. The time depends on the size and weight of the products. In addition, it takes longer time to pack products that easily can be damaged, such as fruit and chips. These products need to be placed carefully in the boxes, and they should not have other products placed on top of them. Therefore, these products require more thinking than, for example, canned goods that can withstand almost high pressures.

Table 4. 4 – The result from the packing experiment

Number of products	Total time in seconds	Time per product in seconds
5	9	1.8
10	13.4	1.3
15	24	1.6
20	31.7	1.6
25	43.2	1.7
30	51.6	1.7

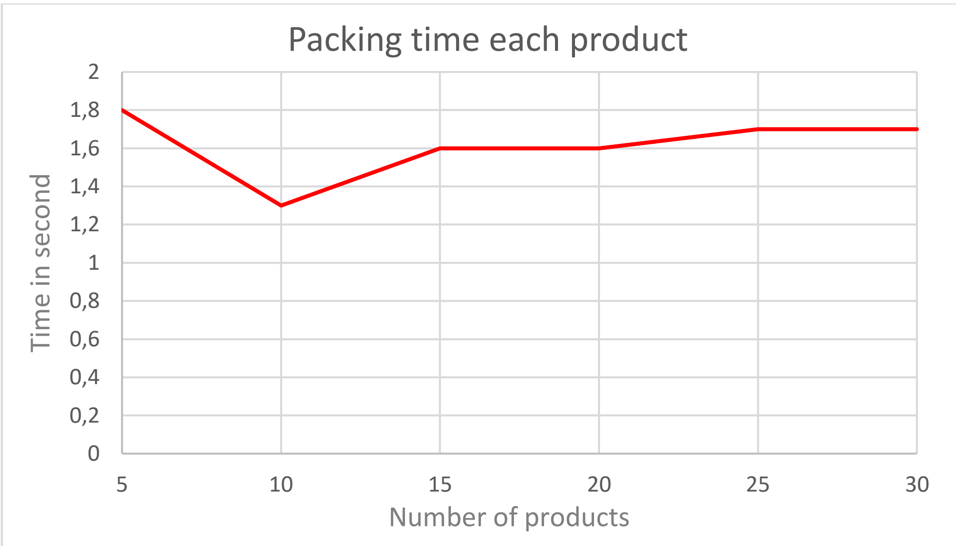

Figure 4. 9 – Packing time per product.

Another interesting part to look at is how much labor capacity that it is needed to pack different numbers of orders. Figure 4.10 shows the total time it takes to pack orders with average sizes of 10, 20, and 30 products. For instance, if the average was20 products in each order it would take about 7 hours to pack 800 orders. This would cost the firm approximately 1050 NOK with an average payment of 150 NOK per hour. This is something one person would be able to do in a workday. The problem is that every order has different time requirements. There may be periods of the day when maybe 200 customers want their orders at the same time, which would take between one and a half to two hours. If they suddenly get orders with short-time delivery, it may be a problem to get the orders ready in time.

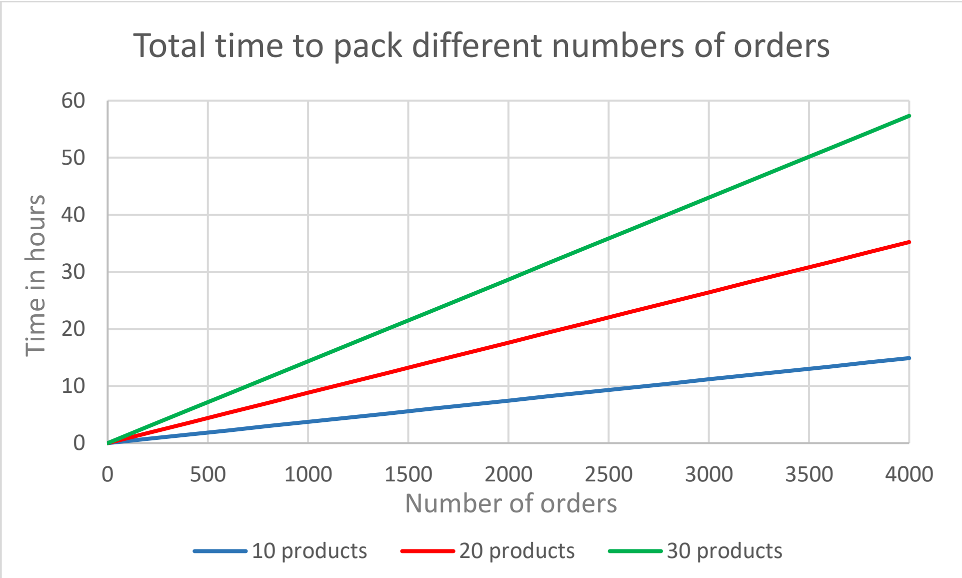

Figure 4. 10 – The total time to pack different numbers of orders for orders with an average of 10, 20, and 30 products per order.

4.4.5 Total time of processing order

So far, we have looked at the two operations, picking and packing, that is required to make an order ready for transportation separately. In this part, these operations are looked at together. Table 4.5 present the total time and time per product to perform both the picking and packing in a store-based option. For instance, it takes approximately 1 minute to process an order of five products and 4 minutes to process an order of 30 products. Table 4.6 shows the time of doing the operations with a warehouse-based model. In this option, the time of processing five products is only 39 second, and when the order increase to 30 product the total time is approximately 3 minutes. Thus, the company would save about 1 minute per order if the average order contained 30 products. If the company have 250 orders a day, they would save over 4 hours to use a warehouse-based option. If the workers are paid 150 NOK per hour on average, the company would save 600 NOK in labor costs every day. If the company delivers products every day regardless of public holidays this would be 219 000 NOK in total every year. In comparison, if the average order consists of only five products they would save about 0.5

minute each order, which would be a total of 109 500 NOK in a year. Thus, the advantages of a warehouse-based option would be twice as large with an average order of 30 products. From this, we could conclude that it would have been more favorable to use a store-based option when the average order size is high.

Table 4. 5 – Total time to processing an order in a store-based model

Number of products	Total time in seconds	Time per product in seconds
5	68	13.6
10	99.4	9.9
15	150	10
20	194.7	9.7
25	221.2	8.9
30	236.6	7.9

Table 4. 6 – Total time of processing an order in a warehouse-based model

Number of products	Total time in seconds	Time per product in seconds
5	39	7.8
10	68.4	6.8
15	104	6.9
20	131.7	6.6
25	158.2	6.3
30	176.6	5.9

Waiting time and queuing theory

The total time above is not including potential waiting time that may arise between the two operations. In the Theory Section 2.3.1, we looked at the queuing theory and which factors that would affect the waiting time. In addition, in Theory Section 2.2, we looked at the relationship between the capacity, lead time and number of product. These two theories are highly connected to each other and are relevant for the time it takes to process an order.

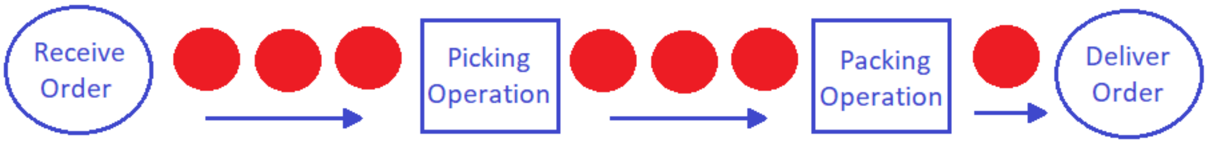

Figure 4. 11 – Waiting time model in processing orders.

Figure 4.11 shows a picture of how the process of the operations would look like. The entire process starts with an order from a customer. All the red spots illustrate customer orders that are waiting to be processed at the different operations. If the company has received many orders at the same time, they are not able to start with the picking operation before they are finished with the other orders waiting in line. This waiting time would be affected by the portion of the capacity that is in use in the picking operations. If there is one person performing all the picking operations the total waiting time would have been all the order prior to the queue multiplied by the time it takes to pick them. If there were 10 orders with an average of 30 products each, the total waiting time would be approximately 31 minutes in a store-based model (ref. Table 4.1), and about 21 minutes in a warehouse-based model (ref. Table 4.2). If they were two workers, the time would be the half of about 16 and 11 minutes, respectively. Something similar would apply in the packing operations. The difference in this lead is that the queues would not be long if there is little capacity put in the picking operations. If the same example with one worker and an average of 30 product each order is used, a new order would come with approximately two and three minutes intervals (depending on which model that is used). The time it takes to pack an order is less compare to the picking time. Thus, if they have the same number of workers in both operations there would not be any queues in the second lead. Waiting is one of the seven wastes for the company and should be removed from the operations (ref. Theory Section 2.3). Waiting time does not directly cost anything for the company because the workers do other things when they do not work on the order, but there may be indirect costs. For instance, every unfinished order still need space for storage, and it shortens the time to do the transportation because the lead time of the operations needed to process an order increase.

Thus, it is important that they make an efficient process with a continuous flow. It can be difficult to calculate how many persons there is a need for in the picking operations because they do not know the number of orders a long way in advance. An advantage with this type of operations are that the workers do not need much prior knowledge. If there are long queues in one of the operations they can, for instance, get help from the colleagues. However, in such a case, they need to make sure that they do not move the queue further into the system. They would not gain anything from that. In an e-grocery sector, it may be better to have waiting time before the picking operations because of the temperature requirements. When the products are picked, it may be hard to comply with all the requirements of the different products.

In some cases, the company may choose to use a model where the same person performs the picking and packing operations of the orders. Unless they have many orders, it may be more optimal this way. Queues could still arise, but they would be arising before and after the operation needed to process the order, as shown in Figure 4.12.

Figure 4. 12 – Waiting line model when the picking and packing is performed by the same person.

Capacity management

The capacity is highly related to the lead time. If they have too little capacity the lead time would be longer because there will be more queues in every steps of operations (ref. Theory Section 2.2 and 2.3.1). Thus, the needed capacity level is also highly affected by the time the company promises to deliver the products. Short-time deliveries would require more resources because everything must happen fast. In periods, there may not be as many short-time deliveries as estimated and then the store may have available capacity. It is costly to have more capacity than it is need for because most of the capacity is at a fixed cost (ref. theory section). For instance, they must pay all the workers regardless of how much work it is to do. Thus, these deliveries will cost more for the company compare to long-time deliveries that give the company more flexibility, and an opportunity to utilize the capacity in a better way.

Typically, traditional customers do their shopping in the evening after work, but to some extent, customers are unpredictable. It can be difficult to know exactly when people choose to do their shopping. Sometimes there could be a high demand in the middle of the day, while other times there are not. Therefore, there is always a need to be many people at work at the same time in the traditional stores, which sometimes causes the stores to have a higher capacity than needed. An advantage of a store-based model is that it is easier to use all the available capacity compared to a warehouse-based option. If there are periods with a low demand from traditional customers, the "traditional workers" could help to process the orders from the online customers, and vice versa, the picking workers could help with customers and unpacking of products. Thus, the company would have the opportunity to have enough capacity to do the operations that it is a need for without losing much money of having too much capacity in periods with low demand.

4.5 Delivery

In addition to the labor costs of processing orders, e-grocery companies have labor costs associated with the deliveries as well. Before we can look at the delivery time, we need to know more about what affects the delivery in general. Figure 4.13 gives an overview of the factors that affect the delivery time and these factors will be analyzed and discussed in this section.

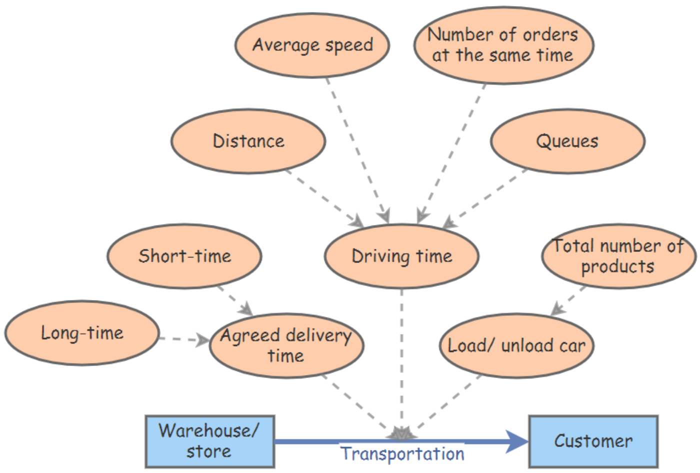

Figure 4. 13 – An overview over the factor that affects the transportation of groceries.

The delivery time the company promise to the customers directly affects the time they have to complete the deliveries. Most of the companies in Norway that offers delivery gives the customers the opportunity to choose between different delivery times. For instance, Kolonial.no offers delivery times from 90 minutes to the next day after the ordering is complete. The problem with a short delivery (for example 90 minute) is that the lead time must be short, and the operations needed to process and deliver the order must start almost immediately after the customer have complete the order regardless if they have a lot of other orders to process. Thus, it is essential that the company have available capacity to handle all the orders. The short-time delivery time may affect the operations of orders with longer delivery times if they do not have enough capacity. Further, it may not be time to organize the transportation of short-time deliveries with other deliveries with longer time. Thus, they may need to drive several times to the same places to deliver all the orders, which require more costs related to transportation time and use of car. Often the customer must pay more for short-time deliveries compare to long-time deliveries. From Theory Section 2.1 we could see that customers have different willingness-to-pay. Therefore, in cases where no customers want to pay extra for fast delivery, the company would have a high amount of available capacity that are not being utilized properly, which cost a lot of money.

With long-time delivery, the company gets more flexibility in their driving schedule, but also here there are some limitation for them to operate in the most efficient way. When the customer orders products they want delivered the next day, they choose between different time windows they want to receive the products. Often this time window is two hours. The company could not deliver the order before this time because the customer may not be home or ready to receive the order. Similarly, delivering the order after this time is undesirable. Some periods of the day are there might few orders that are going to be delivered and the customers may live in opposite direction off each other. Therefore, it may be difficult to find an optimal driving route. In addition, they may need to drive to the same place several times a day because of different delivery times. The most optimal from the company's point of view is to transport several orders at the same time. Then they could save transportation time if the orders are delivered close to each other, which will affect the labor costs positively. They would also use less fuel, and the price of the insurance will be lower because the distance the car drives directly affects the price. The company can operate with a longer delivery window, but this would not be optimal in a customer point of view since they may need the products to a specific time. For instance, if they order products needed for making dinner, they need to have it delivered before they are going to start cooking.

The time it takes to deliver an order is also highly affected by the distance to the customer. Longer distances means increased driving times. The company need to find an optimal limit on how far they are willing to drive to deliver products. Typically, other firms that delivers products to customers have a distance limit of around 2-3 km. The advantage of a small distance is of course that the driving becomes faster, but in addition, the company's customers will be closer to each other, which means that the company is able to serve many customers in a short time.

Further, the average speed they drive are also an important factor in the calculation of the time and labor costs. Table 4.7 present the time it takes to drive different distance on average speeds between 20 and 50 km/h. For instance, an average speed of 40 km/h means that, in theory, the car would constantly be driving in 40 km/h regardless of traffic or other road conditions. It may be difficult to know the exact time, but it gives a good estimate. The time to drive four km compare to two is of course the double. The same implies with the difference between four and eight km. If the store/warehouse have a distance limit on two km and if the speed is 30 km/h in average, they can drive back and forth between the store/warehouse and the customers living on the limit distance seven and a half time in one hour. If the company only serve one customer at the same time, it would be 20 NOK in labor costs per order only on driving if the average payment was 150 NOK per hour. If they could deliver several orders at the same time, the cost per order would decrease. Consider an example where the driving distance to a customer is two km and additional customers are located in the same area with a distance of 0.5 km from each other. With an average speed of 30 km/h, the company would be able to save about 3.5 km, or seven minutes, for each additional customer they serve on this trip given that all customers live within the distance limit of two km.

The average driving speed will depend on where the customers live. If they live in densely populated places, the speed limit would be lower compare to rural areas. Thus, the average driving speed will be lower, and therefore, will there be some difference among the stores depending on where they are placed. Further, if the limiting driving distance increase from, for example, two to four km is it more likely that the driving route would at least have some places with higher speed limit. Therefore, if the limiting driving distance doubles it does not mean that the time also double as the average speed most likely chance as well.

Further, queues in the traffic will affect the average speed and the total transportation time. Typically, there is lot of queues in the morning and evening when almost everyone starts and

Table 4. 7 – Time to drive two, four, and eight km with different average speeds between 20 and 50 km/h.

Average speed	Time to drive 2 km	Time to drive 4 km	Time to drive 8 km
20 km/h	6 minutes	12 minutes	24 minutes
30 km/h	4 minutes	8 minutes	16 minutes
40 km/h	3 minutes	6 minutes	12 minutes
50 km/h	2.4 minutes	4.8 minutes	9.6 minutes

finish their workday. Therefore, a delivery with a time window between 3 and 5 PM, for example, may be more difficult to deliver in time compared to a delivery window between 12 and 2 PM. Everyone knows that it takes longer time to drive through the traffic in these periods, so this is easy to take into considerations for the delivery. However, there could be queues in other times at a day too because queues are to some content unpredictable. For instance, there could be an accident that prevents the flow in the traffic, or roadworks that block the road for short periods. These queues may be a problem for deliveries since they are unexpected, and it would be difficult to do something to prevent them. Some road may have less queues that others, so they may change the delivery route in the periods they know there are lot of queues, which could cause the route to become longer although saving time. It is also possible to adapt to the traffic by using the shortest route in little traffic and using longer and less busy routes when there is more traffic. The only downside of that is that if the amount of traffic is miscalculated, and a short route is used when a long one should have been used instead. Once you are standing in a queue it can be difficult to get out it.

In addition to the driving time, it will take time to load and unload the trucks that also affects the labor costs. The number of products will affect this time. For instance, more products means that the time will increase because the driver would have to go many rounds to get everything into the car. Further, several orders means more stops where the driver must use time on finding the right products and carry them to the customer entrance. The company would have used time on this regardless of they deliver one or more orders at the same time. The advantages with longer delivery time is that the company to some content choose when they are going to use - time on loading the cars. For example, if the company have an order with short delivery time they could drive this separately, instead of using time to load the other orders first.

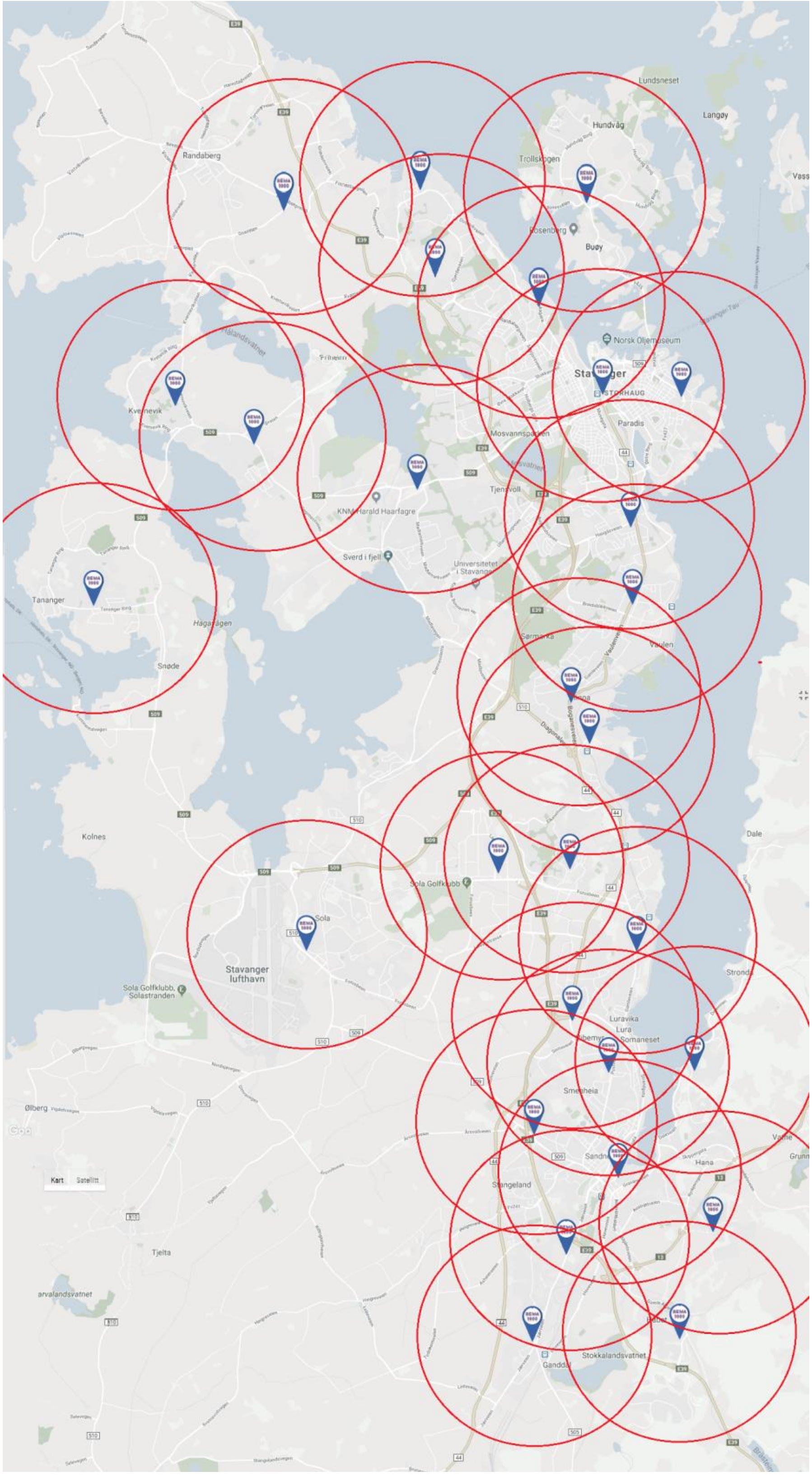

Figure 4. 14 – Example of a store-based model where all the 28 stores to Rema 1000 in the region offer delivery (Rema 1000, 2018)

Figure 4. 15 – Example of a store-based model where just 16 of the 28 stores to Rema 1000 in the region offer delivery (Rema 1000,2018)

4.5.1 Store-based delivery

An advantage of picking products from existing stores is that the operations happens closer to potential customers. A company often have several stores in the same city that they can perform the picking operations in, which makes the driving distance shorter and they are therefore able to serve many customers. Figure 4.14 shows a map that confirms this. The blue spots are stores that belong to Rema 1000, a Norwegian grocery company, and the red circles shows about a two km distance from the different stores. It is important to mention that the 2 km radius is in a straight line from the store, so the driving distance would be a bit longer. As we can see from this map, almost the entire region is cover of red circles. Some places are covered by more than one circle, which means that they do not need to perform picking in every store to cover the same area. Figure 4.15 shows a map with the same radius, but here only 16 of the 28 stores are used to deliver online customers. Almost the same part is covered in this map as in the previous map, and in this map, also some places are covered by more than one circle. The decision on how many stores they should use to the operations should also be based on the number of orders and the costs. For instance, it may be cheaper to only deliver from five stores and increase the delivery distance limit.

The activity that are added in a store-based model compare to operating a traditional store is the picking, packing, and transportation, and all these activity costs money. Also, if every store is going to have their own car and driver available all time, it will further add additional costs. The driver need to be paid regardless if there are any orders that need to be transported or not. In addition, it is well known that it is a poor investment to buy a car because it becomes less valuable in time, and there is need for insurance, maintenance, fees, and so on. An advantage for companies in big regions is that the stores can cooperate with each other. They could have one or more driver that perform the delivery for many stores. For this to work it is essential to carefully choose the delivery time they promise to the customers. If they only offer to deliver products within the next day, they can plan and organize the deliveries in a way that one driver is able to do it. The advantage of using one driver also makes opportunities within the picking. If one of the stores have difficulties of picking every order and another store close by have few orders to prepare, they can corporate and help each other. This implies especially for customers that lives in the middle of the delivery radius of two stores.

Home delivery

There are two different types of home delivery; attended and unattended (ref. Theory Section 2.8). The unattended model would have a longer delivery window than an attended model because they can deliver the orders before agreed time since the customer do not need to be home. The size of the delivery window will depend on how long the product can stay in the delivery boxes. Longer delivery windows would make more flexibility in the driving schedule, and therefore, this model would most likely have fewer costs associated with labor as well as owning and using a car. On the other side, the unattended model has costs associated with the delivery boxes as well. If the company offer cold and frozen products they need to have boxes that can regulate the temperature, and if the order consists of, for example, both frozen and vegetables the box need two separated rooms with different temperatures. Further, the boxes need to be big enough to fit all the products on the customer order, and they need to have a form of security so other people are not able to steal the products. All these requirements would make the costs of these boxes huge.

Figure 4. 16 – Pizzabareren's 16 location in the region (Google Maps, 2018)

The most common type of home delivery in Norway is the attended model. This model only has costs associated with labor and use of car. The attended home delivery model of groceries can be compare against pizza companies. For instance, Pizzabakeren delivers pizza in cities from several small locations, and they offer to deliver the pizza to your home for a fixed amount of money. Figure 4.16 shows that there are about 16 “restaurants” in the region of Stavanger and that they have about 2-3 km distance apart from each other. Thus, Pizzabakeren’s strategy is close to the example presented in Figure 4.15 where the company only use 16 of the stores to perform operations in. The interesting of this comparison is that Pizzabakeren can make profit on their business. Therefore, there should be the same opportunity for the e-grocery companies as well.

The operations that is required to process an order and make a pizza takes about the same time. If there were 30 products in an order it would take about 4 minutes to do the operation to process the order (ref. Table 4.5), in addition there may be some waiting time. This time would depend on the time they have available. If it were an order with short-time delivery, they would most likely calculate less waiting time between the operations. If the waiting time were maximum 5 minutes (approximately time to pick one order) in short-time orders, the total time would be about 9 minutes. In comparison, it takes about 10 to15 minutes to make a pizza. There is no limitation of how many products a customer can order online at an e-grocery company. In some cases, customers may order more products, but the probability that a customer order product that takes more than 15 minutes in total are relatively small since the time to do picking operations each product decrease as the order size becomes bigger.

Further, the companies have some other similarities as well. If the e-grocery company offer chilled and frozen products they would have temperature requirements. The same have Pizzabakeren, but in contrast, they need to make sure that the products stay warm. Moreover, they both have capacity limitations. A pizza company can only deliver as many pizzas in the same time as the oven are able to hold and the workforce could handle, and an e-grocery company have restrictions when it comes to the workforce and storage. The main difference in the operations between these two companies it that is that customers have limited opportunities to choose delivery time when ordering pizza. As mention, the promised delivery time is an essential factor of optimal operation. On the other side, few customers are willing to wait more than 90 minutes to receive the pizza. Thus, the promised delivery time should not make more problem than delivery of pizzas if the e-grocery company have enough available capacity.

If the attended and unattended model is compared against each other it is most likely that the attended model would make most profit because of the costs associated with the delivery boxes. Still, an unattended model may work for an e-grocery company. If the company were going to deliver ten orders to the same area two km away, and these orders had five different delivery times they would drive about 20 km (the length of driving five times back and forth between the store and the area the customers live in) in total on these orders if they use an attended model. If the average speed were 40 km/h, they would use a half hour in only driving time (ref. Table 4.7). If they were able to deliver all these orders at the same time, as they would if they uses an unattended model, they would only need to drive one time back and forth. That would give a total driving distance of about only nine km if the customer lives 0.5 km away from each other. Thus, they would only use 14 minutes (ref. Table 4.7). This would make a difference of 40 NOK in salary if the average worker was paid 150 NOK in an hour, which is 4 NOK each order. In addition, they may save more if one of the five delivery times were in the evening when there are lot queues since than the driving time would have been even longer.

The costs of buying delivery boxes that is needed to use an unattended model will be a one-time investment for the company. If the companies could get these boxes for 1000 NOK each, and use them in ten years, it would cost them 100 NOK every year of having one box. If the customers in the example above had these boxes installed in their yard, they would need to order 25 times (cost divided by savings) every year to cover these costs. This would of course require that all these customers order at the same time. The point is that the unattended model may be optimal if the company have many regular customers. Thus, the decision should be based on how great market share they have, and how often their customers' orders products from them. It is also important to mention that this example does not consider other transportation costs.

Pick-up location

The delivery time becomes shorter and easier for the company if all the customers get the products delivered to the same place. There are two possible pick-up location; in-store or out-of-store. An in-store pick-up location would have been the best "delivery" option for the company in case of delivery costs because then they do not need drivers, cars, or time to transport the products. The challenge then is that when the customers must drive to the store and pick up the order themselves, it may not be as lucrative for them to use the e-grocery option any more. To make it easier for the customer it could be an option to have a drive-through station. Then the customers do not need to go outside the car, which may be difficult with small children. Further, they avoid the potential problem of finding a free parking lot, which especially is a problem during dinnertime when almost everyone's workday is over.

Figure 4.14 and 4.15 showed a map with a two km radius from the different stores. As mentioned, it covered almost the entire region. If the stores work as pick-up locations, they would reach out to even more customers because people would most likely drive pass at least one of the stores when they are driving home from work. Therefore, the living location to a lower degree may affect who the potential customers are in case of in-store delivery.

An out-of-store pick-up location would have required that the company had a driver and a car, but it will anyway be easier than home delivery because they do not need to spend time on finding customers' addresses, finding the correct order when arriving at each customer, and use time on the actual delivering to the customer or delivery boxes. Further, it may be an advantage to use this model compared to an in-store option if it is difficult to drive to the store because of small roads, speed bumps, or a lot of traffic since they can choose placement for the pick-up location. For instance, they can have the location at a gas station that is easy to drive to. This would of course need to be approved by the owner of the gas station.

Pick-up locations are one of the delivery methods that kolonial.no use. They use a type of unattended pick-up location where the customer receives a code to enter the hanger where the orders are placed. In addition, they use "dry ice" to make sure that the products have the right temperature (Kononial.no, 2018). This cooling system only makes the products cold for some hours, therefore kolonial.no need to place the orders in these hangers at a time close to the agreed delivery window. Thus, this delivery option may require that the company drive to the pick-up location several times a day. In addition, these locations would have a capacity restriction in relation to space. Thus, if the company for example have six different pick-up times, they could end up driving back and forth six times. The variable costs would depend on the time it takes to drive these trips and the distance from the picking location. For instance, if it takes 10 minutes on average each time to drive back and forth it would sum to a total of 60 minutes each day. This would cost 150 NOK if this were the hourly payment to the employees.

The question whether the option of choosing an out-of-store pick-up location is better than an in-store option depends on the numbers of pick-up locations as well as the cost of operating these locations. For instance, costs associated with the buildings. Fewer locations would costs less, but then they would reach out to less customers compared to an in-store delivery model, which would negatively affect the income.

4.5.2 Warehouse-based delivery

Like for the picking operations, also for the delivery process it will be a difference if the company use existing warehouses or build a new one. The location of an existing warehouse is fixed. Thus, if the location is not optimal in case of deliveries it cannot be changed. Figure 4.17 show the exact same map as Figure 4.14 and 4.15, where the only difference is that this map shows a warehouse-based model with only one warehouse. The green sport marked with "W" represents a warehouse. This spot has a central location in the map and is one of the most optimal locations if the company were to serve the entire region from only one warehouse. If the warehouse has a location either in the upper or lower part of the map, the driving distance would have been long if they were going to deliver products to customer in the opposite direction. It is approximately 20 km in a straight line from the upper to the lower part of the map, and according to Google Maps, it will take about 80 minutes to drive from one end to the other. The red circle surrounds the area within two km radius from the warehouse. If they use the same delivery distance limit at 2 km as in the store-based model, they are not able to serve as many customers as is they perform the operation needed to process the orders in a store. A company that use a warehouse-based model need to have a longer distance limit compared to a store-based model to be able to get enough customers to cover the costs. The blue circle shows the area within a radius of 4 km. Even if the limit doubled from 2 to 4 km it is probably not enough to cover the costs.

There are also possibilities to use more than one warehouse. The problem is that it is costly to build new warehouses, and they would therefore not have an opportunity to build the same numbers of warehouses as the number of stores that exist.

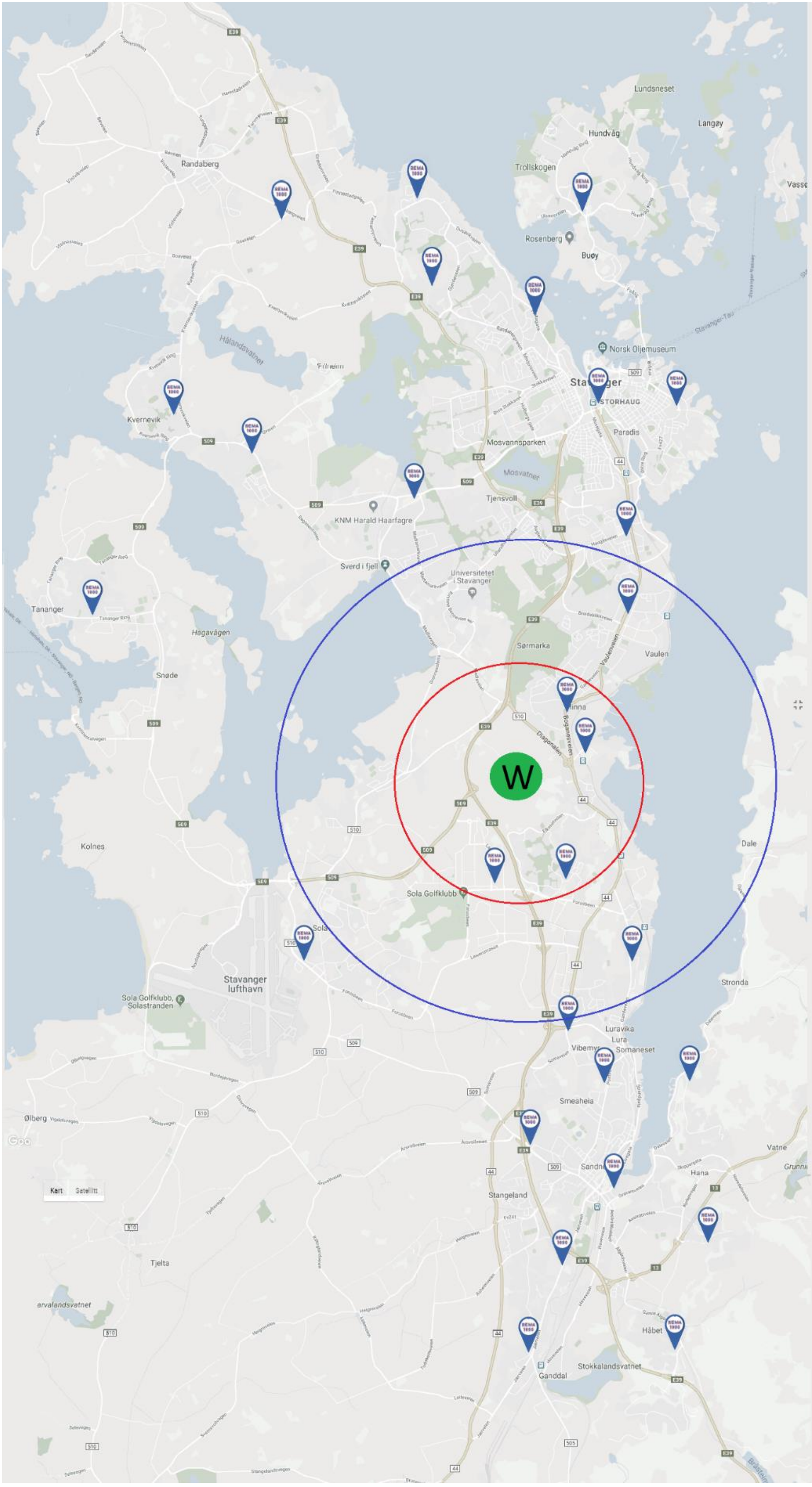

Figure 4. 17 – Example of a warehouse-based model where only one warehouse is used in the region (Rema 1000, 2018)

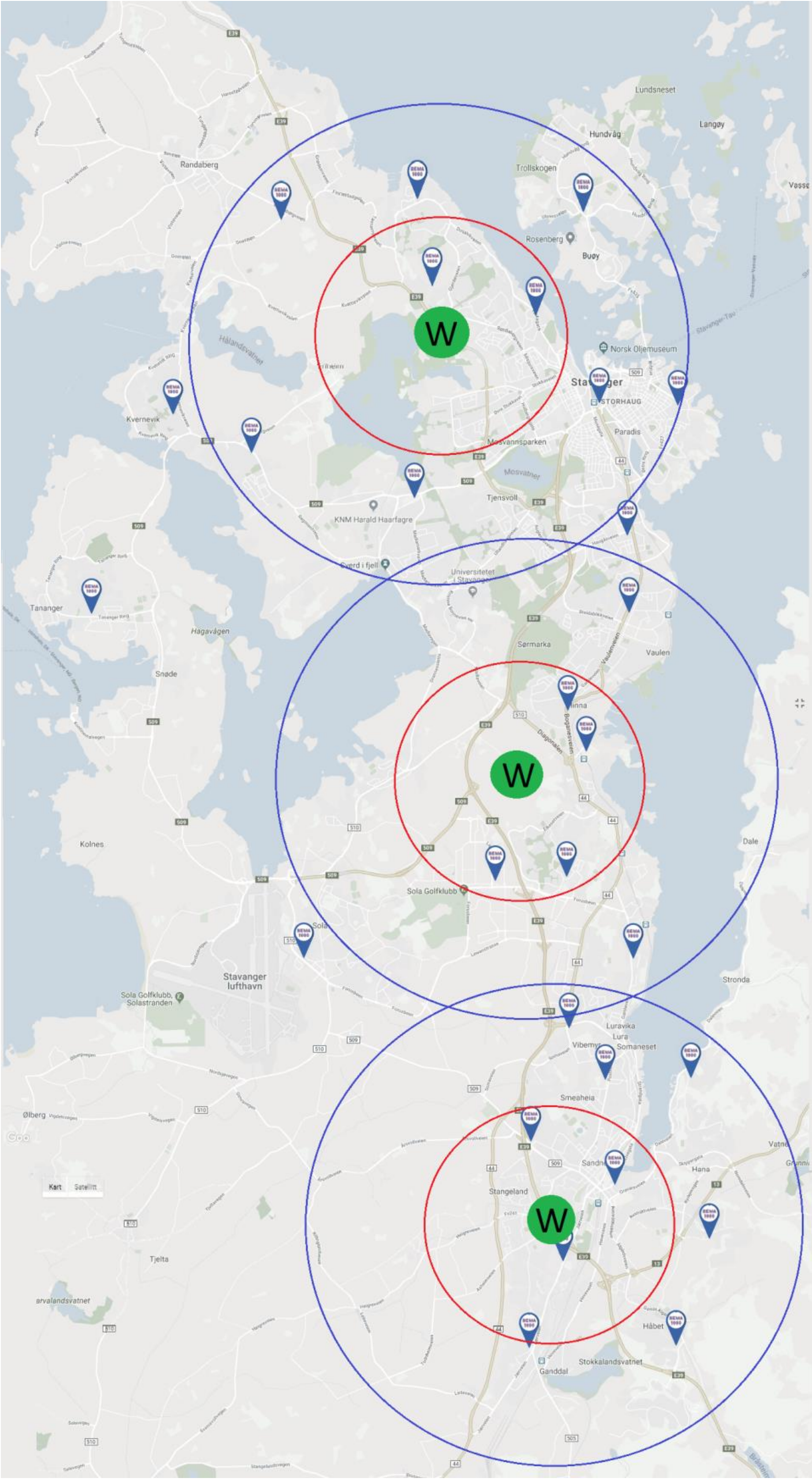

Figure 4. 18 – Example of a warehouse-based model where three warehouses are used in the region (Rema 1000, 2018)

Figure 4.18 shows an example of a model where they use three warehouses. If they have a delivery radius of 4 km, they would be able to serve close to the same number of customers as in the store-based option. A longer distance would make the delivery times longer, and thus the transportation costs would increase. In this example, the warehouses are placed to just cover the largest part of the region. In the real world, this would not have been that easy. It could be difficult to find a central space to build a warehouse, and some places may even have restrictions against industrial buildings.

Some cities outside Norway have tried to serve customers from several warehouses. The problem is that the size of these cities are large compared to cities in Norway. Kolonial.no operates in Oslo, which is the biggest city in the country. They use only one warehouse to serve all the customers that are inside the delivery distance limit to the company. According to Proff.no, they are not operating profitable. They have had negative numbers after taxes the last years. Therefore, this option would most likely be difficult to operate in an optimal way in Norway due to the building costs and market share.

Home delivery

Home delivery would be a bit different for a warehouse-based model compared to a store-based model because there will be less warehouses compare to stores, and as mentioned previously the driving distances would need to be longer to cover an equally large part of the region. The driving distance and the time to perform the deliveries is highly correlated. When the delivery time increase, the costs also increase. Thus, it would be an advantage to have flexibility in the driving schedule, meaning that they are able to coordinate the home deliveries to each other. If they, for instance, were able to deliver several orders at the same time in the same region, they would save time of driving back and forth between the warehouse and the customers. An unattended model would get them more flexibility than an attended model and would probably be a better choice regarding the driving time. The only question is whether the investment costs of the delivery boxes exceeds the money they would have saved by using an unattended model or not.

If we use the same example as in the home delivery in the store-based model, but with a distance to the customers of four km, the total length would be 40 km if they must drive back and forth five times to those ten customers. Since the distance doubles, the driving time would double as well and resulting in a total time of one hour. If they use an unattended delivery mode, they would need to drive only 13 km, which would take about 20 minutes if the customers live 0.5 km away from each other. The difference in salary costs would then be 10 NOK for each order. If the delivery boxes still cost the same and they need to receive 100 NOK in income for every box, each customer would have to order about ten times each year. Thus, a warehouse-based unattended delivery model will still need many regular customers, but the customer does not need to order as often as those in the store-based model do. Therefore, the unattended model is more optimal if the limit distance the company use is long.

Pick-up location

A warehouse could also offer delivery to both an in-warehouse or out-of-warehouse pick-up location, but this does not mean than both models are optimal. The problem with in-warehouse deliveries is that the number of warehouses are less than the number of stores, and they would cover a less area than the store-based model with the same driving distance limit. When the customer has to pick up the products themselves the driving distance become even more important than if the company offer home deliveries. If the customers have to drive an extra trip just to pick up the goods, it might also be easier for them to do the shopping in the traditional stores. The advantage of online shopping being easy and saving time will not be as advantageous any more when customers have to pick up the goods themselves. Further, if the company use an existing warehouse they would not be able to choose the location freely. Often the placement of warehouses is in industry areas, which means that there most likely will be less customers living within a 2 km radius compared to the same area around a typical store. If the company decide to build a new warehouse and use this pick-up model, they should consider this potential problem when deciding the location of the warehouse. Although choosing the locations of the warehouse would still not solve the problem of longer distances. As mentioned previously, the advantage with using pick-up locations is that they would attract more customers than those who live within a radius of about 2 km. Everyone that drives through the area around the pick-up location would be potential customers. There are many people working in an industry area, which means that there are many potential customers. Still, this model would fit a store-based model better since they cover a larger area of potential customers both when it comes to those who live close to the location and those who drive past it.

With an out-of-warehouse model, the company have the opportunity to decide the location of the pick-up station, in addition to how many stations they want. Thus, they have the same opportunity to reach out to an equal number of customers as an out-of-store model. This would also solve the problem that arises with an in-warehouse model, and it may be a more favorable option between these two. It may cost more, but they would reach out to more customers, and they need customers to be profitable.

4.6 Cost analyze

In this section, it is time to connect all the parts together. The total time from the company receive an order to they can deliver it depends on the different methods and models that are used. We have seen that the time to process an order is different for a store-based and a warehouse-based model, and the time to do deliveries varies with unattended and attended home delivery and in-store/warehouse or out-of-store/warehouse pick-up locations. In basic, the total time can be calculated as follow:

$$Total\ time = \text{time to}\ process\ order + deliver\ time$$

In addition to the total time, there exist many other factors that affects which model to use. The purpose of this section is to give some information about the costs associated with the different models. Thus, factors like waiting time will not be included because it does not give any direct costs.

The cost analyses will be based on that the company have either 500, 1000, 1500, or 2000 orders each day. From analyze and discussion Section 4.1 we could see that an e-grocery company most likely will have between 500 and 1000 orders each day in the region, but since this study is about becoming profitable in the long-run it is important to include higher number of orders in case of an increase in market share to see if this affects the company’s profit.

4.6.1 Store-based model

In order to do some estimations of the costs in the store-based model some assumptions have to be made. For the store-based model, the following assumptions were made:

- The average number of product per order is 20.

  Earlier we have looked at different sizes of the customer orders. If the company used fixed price on the deliveries the marginal costs would be lower for the customer if they order many products at the same time. On the other side, each product have different shelf life, so they should not order too many neither.
- The company have 10 stores.

  This number is a little lower than in the example from earlier analysis, but as we have seen previously, Meny use only three stores. Thus, it may be more realistic to make profit with less stores.
- The average distance to a customer is 2 km.

  As mentioned previously, a store-based model covered almost the entire region with a 2 km distance limit for each store.
- Every customer live 0.5 km apart from each other.
- The average driving speed is 30 km/h.
- It takes 15 seconds to load each order into the car.
- The workers have a payment of 150 NOK per hour.
- There will be either four or six delivery windows each day.
- They have 20 pick-up locations.

Processing order

It takes approximately 195 seconds to pick and pack 20 products (ref. Table 4.5). In addition, the workers will use some time from they finish one order and are able to start with a new one (walk from one place to another). This time is assumed to be 15 seconds, so the total time that is used to work on each order is about 3,5 minutes. The formula needed to calculate the total time of processing all the orders would then be:

$$Total\ time\ to\ process\ orders = N * 3{,}5\ minutes$$

Where,

- N = *number of orders*

The result from the calculations are presented in Table 4.8. It can be observed that the time increase when the number of orders increase, and increase is linear. For example, are the time it takes to pick 2000 orders (7000 minutes) twice as high as the time it takes to pick 1000 orders (3500 minutes).

Table 4. 8 – Total time to process different numbers of orders in a store-based model.

Number of orders	Total time (minutes)
500	1750
1000	3500
1500	5250
2000	7000

Attended home delivery

An attended model would most likely require several trips forth and back between customers and the stores because of different time windows and customer preferences. If we use the assumption that it is at average two km to drive to the customers from the stores and that the company offers six different delivery windows, each store would have to drive six times back and forth with a total distance of four km each trip. Further, we need to include the time it takes to drive between the customers. Thus, the total driving distance can be calculated by using this formula:

$$Total\ driving\ distance = 4\ km * (W * S) + \big(N - (W * S)\big) * 0.5\ km$$

Where,

- W = *number of delivery windows*
- S = *number of stores*
- N = *number of orders*

If the drivers were able to drive at an average speed of 30 km/h, they would use 2 minutes each km. Further, they will also use time to load and unload the truck. In this model, it is required that the driver deliver the product in person to the customer and it is assumed that it takes two minutes. In addition, it takes 15 second to load the car. This would sum to a total of 2.25 minutes, and the total delivery time would then be:

$$Total\ delivery\ time = 2\ minutes * Total\ driving\ distance + N * 2.25\ minutes$$

Where,

- *N = numbers of orders*

From these calculations, we can estimate the labor costs. In addition to this cost, there are also costs associated with owning and using a car. It is assumed that the total costs of owning one car each year are fixed at 100 000 NOK, including fees, fuel, maintenance, insurance, and so on. If they offer deliveries six times each week it will cost approximately 320 NOK each day. A car has capacity restrictions regarding the time to perform the deliveries. Thus, they would need several cars to be able to deliver all the orders in the agreed time. If each car can be used for 12 hours each day (included driving, loading, and unloading), the number of needed cars can be calculated by using the following formula:

$$Number\ of\ cars = \frac{\left(\frac{total\ delivery\ time}{60}\right)}{12\ hours}$$

Since it is not possible to buy half a car each number are rounded upwards. This formula does not include any capacity restriction in form of available space for transporting orders. The numbers need to be adjusted if:

$$\frac{\frac{N}{W}}{number\ of\ cars} > Space\ restriction$$

Where,

- *N = number of orders*
- *W = number of delivery windows*

Further, for simplicity it is assumed that the number of cars does not affect the total driving distance. In the real world, this distance would have been longer because several cars need to drive the distance at four km between the stores and the first customer or last customer. Table

4.9 present the total driving distances, delivery times which includes the time to drive, load, and unload the cars, in addition to the number of cars that are needed. This table shows that the total delivery time increase with 1625 minutes, or 4,5 hours, when the order number increase with 500. Since the total delivery time increase the number of needed cars also increases. The required number of cars increase by three from 500 to 1000, while for all the other increases of numbers of orders the number of cars increase by two.

It is assumed that the space restriction is 65 orders for both the store-based and warehouse-based model. Thus, the number of cars does not need to be adjusted for capacity restriction because they only need to deliver around 30 product each delivery window.

Table 4. 9 – Total distance, time and number of cars needed to deliver orders in an attended store-based model

Number of orders	Total driving distance (km)	Total delivery time (minutes)	Number of cars
500	460	2045	3
1000	710	3670	6
1500	960	5295	8
2000	1210	6920	10

Table 4. 10 – Costs of processing and deliver orders in an attended store-based model.

Number of orders	Total time (hours)	Labor costs (NOK)	Car costs (NOK)	Total costs (NOK)
500	63.25	9 487.50	960.00	10 447,50
1000	119.50	17 925.00	1 920.00	19 845.00
1500	175.75	26 362.50	2 560.00	28 922,50
2000	232.00	34 800.00	3 200.00	38 000.00

Now, we have all the information that is needed to calculate the costs of processing and delivering the orders. The results are present in Table 4.10, where the total cost consists of cost related to car and labor. The costs of the cars are calculated by multiplying the number of cars with the costs for each day, which is 320 NOK. From this table we can see that when the number of orders increase by 500 the total costs increase with about 9 000 NOK. The costs increase more between 500 and 1000 orders compare to the other intervals because of the unequal change in the number of required cars.

Further, the cost for each order becomes smaller when the number of orders increases. Therefore, it will be an advantage for the company to have, for instance, 2000 orders compared to 1500. This is because the number of delivery windows is the same regardless of the number of orders, and thus the only extra cost is related to the drive between the customers (distance of 0.5 km), the time to load and unload the car, and a possible change in the number of cars. It is important to mention that if the number of cars were accounted for in the total delivery time, the outcome would may be different.

Unattended home delivery

In an unattended model the company would get more flexibility because the customers do not need to be home during delivery. In this model, the products will be delivered in a box that can control the temperature, which means that the products could stay there for some time before being damaged. It will therefore be assumed that they only need four of the delivery window that is used in the attended model. Thus, they would need to drive back and forth between the customers and the store only four times each day. Further, the time to unload the car would be lower compared to the attended model because the driver does not need to use time to wait at the door for the customers to answer. It is assumed that the time to unload the truck is 45 seconds, while the time to load the truck will still be the same, i.e. 15 seconds. Thus, the total time would be one minute for each order. The formula needed to calculate the total driving distance is the same as in the attended model, the only difference is the size of W (the number of delivery windows). The new formula to calculate the total delivery time would be:

$$Total\ delivery\ time = 2\ minutes * Total\ driving\ distance + N * 1\ minutes$$

Where,

- *N = number of orders*

The result of the driving distance, delivery time, and the needed number of cars is presented in Table 4.11. As mentioned previously, the difference between the attended delivery and unattended delivery is that there are less delivery windows in the last model. Thus, this would require that there are more orders that are going to be delivered each time. In order to not surpass the space restriction of 65 orders for each delivery, there is a need to adjust some of the numbers. In some cases, it may be cheaper to offer more delivery windows to better increase the total capacity of the cars. All such opportunities need to be considered. The space capacity becomes a restriction for 1500 orders when they offer only four delivery windows and five cars. The cheapest option is to adjust the number of delivery windows up to six and the number of cars down to four. Then the restriction is meet, and it would cost 290 NOK less than just increase the number of cars and 145 NOK less than offer 5 delivery windows and increase the number of cars with one. The restrictions are complied with 2000 orders either. In this case, it is also cheapest to increase the delivery windows from four to six windows and to use six cars. It they had only used four delivery windows it would have required eight cars, and it would have cost 290 NOK more.

Table 4. 11 – Total distance, time and number of cars needed to deliver orders in an unattended store-based model

Number of orders	Total driving distance (km)	Total delivery time (minutes)	Number of cars
500	390	1280	2
1000	640	2280	4
1500	960	3420	5 → 4
2000	1210	4420	6

In contrast from the other models, the unattended model would have costs associated with the delivery boxes. It is assumed that each box costs 100 NOK and that the average customer orders 10 times in a year. This makes an extra cost of 10 NOK each order. Thus, 500 orders will cost 5 000 NOK, 1000 orders will cost 10 000 NOK, and so on.

The costs of processing and delivering orders are presented in Table 4.12, and the total costs consist of costs associated to labor, car, and delivery boxes. The total costs increase by about 12 500 NOK when the number of order increase by 500. Since the number of cars needed to be adjusted for, the costs of the cars also increased. The costs associated with both labor and owning a car is smaller in this model compare to the attended model, but because of the extra costs of the delivery boxes, this model is overall more expensive.

Table 4. 12 – Cost of processing and delivering orders with an unattended store-based model.

Number of orders	Total time (hours)	Labor costs (NOK)	Car costs (NOK)	Delivery box costs (NOK)	Total costs (NOK)
500	50.50	7575.00	640.00	5 000.00	13 215.00
1000	96.33	14 449.50	1 280.00	10 000.00	25 729.50
1500	144.50	21 675.00	1 280.00	15 000.00	37 955.00
2000	190.33	28 549.50	1 920.00	20 000.00	50 469.50

In-store pick-up locations

As mentioned previously, there is no need for transportation in an in-store picking model and no need for drivers and cars. Thus, the total costs will only consist of the labor that used to processing the orders. Therefore, the labor costs and the total costs will be the same. Figure 4.13 present this total cost for different numbers of orders. When the number of orders increase with 500 the size of the total costs increases with approximately 4 376 NOK, and this is less than half of the total costs that is in the attended and unattended model.

Table 4. 13 – Costs of processing and delivering orders with an in-store model.

Number of orders	Total time (hours)	Labor costs (NOK)	Total costs (NOK)
500	29.17	4 375.50	4 375.50
1000	58.33	8 749.50	8 749.50
1500	87.50	13 125.00	13 125.00
2000	116.67	17 500.50	17 500.50

Out-of-store pick-up locations

The difference between the unattended model and the out-of-store based model is that the first model deliver orders to many different “unknown” places. In this case, the out-of-store model have 20 fixed locations. This means that each store has responsibility for two locations each. This analysis will be made based on that all the stores share all the drivers and cars, and that they must deliver products to these locations four times each day as in the unattended model. Further, it is assumed that the average distance to deliver orders to two locations is five km, which include time to drive from the store to both of the locations, and further to the next store. The formula to do the calculation is as follows:

$$Total\ driving\ distance = 5\ km * 10 * W$$

Where,

- *W = number of delivery windows*

In addition, time to load and unload the truck also need to be included. The same time as in the unattended model, i.e. one minute for each order, for loading and unloading will be used because the products are not delivered directly to the customers. The formula of delivery time would then be the same.

Table 4. 14 – Total distance, time and number of cars needed to deliver orders in an out-of-store model.

Number of orders	Total driving distance (km)	Total delivery time (minutes)	Number of cars
500	200	900	2
1000	200	1400	2 → 4
1500	300	2100	3 → 4
2000	300	2600	4 → 6

Table 4.14 present the total distance, delivery time, and number of needed cars. With the same space restriction at 65 orders for each trip, there is a need to increase the number of cars at the different numbers of orders. With 1000 orders, they could increase the number of delivery windows to six and just have one car extra, but the labor costs of doing this makes this alternative 180 NOK more expensive. Thus, it would be better to instead increase the number of cars from two to four. The delivery of 1500 orders would have been cheapest if they increase the number of delivery windows to six and just add one more car. This would cost 820 NOK compare to 960 NOK of adding three cars to comply the space restrictions. Likewise, with 2000 orders the best option is to increase the number of delivery windows to two, but in this case add two cars. In this model, the total driving distance change only when the number of delivery windows does. Therefore, the numbers are the same for 500 and 1000 orders and for 1500 and 2000 orders.

The special thing about an out-of-store model is that this model have extra costs relative to the store-based model because they need to build or rent the building that the products are going to be stored in between the orders are transported and customers are picking them up. It will be assumed that each location costs 20 000 NOK each year. This cost includes costs of the refrigerators and associated electricity costs. With six days of deliveries each week this would sum to a total of 1 278 NOK each day for all the 20 locations.

The costs of processing and delivering an order in the out-of-store model are presented in Table 4.15. In this model, the total cost consists of costs associated with labor, cars, and pick-up locations. The increase in total costs from 1000 to 1500 orders is about 100 NOK less than the increase between the other order numbers. The main reason for this is that the number of needed cars are the same in these two options and that the change in labor costs are the smallest in this case.

Table 4. 15 – Costs of processing and delivering orders in an out-of-store model.

Number of orders	Total time (hours)	Labor costs (NOK)	Car costs (NOK)	Pick-up location costs (NOK)	Total costs (NOK)
500	44.17	6 625.50	640.00	1 278.00	8 543.50
1000	81.67	12 250.50	1 280.00	1 278.00	14 808.50
1500	122.50	18 375.00	1 280.00	1 278.00	20 933.00
2000	160.00	24 000.00	1 920.00	1 278.00	27 198.00

4.6.2 Total time – warehouse-based model

The difference between the costs of the store-based and warehouse-based model is the costs associated with building, renting, or buying a warehouse. It is difficult to know the exact costs of this, so it will be assumed that each warehouse makes an extra cost of five million NOK each year including power, maintenance, and every extra cost it gives in relation to the store-based model. The daily cost would then be approximately 16 000 NOK if they deliver orders six times each week.

Similar as to the store-based model, there is also a need for making some assumption in the warehouse-based model. Some of them are the same as the store-based model to be able to compare these models against each other, and some are difference because it is two different ways to do things. The assumptions are as follows:

- The average number of product per order is 20.
- The company have only one warehouse.
  The costs of operation a warehouse is high, thus it would not be realistic to use more than one in a small region as Stavanger.
- The average distance to a customer is 8 km.
  The distance in the warehouse-based model is increased to eight km from earlier analysis. If they are only going to use one warehouse they need a longer limited distance to cover the same region as a store-based model.
- Every customer live at the distance limit and half km apart from each other.
- The average driving speed is 30 km/h.
- It takes 15 seconds to load each order into the car.
- The workers have a payment of 150 NOK per hour.
- There will be either four or six delivery window each day.
- They have 20 pick-up locations.

Processing order

The time to processing an order in a warehouse-based model is about 132 second, and the same time at 15 seconds between the orders as in the store-based model will be used. Thus, the total time for each order will be 147 seconds, or approximately 2.5 minutes. For simplicity, this number will be used in the following. The total time to processing the orders will be calculated by the following formula:

$$Time\ to\ process = N * 2.5$$

Where,

- *N = number of orders*

The total processing time for the numbers of orders between 500 and 2000 are presented in Table 4.16. Like the store-based model, the difference between the number of orders doubles when the number of orders doubles due to a linear relationship.

Table 4. 16 – Total time to process different number of orders in a warehouse-based model.

Number of orders	Total time (minutes)
500	1250
1000	2500
1500	3750
2000	5000

Attended home delivery

The only difference between the attended home delivery in the store-based and warehouse-based model is that the average driving distance is longer. It increases from two to eight km. The number of delivery windows is still the same, and the company need to drive six times back and forth between the customers and the warehouse, which is a total of 16 km each trip. The driving distance is then calculated as follows:

$$Total\ driving\ distance = 16\ km * W + (N - W) * 0.5\ km$$

Where,

- *W = number of delivery windows*
- *N = number of orders*

The time to load and unload the truck will still be the same each order (2.25 minutes). Therefore, the same formula as in the attended store-based option will be used to calculate the total time to process and deliver the orders.

Figure 4.17 present the total driving distance in km and total delivery time in minutes. The cars needed to deliver 1000 orders are the only part that stick out compare to the store-based model. The number is one less in this model because of differences in the formula of distance calculation. Like the attended store-based model there is no need to adjust the number of cars in this model neither if they use the same space restriction.

Table 4. 17 – Total distance, time and number of cars needed to deliver orders in an attended warehouse-based model.

Number of orders	Total driving distance (km)	Total delivery time (minutes)	Number of cars
500	343	1811	3
1000	593	3436	5
1500	843	5061	8
2000	1093	6686	10

Figure 4.18 present the costs of processing and deliver the orders with the attended warehouse-based model. The difference from the store-based model is that the total costs in this model consists of labor, car, and building costs. When the number of orders increase with 500 the costs increase by about 8000 NOK. There are some differences between the different numbers, where the largest difference is between 1000 and 1500 orders. The time to process and deliver the orders increase with the same time when the number of orders increase by 500. The reason for this is that the change in the number of required cars increase more with these number of orders compare to the other.

Table 4. 18 – Costs of processing and deliver orders in an attended warehouse-based model.

Number of orders	Total time (hours)	Labor costs (NOK)	Car costs (NOK)	Build costs (NOK)	Total costs (NOK)
500	51.02	7 653.00	960.00	16 000.00	24 613.00
1000	98.93	14 839.50	1 600.00	16 000.00	32 439.50
1500	146.85	22 027.50	2 560.00	16 000.00	40 587.50
2000	194.77	29 215.50	3 200.00	16 000.00	48 415.50

Unattended home delivery

The same assumption is made for the unattended warehouse-based model as in the same model for the store-based option. They need to deliver orders at least four times each day, and the loading and unloading takes one minute in total.

Table 4. 19 – Total distance, time and number of cars needed to deliver orders in an unattended warehouse-based model.

Number of orders	Total driving distance (km)	Total delivery time (minutes)	Number of cars
500	312	1124	2
1000	593	2186	3
1500	834	3168	4
2000	1093	4186	6

The total driving distance, delivery time, and number of needed cars are presented in Table 4.19. Like the unattended store-based model, this model also need to adjust some numbers to meet the space restrictions. This implies for every number of orders except from 500. The cheapest option for all the other order numbers is to increase the delivery windows to six windows and use three, four, and six cars.

Table 4.20 presents the costs of processing and delivering orders. The costs associated with the delivery boxes are assumed to be the same in the store-based and warehouse-based model, and the total costs consist of both labor, car, delivery box, and build costs in this model. In contrast form the attended warehouse-based model, are the difference in total costs between 1000 and 1500 orders the smallest among the intervals of number of orders. Some of this difference is seen partly because the time they use to process and deliver orders are smaller and partly because the unequal number of required cars.

Table 4. 20 – Costs of processing and deliver orders in an unattended ware-house based model

Number of orders	Total time (hours)	Labor costs (NOK)	Car costs (NOK)	Delivery box costs (NOK)	Build costs (NOK)	Total costs (NOK)
500	39.05	5 857.50	640.00	5 000.00	16 000.00	27 497.50
1000	78.10	11 715.00	960.00	10 000.00	16 000.00	38 675.00
1500	115.30	17 295.00	1 280.00	15 000.00	16 000.00	49 575.00
2000	153.10	22 965.00	1 920.00	20 000.00	16 000.00	60 885.00

In-warehouse pick-up locations

Like an in-store model, an in-warehouse model does not need either labor or cars to perform the transportations. The total time, labor costs, and total costs to process and deliver orders with this model are presented in Table 4.21. The labor costs and total cost are the same, just like in the in-store model. The increase in time is 3 126 NOK when the number of orders increase with 500. This is less than for the in-store model because it is more efficient to perform the picking in a warehouse. This model would also be the least labor-consuming model of all the store-based and warehouse-based models. The problem is that the building costs makes the total cost high, and then the in-store model would be the model with overall lowest costs.

Table 4. 21 – Costs of processing and deliver orders with an in-warehouse model

Number of orders	Total time (hours)	Labor costs (NOK)	Build costs (NOK)	Total costs (NOK)
500	20.83	3 124.50	16 000.00	19 124.50
1000	41.67	6 250.50	16 000.00	22 250.50
1500	62.50	9 375.00	16 000.00	25 375.00
2000	83.33	12 499.50	16 000.00	28 499.50

Out-of-warehouse pick-up locations

The difference between the out-of-warehouse and the out-of-store model is that a warehouse-based model only performs operations in one place. Thus, in theory, they can deliver orders to all the pick-up locations at the same time without driving back and forth. If the pick-up locations were two km away from each other, they would have to drive about 40 km in total to deliver products to every location. The only problem would be the space restrictions. As we have seen, there was a need to adjust the numbers in the out-of-store model. In the out-of-warehouse model they may have 2000 orders each day that are going to be delivered at three different times, and in such a case they would need to fit about 650 orders in the car at the same time. If they have a limit of 65 orders each trip, they would need to drive several times back and forth. The number of driving trips will vary with the number of orders. For simplicity, there will be no fixed number of delivery windows in this case. In addition, it is assumed that the average driving length of each trip, i.e. to drive back and forth between the locations and the warehouse, is six km, and that each pick-up location is still 2 km away from each other. The calculations will be as follows:

$$Total\ driving\ distance = \left(\frac{N}{65}\right) * 6\ km + \left(N - \left(\frac{N}{65}\right)\right) * 2\ km$$

Where,

- *N = number of orders*

The same formula as in the out-of-store model is used, where it takes two minutes to drive each km in addition to one minute each order to load and unload the car. Also, the same formula to calculate the required number of cars. Table 4.22 present the results of total driving distance, delivery time and number of needed cars is used. This model requires the most cars out of all models for every number of orders because the car is included as a factor in the total driving distance. Thus, the difference would have been smaller if the same was done during the calculations for the other models as well.

Table 4. 22 – Total distance, time and number of cars needed to deliver orders in an out-of-warehouse model

Number of orders	**Total driving distance (km)**	**Total delivery time (minutes)**	**Number of cars**
500	1030.77	2561.54	4
1000	2061.54	5123.08	8
1500	3092.31	7684.62	11
2000	4123.08	10246.16	15

Table 4. 23 – Costs of processing and delivering orders in an out-of-warehouse model

Number of orders	**Total time (hours)**	**Labor costs (NOK)**	**Car costs (NOK)**	**Build costs (NOK)**	**Pick-up locations costs (NOK)**	**Total costs (NOK)**
500	63.52	9 528.00	1 280.00	16 000.00	1 278.00	28 086.00
1000	127.05	19 057.50	2 560.00	16 000.00	1 278.00	38 895.50
1500	190.58	28 587.00	3 520.00	16 000.00	1 278.00	49 385.00
2000	254.10	38 115.00	4 800.00	16 000.00	1 278.00	60 193.00

It is assumed that the costs of having pick-up locations in this model is the same as in the out-of-store model. Thus, the total costs will include a daily cost of 1 278 NOK. Table 4.23 presents the costs associated with using an out-of-warehouse model in addition to the total cost. Like the unattended warehouse-based model the increase in total cost are smallest between 1000 and 1500 orders. The increase in the labor, building, and pick-up location costs are the same for all increases in the number of orders. Thus, for this model also, it is the car costs that makes the difference.

4.7 Profit analyses

In order for a company to be profitable, its income have to exceed the costs (ref. Theory Section 2.1). We already have estimated the costs associated to the different models; therefore, it is now time to estimate the income and profit each model gives. The income is affected by the money they make on the deliveries in addition to the profit margin on each product. The income can be calculated as follows:

$$Total\ income = delivery\ income + income\ from\ profit\ margin$$

The profit margin would be the same in every model because it is only affected of the total price of the orders. The profit margin for each product is normally around two percent for groceries. Therefore, this is the number that will be used in this analysis. It will be assumed that each customer orders for 600 NOK in average. The income of the profit margin are calculated as follows:

$$Income\ from\ profit\ margin = 600\ NOK * 0.02 * N$$

Where,

- *N = number of orders*

Table 4.24 presents the total profit margin the company would earn on the different numbers of orders. The income increases with 6 000 NOK when the number of orders increases with 500. Further, the profit of each model is calculated by subtracting the costs from the income. It is assumed that the company offer the deliveries to the same price for the different models, regardless if the store-based or warehouse-based model is used. Thus, for both models of attended deliveries, it is only the costs that make difference between them, and the same is the case for both models of unattended deliveries.

Table 4. 24 – Total income of the profit margin at the different number of orders with

Number of orders	Income from profit margin (NOK)
500	6 000
1000	12 000
1500	18 000
2000	24 000

4.7.1 Attended delivery model

The prices on attended home deliveries vary from zero to over 100 if the customers wants the products to the next day. For simplicity, it is assumed that there is a fixed price at 80 NOK for each order. Table 4.25 presents the total income the company would make by using an attended delivery model. The total income consists of the profit margin and the income associated with the deliveries (as the formula shows).

Table 4. 25 – Total income in an attended model of orders with an average value of 600 NOK

Number of orders	Profit margin (NOK)	Delivery income (NOK)	Total income (NOK)
500	6 000	40 000	46 000
1000	12 000	80 000	92 000
1500	18 000	120 000	138 000
2000	24 000	160 000	184 000

Table 4.26 presents the profit the company will have after the costs of labor and owning and using cars in the store-based model, and Table 4.27 shows the same costs but for a warehouse-based model. In the warehouse-based model also the costs of the building is included. The profit is higher for all the numbers of orders in the store-based model, but this would not have been the case if the building costs were included. Thus, the warehouse-based model can do all the operations more efficient in case of costs, but not efficient enough for it to be preferable between these two options. Further, the difference decreases as the number of orders increases, which

means that at some point the warehouse-based model would give more profit than the store-based model.

To investigate how many orders that is the most optimal to have in each model we also need to look at the marginal profit (ref. Theory Section 2.5). In some cases, they may not earn more money by having more customer orders. The marginal income in the attended model is constant at 92 NOK each customer, and both store-based and warehouse-based have decreasing costs when the number of orders increase. Thus, the profit for each order will decrease when the total number of orders increases. In the first mentioned model, the margin profit for each order increase from about 71.10 to 73.00 NOK, while for the other model it increase from 42.80 to 67.80 NOK. This means that the attended warehouse-based model would have a larger advantage of having many orders, and that the store-based model would be the best in form of profit.

Table 4. 26 – Profit of using a store-based attended model.

Number of orders	Total income (NOK)	Total costs (NOK)	Profit (NOK)
500	46 000	10 448	35 552
1000	92 000	19 845	72 155
1500	138 000	28 923	109 077
2000	184 000	38 000	146 000

Table 4. 27 – Profit of using a warehouse-based attended model

Number of orders	Total income (NOK)	Total costs (NOK)	Profit (NOK)
500	46 000	24 613	21 387
1000	92 000	32 440	59 560
1500	138 000	40 588	97 412
2000	184 000	48 416	135 584

4.7.2 Unattended delivery model

Some customers may prefer to get the orders delivered personally as in the attended model, while others do not. Thus, it is assumed that the income in the unattended model is the same as in the attended model. Table 4.28 and 4.29 shows the profit of using an unattended store-base and warehouse-based model. The differences between the two models are almost the same as in the attended models, and the same trend of a decreasing difference for increasing numbers of orders is found in this model.

The marginal income in the unattended model is the same as in the attended model since the income are the same in these two models, and also here the marginal costs decreases. The marginal profit in the store-based model increase from 65.60 to 66.80 NOK, which is less than in the attended model. The warehouse-based model has a larger increase from 37.00 to 61.60 NOK, and it is about 8 percentage points more than for the attended model.

Table 4. 28 – Profit of using a store-based unattended model.

Number of orders	Total income (NOK)	Total costs (NOK)	Profit (NOK)
500	46 000	13 215	32 785
1000	92 000	25 730	66 270
1500	138 000	37 955	100 045
2000	184 000	50 470	133 530

Table 4. 29 – Profit of using a warehouse-based unattended model.

Number of orders	Total income (NOK)	Total costs (NOK)	Profit (NOK)
500	46 000	27 498	18 502
1000	92 000	38 675	53 325
1500	138 000	49 575	88 425
2000	184 000	60 885	123 115

4.7.3 In-store and in-warehouse delivery model

Most of the companies that offers in-store deliver do this for free to make it tempting for customer to choose this “delivery” method. Therefore, the same is assumed in this case. This means that the only money they will earn on the in-store option is the profit margin on the products, as shown in Table 4.30.

Table 4. 30 – Total income in an in-store and in-warehouse model of orders with an average value of 500 and 1000 NOK.

Number of orders	Profit margin (NOK)	Total income (NOK)
500	6 000	6 000
1000	12 000	12 000
1500	18 000	18 000
2000	24 000	24 000

Table 4. 31 – Profit of using an in-store model.

Number of orders	Total income (NOK)	Total costs (NOK)	Profit (NOK)
500	6 000	4 376	1 624
1000	12 000	8 750	3 250
1500	18 000	13 125	4 875
2000	24 000	17 501	6 499

Table 4. 32 – Profit of using an in-warehouse model.

Number of orders	Total income (NOK)	Total costs (NOK)	Profit (NOK)
500	6 000	19 125	-13 125
1000	12 000	22 251	-10 251
1500	18 000	25 375	-7 375
2000	24 000	28 500	-4 500

The profit of the in-store is presented in Table 4.31. As mentioned previously, the total costs of an in-store model is lowest. Regardless of this, this model gives the least profit out of the store-based models. This is because the income is relative small compared to the other models since they do not take any extra to perform the operations needed to processing the orders. Overall, the profit increases as the number of orders increases. The same trends are found in the profit of the in-warehouse model that are present in Table 4.32. The biggest difference is that the extra building costs of 16 000 NOK makes the profit negative for all the different numbers of orders. Because of this, the marginal profit would also be negative in the in-warehouse model. The marginal profit increases when the number of orders increases. Thus, it will eventually become profitable when the number of orders is higher than 2000. In the inside store and warehouse pick-up models the marginal income is constant at 12 NOK, and the marginal profit in the in-warehouse model change from -26.30 to -2.30. The unique thing about the in-store model is that this is the only model that have a constant marginal cost at 8.80 NOK. Thus, the marginal profit is also constant at 3.20.

4.7.4 Out-of-store and out-of-warehouse delivery model

A delivery to a pick-up location need to cost less for customers than a home delivery because the customers must pick up the products by themselves. If the price had been the same as in the attended and unattended model, most customers would have preferred these models instead because they get more out of the money. Thus, it is assumed that the price is the half and that the company would receive 40 NOK for each order. The total income is presented in Table 4.33.

Table 4. 33 – Total income in an out-of-store and out-of-warehouse model of orders with an average value of 500 NOK.

Number of orders	Profit margin (NOK)	Delivery income (NOK)	Total income (NOK)
500	6 000	20 000	26 000
1000	12 000	40 000	52 000
1500	18 000	60 000	78 000
2000	24 000	80 000	104 000

Table 4. 34 – Profit of using an out-of-store model.

Number of orders	Total income (NOK)	Total costs (NOK)	Profit (NOK)
500	26 000	8 544	17 456
1000	52 000	14 809	37 191
1500	78 000	20 933	57 067
2000	104 000	27 198	76 802

Table 4. 35 – Profit of using an out-of-warehouse model.

Number of orders	Total income (NOK)	Total costs (NOK)	Profit (NOK)
500	26 000	28 086	-2 086
1000	52 000	38 896	13 104
1500	78 000	49 385	28 615
2000	104 000	60 193	43 807

Table 4.34 and 4.35 presents the profit the company would get from out-of-store and out-of-warehouse models. Also here, the store-based model gives more profit than the warehouse-based model. The difference from the other models is that the store-based model would be the best regardless of the extra costs of 16 000 NOK in the warehouse-based model.

The marginal income is constant at 52 NOK for both models, while the marginal costs are decreasing for both. The marginal profit for the out-of-store model increased from 37.50 to 39.00 NOK when increasing the number of orders from 500 to 2000, while the same increase goes from -1.60 to 37.50 NOK in the out-of-warehouse model.

4.7.5 Comparison of results

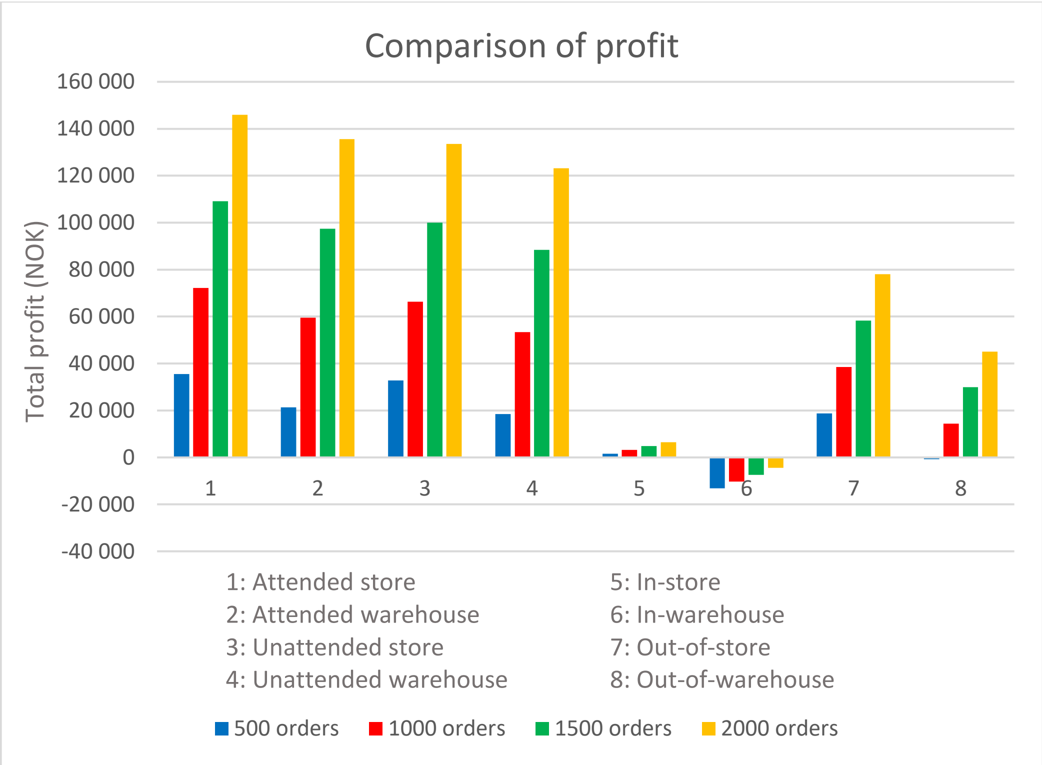

Figure 4. 19 – Comparison of the result from the profit analysis

Figure 4.19 present a comparison of the results that were found in the previous sections. From this figure, it is easy to see which models that are the best and worse regarding profit. The attended store model is the model that overall gives the highest profit of 146 000 NOK, while the model of in-warehouse pick-up location give the lowest profit of negative 13 125 NOK. Thus, the company would be better off not offering the in-warehouse based pick-up model at all unless they are able to increase their market share drastically. Further, the store-based models are better than all the warehouse-based models because of lower costs, and therefore, the entire advantage of a more efficient picking in the warehouse-based model is lost.

The smallest difference in total profit is found between the store-based and warehouse-based models in the attended delivery model. The difference is about 14 000 NOK for 500 orders and only 10 000 NOK for 2000 orders. In the pick-up model, where the customers have to pick-up products outside the store or warehouse, have the largest difference in total profit. The difference in profit varies from 19 500 NOK for 500 orders to about 33 000 NOK for 2000 orders.

The e-grocery market in Norway is relatively small, but it has great opportunities. Therefore, it is important that the companies offer an e-grocery concept that tempt customers to shop online and that the companies deliver a service customer would want to pay for. As mentioned in the introduction, the most likely reason for people to choose to shop groceries online instead of traditional stores is to save time and make it easier for themselves. The attended and unattended model is the overall easiest to use for most of the customers because the products are delivered to the customers' home address. Therefore, these models would probably be the best from a customers' point of view. On the other side, the prices of these models are higher than for the pick-up models because they require more work for the company. People have different willingness-to-pay, and some may not be willing to pay 80 NOK for home delivery. Especially if the customer has a small order since then the average price for each product would become high compared to buying the same products in a traditional shop. Therefore, some customers may rather prefer to pay a little less and instead pick up the order themselves at a pick-up location. The problem with a pick-up location is that most of the advantages e-grocery companies have over traditional store get lost because the customer would save less time on the e-grocery shopping compared to traditional shopping than if the products were delivered directly home. When this advantage of saving time reduces, the e-grocery service would be less tempting for customers. Thus, the home delivery models would most likely attract more customers than the pick-up models. Moreover, when it comes to the in-store model they may also lose money on using this model compare to just offer traditional shopping given that the customers already use the companies' traditional stores. This is because they then would earn the same amount but not being paid for the time it takes to process the orders.

From the company's point of view, the easiest model is the pick-up locations inside the store and warehouse, but this model creates the least profit of them all, even negative profit in the warehouse-based model. In addition, as already mentioned, it is probably the least tempting model for the customers. The next best option regarding the amount of work for the company is the pick-up locations outside the store and warehouse. However, because of high costs and low income, this model does not create a very good profit. If the company want to stay competitive, they need to offer an option that is tempting for the customers in the long-run. For instance, if a customer uses the service of pick-up locations for some months but discovers that he does not save much time by using this service, he might go back to traditional shopping again.

Further, we have seen that the amount of profit is greater in every store-based model compared to warehouse-based models, but that in some circumstances it may be wiser to select the warehouse-based models because the store-based picking could affect the traditional shoppers in the store (ref. Section 4.4.1). It is important that the company do not lose the traditional shoppers since these customers will give more profit to a company than the online shoppers since the e-grocery market is still small in Norway. By losing the traditional customers, the costs of offering the store-based models would have been even higher. The profit analysis was made based on that every store has 50, 100, 150, or 200 orders each day. With the fixed number of product for each order at an average of 20, between 3 to 12 hours of labor are required to process these orders, which means one or two workers in each store. With such a few additional workers in each store, the traditional shoppers will probably not be bothered. Thus, if the numbers of orders are low, like in the profit analysis, the factor of affecting traditional customer will likely not be a problem.

It is also possible to reduce costs buy increase the investment (ref. Theory Section 2.6). Therefore, it is not completely wrong to use a lot of money on building or rent expensive but efficient warehouses. The result from the analysis also showed that the warehouse-model overall is the most efficient model when it comes to processing and transport orders. There have been a lot of failure in the e-grocery market in both the world and in Norway. The problem for most of the companies is that they have not been able to get as many customers as they need, in addition to do the operations efficient enough. The e-grocery market in region of Stavanger is probably only about one percent each company (ref. Section 4.1). In addition, there have been some fluctuations in the e-grocery market in Norway. Thus, it is risky to do a lot of investment in this market.

To become profitable in the long run it requires that they can hold or increase their market share. The store-based model has more restrictions in relation to the capacity because there may not be space to build a bigger store, and it could affect the demand for traditional shoppers. Therefore, the warehouse-based model has better conditions for a huge growth. The problem of using the maximum of the capacity is that the lead time increase as well (ref. Theory Section 2.2). Thus, the time to process and deliver the orders would have become longer, and it would have become less tempting for customers to choose online shopping over traditional shopping. If the company have 28 stores, as Rema 1000, in the region they can still grow a lot before they need to change model.

4.8 Further discussion

If the lifetime value of the customer is about four times higher than the costs associated with the customer, the firm would stay profitable of having this customer (ref. Theory Section 2.5.1). The total costs that were calculated in Sections 4.6.1 and 4.6.2 did not include potential advertisement costs. The advantage of using a store-based model is that the company already have a customer base and a brand name people know since they have been in the market for some time. In addition, customers often choose the company they are familiar with. Thus, every time the potential customers drive by one of the stores to the company, it is more likely that the customer would choose them over some other e-grocery company without traditional stores. If people have not previously heard about a company, they can have difficulties trusting that it is safe to order from this company. Therefore, a warehouse-based model would require more advertisement than a store-based model. Thus, the costs of using a warehouse-based model would probably be higher than calculated.

This analysis is based on the number of potential customers that use the market today. In the future the e-grocery companies share may increase, which might change the results found in this study. In the warehouse-based model, the operations can be performed more efficiently than the store-based models. Therefore, the warehouse-based models have the potential to become more profitable than the store-based in the future. Moreover, the stores have limitations due to the capacities in the stores and that they should keep their traditional customers satisfied. In Section 4.4.1, we could see that a store-based model should not have too many workers at the same time working in the store. Thus, the store will eventually lose traditional customers if the market share in the e-grocery service increase, which makes a limitation of how much a store-based company can grow in the further. In the analysis of the cost of the models, there 10 stores were used. Rema 1000 has 28 stores in the region, which means that they can grow at least 300 percent and have about 6000 orders before they may consider using a warehouse-based model. The e-grocery market in Norway has not increased a lot since the first company started e-grocery service in this country, and it will most likely take at least a decade for larger increases to be observed. Its market share might not even increase at all.

5. Validation

For the result to be to be credible, the experiments and the assumptions need to be reliable. In this study, it has been difficult to find data about the e-grocery market from the real world to use in the calculations. Therefore, in order to get data, experiments had to be conducted and many assumptions had to be made. In this section, a critical look will be taken on the analysis and discussions part of this thesis, and the methods used will be both criticized and defended. There is always something that could have been done in a better way. However, this does not mean that the results are completely wrong.

5.1 A critical look at the estimation of picking and packing time

The performed experiments were relatively simple regarding that not all possible factors that may affect the picking and packing time were included. In addition, the time to do the picking in the warehouse-based model was only estimated based on the result of the experiments that were performed in the store-based model. The downside of this method is that the experiments were highly connected to my action. Thus, the results are based on my speed of picking and packing products and does not necessarily be a representative speed for everyone. To get a more correct time, more experiments should have been performed were several different persons conducted the picking operations. In addition, the composition of the shopping lists will affect the time. The most optimal would be to perform the experiment on a larger scale. For instance, make other random people share different shopping lists with this study to get more realistic results.

On the other side, the most important part of the study was to investigate which model that will be the most profitable in the long-run. Thus, that the estimated times from the experiments are uncertain might not affect the results of this study as the most essential part were to compare the different models with each other. In other words, the analysis of the different models were all affected by the same uncertain results of the experiments. During the analysis of the models, the question of interest was to compare the differences between the models over time and investigate which factors that affects the different model. Furthermore, the picking operations are more efficient in warehouses, which makes logical sense because of a more efficient layout in warehouses. In the comparison that was done in Section 4.7.5, we could see that there was a difference of several thousands of NOK of the profit in the store-based and warehouse-based models. The smallest difference was of about 10 000 NOK. Thus, if the time to do the picking in a warehouse-based model were some seconds faster compared to the time to do it in the store-based model, the results would not have been significantly different. For instance, if it takes 10 seconds less to do the picking of 20 products it would have made a difference of just about 200 NOK for 500 orders and less than 850 NOK if there were 2000 orders.

Another weakness of the experiments where the picking speed was estimated is that they were performed on the same day in only one store. There are large differences from store to store, in both the size and the placement of the products. If the experiments had been performed in a smaller store, the distances between the products would have been shorter and the picking time would then be less, and vise versa with a bigger store. In addition, the numbers of traditional customers change from day to day and the time of the day. Typically, there are more customer shopping grocery the days before the weekend (Thursday and Friday) than the days after a weekend (Monday and Tuesday), and there are more customers in the evening than in the middle of the day. The experiments in this study were conducted on Friday at 1 PM. If they had been performed later that day, the picking time would have been longer because the store would have been busier due to more customers in the store. Thus, in order to get better estimates of the picking times, more experiments could have been performed and these should have been performed on different days and at a different time of the day.

5.2 About the uncertainties of the assumptions and the effect of them

There are uncertainties associated to the assumptions. The assumptions can be close to reality, far from reality, or somewhere in between. If the assumptions are far from reality, changing one or more of the assumptions could result in completely different results of the analysis. This is hopefully not the case in this study, as the assumptions are made as realistically as possible based on how the actual market is. Thus, the possible errors in the assumptions are hopefully not too large. Even if the assumptions have some errors, these errors might not affect the overall result of this study very much. In the following small changes in some of the assumptions will be discussed and given a short analysis.

If the assumption of average order size is wrong and changes, the estimated time to perform the picking operations also will change. In this study, we found that the store-based model created the highest profit for all of the four different delivery methods. If the order size increases, the picking operations would only become more efficient and making the store-based model even more competitive to the warehouse-based model. If the order size decrease, on the other hand, the cost per order will increase more in the store-based model compared to the warehouse-based model. However, the probability that the order size decreases is lower than that the probability that the order size decreases as orders with few products is more costly for the customers than orders with more products considering that the delivering costs are constant. Many customer are not willing to, for instance, pay 80 NOK for home delivery of only 5 products. Thus, changing the ordering size, will most likely not change the conclusion on which of the models that give the highest profit.

Changes to the costs associated with cars, warehouses, pick-up locations, delivery boxes, and labor will also affect the profitability of the models. For instance, if the payment per hour increase from 150 to 180 NOK each hour used of labor would become 30 NOK more expensive. The biggest change with an increase in payment would be that the difference between the store-based and warehouse-based models will become smaller since the total labor time are shorter when the operations are performed in a warehouse.

Further, not all the factors affect all the models. For example, it is only the unattended model that have delivery boxes. Thus, if the costs of these boxes are higher is it only the profit in the unattended models that will change. Similar, if the costs of having a warehouse increase, is it only the warehouse-based model that would be affected, and if the costs of the pick-up location were larger it will only affect the outside pick-up models. If one of these factors change it would have a larger impact on the total result compared to a change in a factor that affects all the models like the labor cost. In addition, for the factors like the cost of a warehouse and the pick-up location cost are the more difficult to make a realistic assumption as there are many factors that affects these results. For example, the costs of operating a warehouse depends on the size, level of taxes in the region, amount of used electricity, and so on. Therefore, the results in the store-based models are probably more realistic than the warehouse-based models, and the attended and inside pick-up locations models that are probably the closest to the reality out of the different delivery models. Further, the assumptions in-store model is the least uncertain assumptions because there are few factors that affect the total time of the operations in this model since the company would not need to perform deliveries.

The common factor for all the potential changes in the assumptions regarding the costs is that they all have a small impact of the total result. Thus, several factors are required to make a significant change in the conclusion of the most profitable model. It should also be mentioned that these factors need to change in the same direction to not reset the effect of each other. For instance, if the labor costs becomes higher and the cost associated with a car becomes lower the change in the total costs will not be as high as if they both increase.

So far, we have looked at possible changes in the assumptions at the costs side, but there could also be changes at the income side. Since there are fewer factors that affect the income compared to the costs, a change in one of the income factors has the potential to result in a large change of the total profitability. For instance, if the average price of the orders were 10 NOK higher the income would increase with 5 000 NOK for 500 orders, and four times as much for 2000 orders. Further, it the profit margin was 3 percent instead of 2 percent, this would make a total difference of 3 000 NOK for 500 orders.

There are many weaknesses with the analysis since many assumptions were required, but we have seen that a change in some factors not necessarily create a big change in the overall results. In addition, most of the factors are based on the actual situation in the market that exist in the region of Stavanger, which strength the reliability of the results of the analysis.

6. Conclusion

Throughout this study, we have looked at different ways to process and deliver an e-grocery service, including the time, cost, and income of each model. Now it is time to point out the most important observations in relation to the research objective, which were to i*nvestigate models that can make an e-grocery company profitable.*

We have seen that the operations needed to process and deliver orders are more efficient in a warehouse compare to in a store since they can organize the products in a better way. Because the stores need to ensure that the store functions optimally also for traditional customers, the stores have limitations to the layout of shelves and the placements of products that needs to be considered. In addition, the picking operations in the store-based models may be affected by the traditional customers in the store, and the time to perform the operations are more uncertain compared to the warehouse-based models. Regardless of this, the costs of operating a warehouse-based model are higher than the cost of operating a store-based model because of the fixed costs associated to having a warehouse. In addition, the warehouse-based model has higher advertisements costs of getting the same number of customers as in the store-based model. Thus, the store-based model is the model that gives the highest profit.

Further, we have seen that the companies need to find a way to do more with less to become profitable. The demand for the company is uncertain because customers to some extent are unpredictable. The advantages of the store-based models are that they can better utilize the capacity in periods with low demand since they can use existing buildings and workforce. Workers can switch between operations needed to run the online services and the traditional store. Therefore, the potential risk of paying for labor that is not used is less in this model.

Furthermore, we have seen that the most essential factor when deciding which model to use is the customer preferences. Most of the customers would choose the home delivery models because the pick-up location models do not give them a lot better deal than doing the shopping themselves. Thus, if the company is going to gain customers and make money is it probably the attended or unattended delivering model they should choose. The disadvantages with the unattended model are that it require more regular customers than the attended model since the costs of the delivery boxes are fixed and that the company would need one box each customer if it the boxes are installed in the customer's yards. Thus, the attended model is probably the best model considering the uncertain numbers of customers and fluctuations in the market.

The difficult part of this study is that this is a complex market that has a lot of factors that affects every model. As mentioned previously, many assumptions hade to be made to do perform the calculations of the profit. Thus, it is difficult to say exactly which model that is the best in the long run, but the most logic choice based on the result of the analysis and discussion would be to use the store-based picking model since it has the lowest costs and the attended delivery model since this is the model that most customers probably prefer. In addition, it was the store-based attended model that gave the highest profit of them all.

For future research, it would have been interesting to investigate new possibilities in the market. For instance, it is possible to do a combination of the store-based and warehouse-based model. The required operations to process the orders could be done in the warehouse to the stores, and then transport the readily packed orders to the stores along with the other products the store orders to the traditional customers. It could have been interesting to see if they then could save time on the picking operations. In such a combined model, there will be no extra costs of building a warehouse closer to the customers. This solution will, of course, require longer lead-time if the stores ordering systems remain the same, but it is possible to change this. If it is possible to make such a combined model work, there is a possibility that the companies can earn even more than with the models that are investigated in this study.

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Appendix 1 – Shopping list from experiment

List 1 – 5 products:

1. Cucumber
2. Bread
3. Meat farce – 400 G
4. Milk – 1 liter
5. Cheese – 500 G

List 2 – 10 products:

1. Potato – 2 KG
2. Bell pepper
3. Egg – 12 pieces
4. Cold cut ham – 100 G
5. Chicken
6. Butter – 500 G
7. Milk – 1 liter
8. Orange juice – 1 liter
9. Toilet paper
10. Chips

List 3 – 15 products:

1. Salad
2. Carrot
3. Broccoli
4. Bread
5. Sugar
6. Bacon
7. Pork
8. Cold cut ham
9. Butter
10. Apple juice
11. Yogurt
12. Pasta
13. Frozen fish
14. Fanta
15. Hand soap

List 4 – 20 products

1. Tomato
2. Pepper
3. Salad
4. Bread rolls
5. Egg – 12 pieces
6. Fish cakes
7. Meat farce – 400 G
8. Mayonnaise
9. Cold cut ham
10. Butter
11. Milk
12. Apple juice
13. Rice
14. Pepper sauce
15. France fries
16. Frozen pizza
17. Detergent
18. Flour
19. Sugar
20. Chocolate

List 5 – 25 products

1. Strawberry
2. Potato
3. Pepper
4. Carrot
5. Rutabaga
6. Bread
7. Egg
8. Bacon
9. Ready-made pizza dough
10. Ready-made pizza sauce
11. Meat force
12. Milk
13. Orange juice
14. Cheese
15. Yogurt
16. Flour
17. Baking paper
18. Corn

19. Nacho chips
20. baby food
21. Fanta
22. Hand soup
23. Toilet paper
24. Shampoo
25. Chocolate

List 6 – 30 products

1. Salad
2. Pepper
3. Cucumber
4. Tomato
5. Broccoli
6. Bread
7. Bread rolls
8. Sausages
9. Chops
10. Cold cut ham
11. Steak
12. Butter
13. Milk
14. Orange juice
15. Baby food
16. Nan bread
17. Fanta
18. Pepper sauce
19. Pasta
20. Flour
21. Sugar
22. Baking paper
23. Cat food
24. Detergent
25. Dish brush
26. Chocolate
27. Chips
28. Shampoo
29. Hand soap
30. Toothpaste